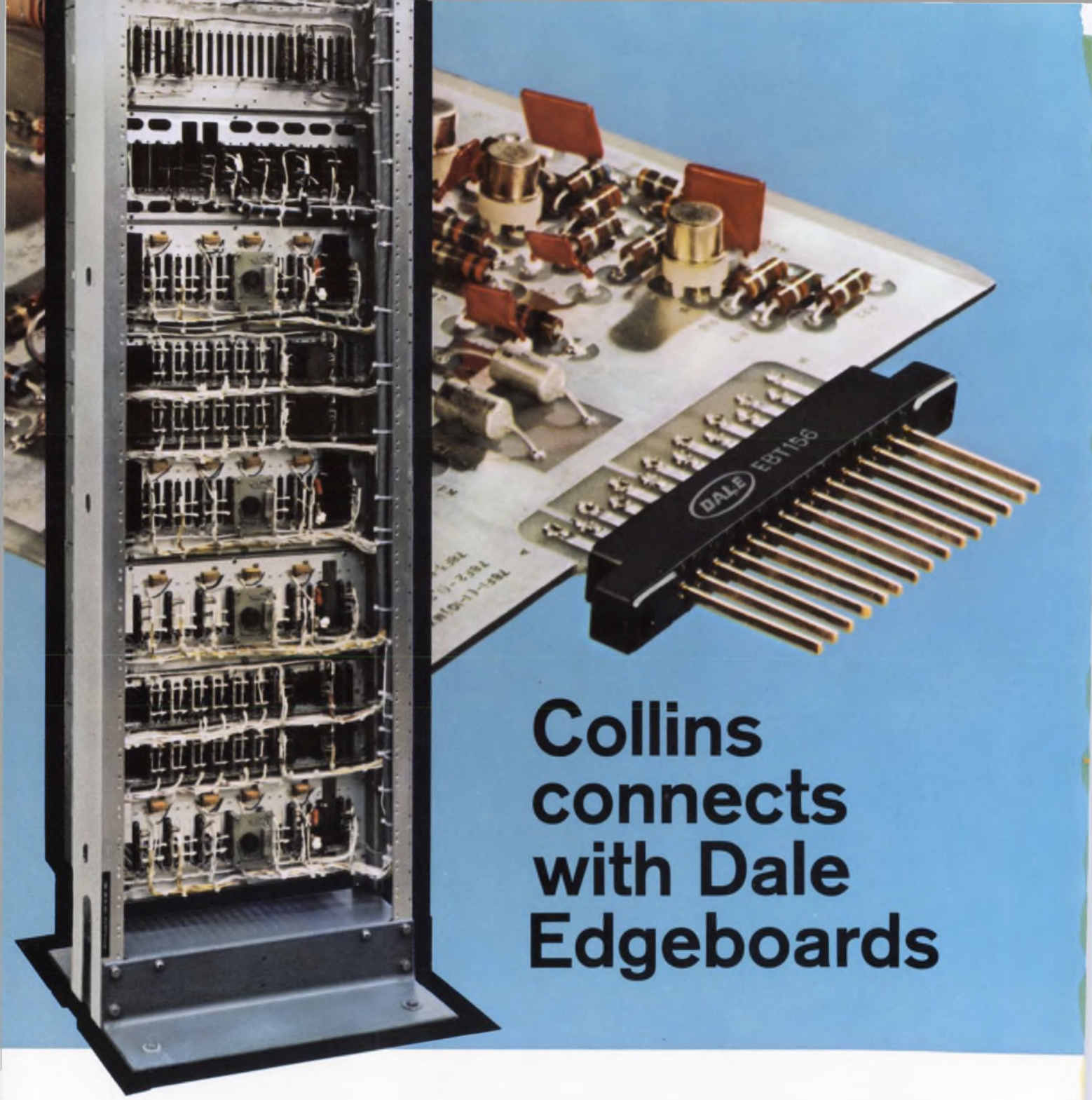
VOL. 18 NO. 11

Electronic Design

FOR ENGINEERS AND ENGINEERING MANAGERS

MAY 24, 1970

Electronics is invading sports. From scuba diving to ski racing, engineers are rolling up points. But their biggest gains are in computer-operated scoreboards. The giant animated displays of these megabuck marvels have thousands of incandescent lamps that pose stringent problems in solid-state control. See page 36.



Collins connects with Dale Edgeboards

Here's a better .156" edgeboard. Proven in dozens of applications—including Collins' high performance MX-106 Radio Carrier System shown here. Specify the EBT 156 for single readout 1/16" card applications where you must blend low cost with worry-free performance. Special protected entry aligns and straightens board before contact is made. Prevents contact damage and makes it easier to handle out-of-tolerance boards. Withstands 250 insertion/removal cycles... <1 μsec. discontinuity during vibration and shock tests per MIL-C-21097B. Dale's EBT 156 is available in six models—8 to 22 contacts. Wirewrap, eyelet or dip solder terminals. Need higher densities? Check Dale's .050" *Thinline* series. They're both in our complete new catalog.

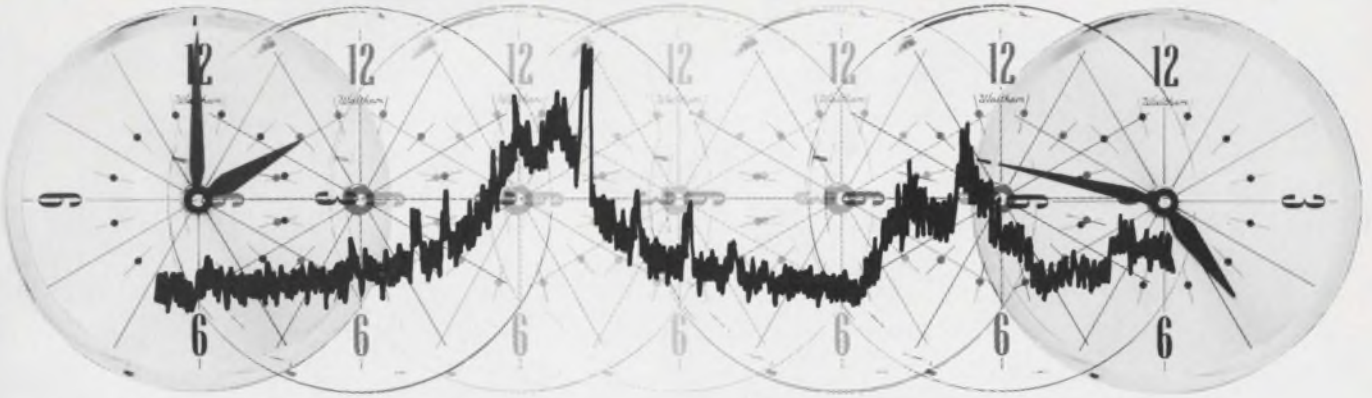
PHONE 605—665-9301 OR WRITE TODAY!

DALE®

DALE ELECTRONICS, INC.
Box 180, Yankton, South Dakota 57078 *A subsidiary of The Lionel Corporation*

VSMF

INFORMATION RETRIEVAL NUMBER 232



A wave analyzer with a 10,000-second sweep time? Why?

090/6

...because, in low-frequency spectrum analysis work, you need to use a narrow-bandwidth window. The narrower the window you use, the slower you must sweep it across the frequency range to be analyzed. And the slower you sweep, the smaller a frequency range you can cover in any given time. Thus, until now, your choice has been either accuracy or range but not both.

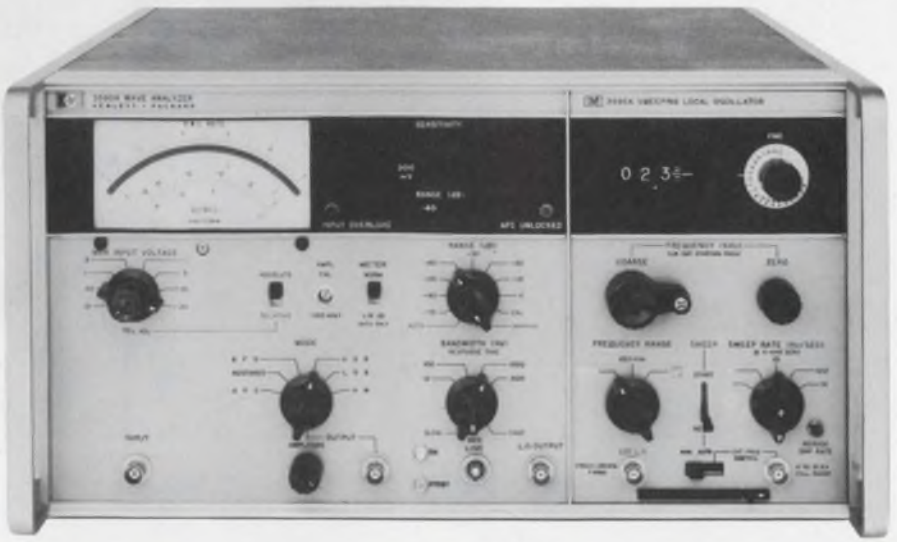
The new HP 3590A/3595A system solves that dilemma. The HP 3595A plug-in is a sweeping local oscillator with 10,000 seconds of sweep time available. By using it with the HP 3590A Wave Analyzer mainframe, you can scan the entire three-decade audio frequency range at 2 Hz per second, in one sweep. And, by adding an HP X-Y recorder, you can see the results on a single 11 x 17-inch graph.

In addition to extended sweep time, the 3590A/3595A combination also gives you a choice of five sweep rates (from 1 Hz to 1,000 Hz per second) and four filter bandwidths (from 10 Hz to 3,100 Hz), an 85 dB dynamic range over either of two frequency ranges (20 Hz to 62 kHz and 200 Hz to 620 kHz), 3 μV to 30 V sensitivity, and built-in autoranging for ease of operation.

The result is a systems-analysis tool ideally suited for work in the lower frequency ranges, with the capability to work in higher frequency ranges as well!

The 3590A Wave Analyzer mainframe is $3200; the new 3595A plug-in with the 10,000-second sweep time is $1250. Other plug-ins available for the 3590A are: the 3592A slave and program unit, for use with a second mainframe, $80; the 3593A with 3-digit mechanical display and 620-second maximum sweep time, $1100; and the 3594A with 5-digit electronic counter frequency display and 620-second maximum sweep time, $1600.

To get complete information on the HP 3590A and the various plug-ins, contact your local HP field engineer. Or, write to Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.



HEWLETT hp PACKARD

SIGNAL ANALYZERS

INFORMATION RETRIEVAL NUMBER 2

Allen-Bradley Type G variable resistors help seal Sylvania's rescue transceivers against

ocean dunkings

Built primarily for aiding in the location and recovery of downed airmen, Sylvania's emergency rescue transceiver must be reliable under extremely adverse conditions. It is lightweight and compact enough to be carried in the pocket of a flight jacket. It must withstand impact and immersion in salt water without damage.

Essential to meeting these requirements is Allen-Bradley's Type G variable resistor. It's rugged. It's compact. And it provides the necessary seal against water. This particular Type G has two "O" rings—one between the bushing and shaft, and one between the bushing and mounting panel. This dual seal prevents water entering the enclosure, as well as the control.

The Type G variable resistor features the Allen-Bradley solid, hot-molded resistance track. It gives long life—less than 10% resistance change after 50,000 complete cycles. The noise level is extremely low, and the smooth adjustment provides virtually infinite resolution. Low inductance permits operation across a broad frequency spectrum.

For complete details and immediate delivery on this ½-inch diameter Type G ½-watt variable resistor, call your authorized A-B industrial electronics distributor. Or write: Marketing Dept., Electronics Div., Allen-Bradley Co., 1201 South Second Street, Milwaukee, Wis. 53204. Export Office: 1293 Broad St., Bloomfield, N. J., U.S.A. 07003. In Canada: Allen-Bradley Canada Limited.

Type G variable resistor shown actual size

Sylvania AN/PRC-90 dual channel rescue transceiver permits two-way voice communication, the transmission of Morse code or the sending of a homing beacon.

A-B ALLEN-BRADLEY
QUALITY ELECTRONIC COMPONENTS

 EC69-11A

VOL. 18 NO.

Electronic Design 11

FOR ENGINEERS AND ENGINEERING MANAGERS

MAY 24, 1970

NEWS

TECHNOLOGY

PRODUCTS

Departments

Cover: Electronic scoreboard in the San Diego Municipal Stadium designed by the Cubic Corp., San Diego.

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. 81,801 copies this issue.

Decimals: Autopoint and scientific notation.

Automatic entry of e and π.

Ten directly addressable storage registers

Programming: Up to 128 steps. Conditional branching and automatic entry of programs with card reader.

Model 1655. Size: 13″ x 13½″ x 6½″.

Announcing an important breakthrough for engineers and scientists. Calculators based on the latest MOS/LSI technology. In both printing and display models. Available in over 350 cities coast to coast. Supported by more than 3,300

Dynamic range: 10^{-99} to 10^{+99}

Automatic special functions:
a^x, Log_{10}/Log_e, SIN/COS,
SIN^{-1}/COS^{-1}, $\times!$, $\frac{1}{x}$,
Radians to Degrees,
Single key Σx, Σx^2, N,
Rectangular to Polar Conversion.

Just plug in
and put it to work.

Weight: Twelve pounds.

sales and service technicians. Monroe men who know everything there is to know about calculators. Because calculators are our only business. That's how we got our name. Monroe. The Calculator Company

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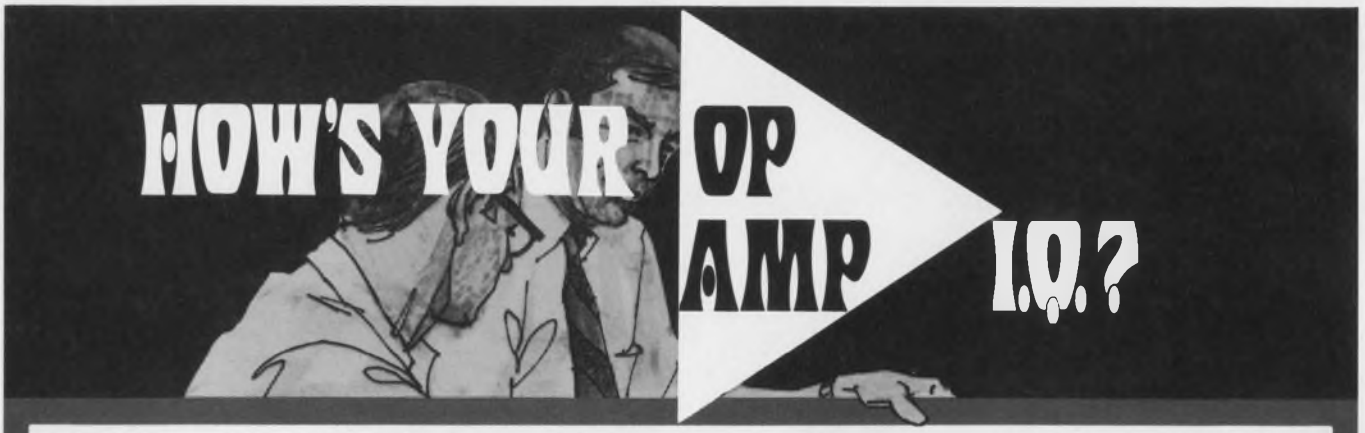
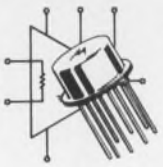
550 Central Avenue, Orange, New Jersey 07050

INFORMATION RETRIEVAL NUMBER 4

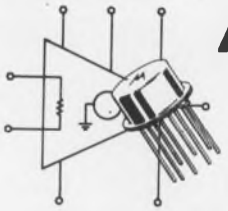


Q. When you need a high-performance operational amplifier that combines low input current and high slew rate, and is **internally compensated,** *what's your first choice?*



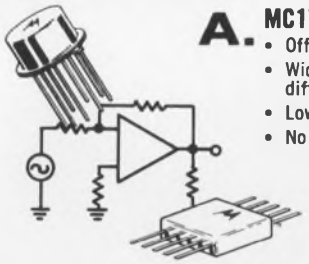
A. MC1556G
- 2.0 nA (max) input offset current.
- 15.0 nA (max) input bias current.
- 4.0 mV (max) input offset voltage.
- 40 kHz (typ) Power Bandwidth
- 2.5V/μS (typ)[UnityGain]slew rate

Q. When your design calls for an op amp with maximum slew-rate capability plus other high-performance characteristics; and, a hermetic package at a realistic cost, *what would you choose?*

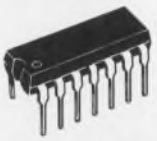


A. MC1539/MC1439G
- Slew Rate — 34 V/μS (typ) at A_V = 100
- Class AB output for excellent linearity.
- 20V p-p output swing at 10 kHz (min).
- 2.0 mV (typ) input offset voltage.

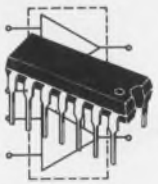
Q. What's the best all-around, internally-compensated, general-purpose op amp available today? *Hint: Same pin configuration as the MC1709.*



A. MC1741/MC1741C
- Offset voltage-null capability.
- Wide common-mode and differential voltage ranges.
- Low-power consumption.
- No latch-up problems.

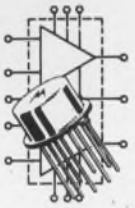


Q. For optimum economy — where high gain is required with excellent stability — *what's your ideal op amp choice?*



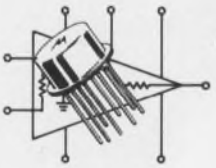
A. MC1437
- Two op amps on one chip (Dual MC1709) — for very little more than the cost of one.
- High-performance open-loop gain.
- Low temperature drift.

Q. Suppose you want to avoid cascading packages and have some rather severe economic restrictions in addition to high-performance specifications. Obviously, a dual op amp is the answer. *What's your best bet?*



A. The NEW MC1558G/MC1458G
- Internal frequency compensation.
- Short-Circuit protection.
- Dual MC1741
- Only $4.50 (100-up) MC1458 G

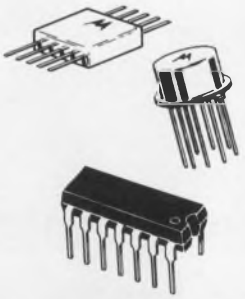
Q. What is the "industry-standard", general-purpose op amp? Probably, *the one that has been specified more often than any other.*



A. MC1709/MC1709C
- 150 ohms (typ) output impedance.
- Large output-voltage swing.
- Low Temperature drift.
- High open-loop gain.

Q. If none of these op amps fit your specific application, *what do you do next?*

A. Select one of the others from Motorola's "broadest of all" op amp lineup:



MC1520
differential output/wide bandwidth
MC1530/1430
uncompensated
MC1531/1431
low input currents
MC1533/1433
V_{IO} adjustable
MC1535/1435
Dual Op Amp
MC1712
Wide Bandwidth

If you scored 100%, it's probable that you are already benefitting from Motorola's wide range of op amp types. If not, you should write for our Application Selector Guide — to P.O. Box 20912, Phoenix, Arizona 85036.

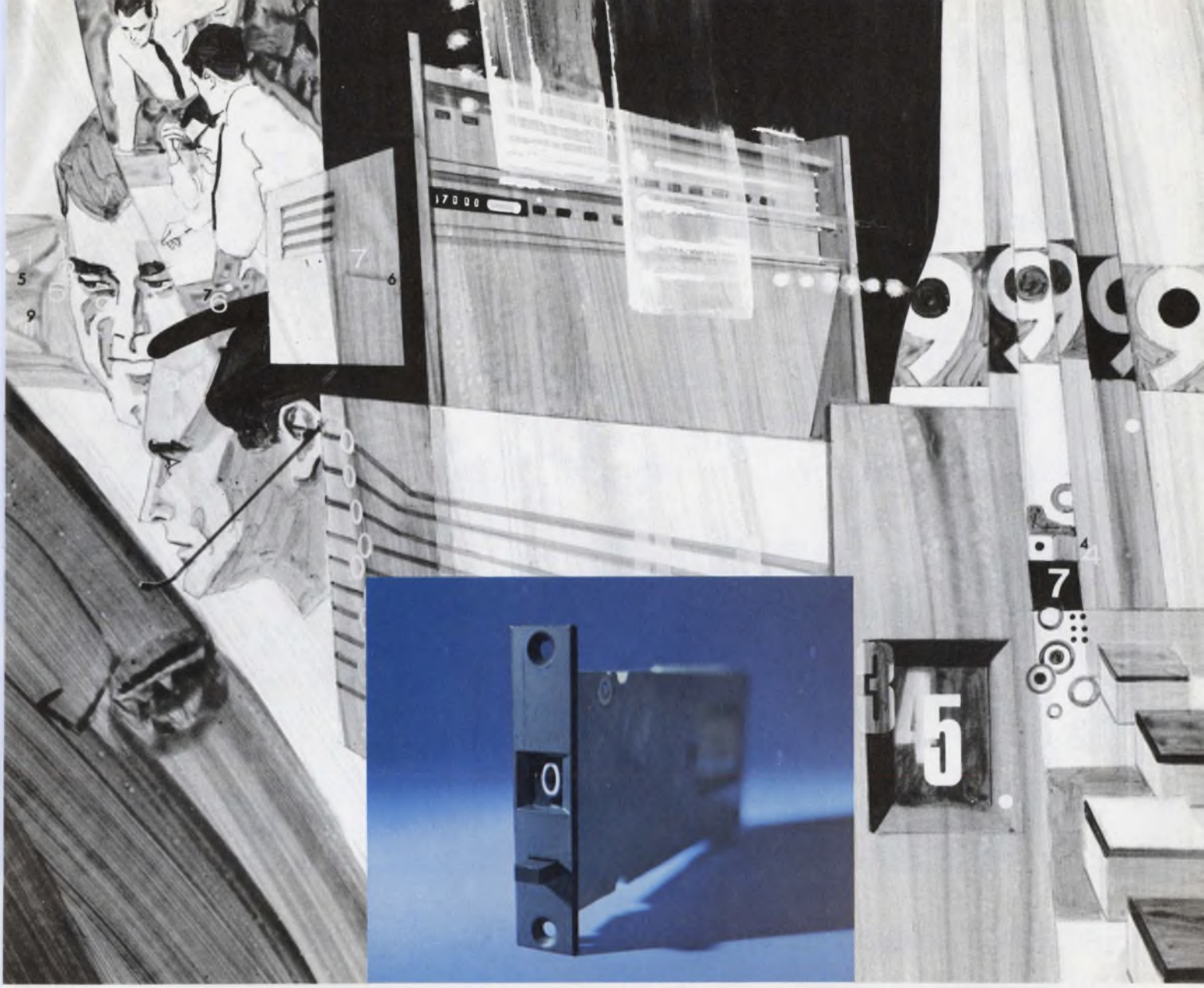
We may ask more questions, later!

—where the priceless ingredient is care!

MOTOROLA
INTEGRATED CIRCUITS

INFORMATION RETRIEVAL NUMBER 5

INFORMATION RETRIEVAL NUMBER 6 ►



the decade and its capability

1969. Application of the versatile Veeder Decade is limited only by the designer's imagination, and . . .

you'll find that its tremendous flexibility produces ever-widening vistas of possibility. A module that's easily stacked into a compact, multi-digit counter package, the Decade is the ideal unit for high-speed count accumulation, storage and transfer in data processing, control equipment systems, and . . . well, about the only thing *we can't count* is the number of applications for this unique product. The Series 1969 is a single wheel electric counter with electric read-out (BCD or decimal), transfer and reset, and 2400 cpm speed. It combines large figure readability with narrow width for space economy. Another Decade model, the Series 7266, offers wheel configurations for recording time and counting dozens and denominations of money. The 1969 is only one of the many performers in Veeder-Root's total capability lineup of counting, recording, and controlling instruments—mechanical, electrical, electronic. For information about our complete line, write: Veeder-Root, 70 Sargeant St., Hartford, Conn. 06102. (203) 527-7201.

VEEDER-ROOT

INNOVATORS IN NUMERICS: COUNTING/RECORDING/CONTROLLING

VR

Veeder-Root World-Wide: Argentina: Buenos Aires • Australia: Melbourne • Brazil: Sao Paulo • England: New Addington, Surrey • Scotland: Dundee • West Germany: Neuhausen/Filder • Canada: Toronto

GENERAL ELECTRIC

p.s.

PROBLEM SOLVERS

General Electric helps you solve the tough ones

GE has the broadest line of electronic components in the industry. From the tiniest integrated circuits to powerful high performance motors, GE components help you solve your tough problems . . . in design, in performance, in economy. Take a look at these GE problem solvers.

p.s.1 **General Electric delivers 19 new epoxy TO-18 transistors for demanding applications.** GE's encapsulated devices are performance-proved, reliable. And they cost less than metal-case devices.

The new epoxy transistors include PNP types, PNP/NPN complementary pairs, and low level amplifiers. They offer breakdown voltages as high as 60V with excellent beta linearity and dissipate up to 500 mW. They handle collector currents up to 1 amp. Get spec sheets on GE's new epoxy transistor lineup. Circle number 211.

p.s.2 **GE meter relays put accurate dependability into critical new medical systems.** A new heartbeat monitor, for instance, uses GE meter relays to indicate the heart beat visually. And they have the added capability to sound an alarm when preset limits are reached.

Either the easy-reading BIG LOOK® or the low profile HORIZON LINE® styles feature solid state control for precise accuracy. Put GE dependability into your critical circuits. Circle 212 for details.

p.s.3 **Forget capacitor leakage problems with GE military-type tantalum wet slugs.** The special GE design incorporates a double elastomer seal that maintains performance even through the 35 temperature cycles required by MIL-C-3965E. And life tests show a capacitance change of less than 5% in 2000 hours operation.

GE wet slugs come in 4 case sizes for applications up to 125 volts dc; 1.7 to 1200 μf. GE's 20 years experience is your assurance of dependability. For complete information, circle 213.

p.s.4 **GE Microwave Circuit Modules save up to 60% in size and weight** for critical communications and radar systems. GE MCM's may be used as oscillators, amplifiers, multipliers, detectors, mixers, integrated isolators and circulators. And they are extremely stable even in adverse environments.

The GE C-2003E, for example, is used in pulsed transponder applications. It operates dependably from —54 to +125C and withstands vibrations at 15G from 20 to 500 Hz. Frequency stability is ±3MHz with minimum life of 500 hours operation. Get GE's MCM catalog. Circle 214.

p.s.5 **New magnetic material gives 6% increase in residual flux density . . . resists demagnetization.** GE's new Alnico 8C was developed for applications requiring high resistance to demagnetization plus a higher flux output than other Alnico 8 alloys.

Alnico 8C is the latest development in GE's complete line of Alnico permanent magnets. It's another example of the technical expertise you get when you specify General Electric to solve your magnet problems. For details on the entire GE Alnico family circle 215.

p.s.6 **Get more capacitance in less space with GE computer-grade capacitors.** These aluminum electrolytic units deliver up to 540,000 μf at 5 VDC (34,000 μf at 100 volts) . . . highest capacitance per case size available. They are rated for continuous duty at 65C or at 85C

with the broadest line of electronic components

with proper voltage derating.

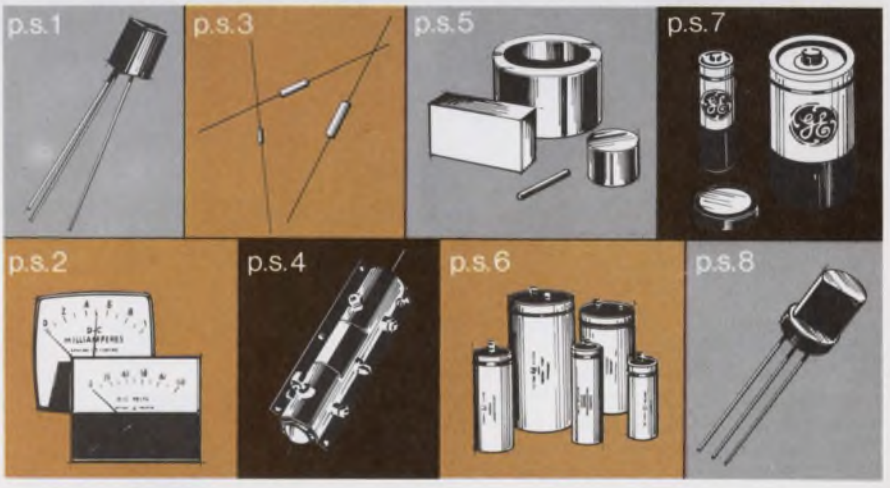
GE computer grades feature high ripple current capability with low equivalent series resistance. Nine case sizes are available. Circle 216.

p.s.7 Rechargeable GE nickel-cadmium batteries give you longer operating life. Proved GE reliability puts longer battery power into your application at an economical price.

Nominal ratings range from 0.1 amp-hours to 4.0 amp-hours in sealed cells and up to 160 amp-hours in vented types at the one-hour rate. Put dependable GE power in your circuit. Circle reader card number 217.

p.s.8 Programmable UJT lets you control the key parameters with just two resistors. That's right. You control η, R_{BB}, I_P and I_V so that you design your own unijunction *as you design the circuit.*

Low leakage and peak point currents make GE's D13T programmable UJT a natural for long interval timers. High breakdown voltages, fast trigger pulsing and low voltage operation add versatility. And the plastic TO-98 case helps solve economy problems. Get full details. Circle number 218.

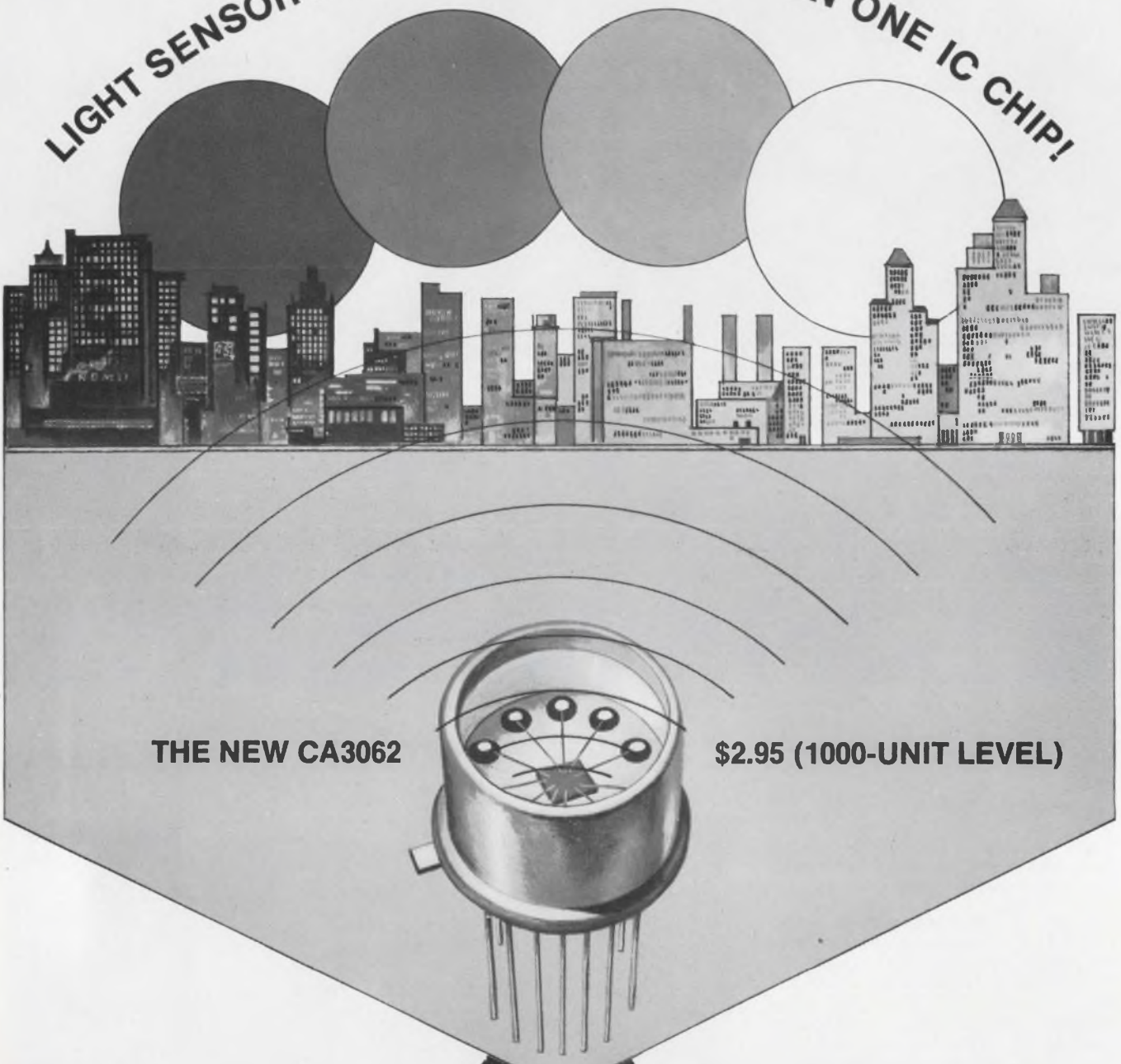


Let General Electric help solve your component problems. Call your nearest Electronic Components Sales Operation Office. Or check with one of the many authorized GE distributors. P.S. Problems? General Electric has solutions. 285-64

GENERAL ELECTRIC

INTRODUCING NEW RCA SUPERSWITCH:

LIGHT SENSOR AND POWER AMPLIFIER ON ONE IC CHIP!

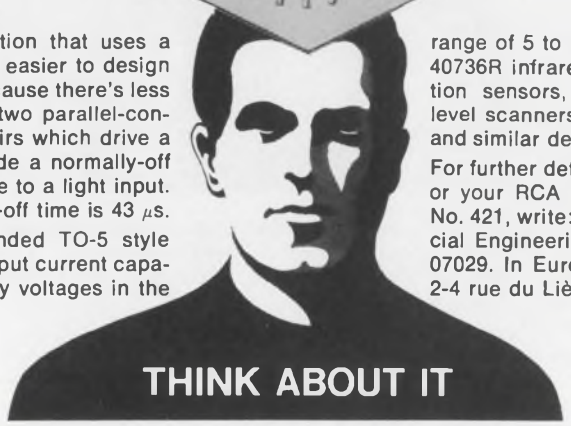


THE NEW CA3062 **$2.95 (1000-UNIT LEVEL)**

Choose any medium-speed application that uses a light sensor. You'll find the circuitry easier to design when you use the RCA-CA3062—because there's less to design. The CA3062 consists of two parallel-connected photosensitive Darlington pairs which drive a differential power amplifier to provide a normally-off and a normally-on output in response to a light input. Turn-on time is typically 38 μs. Turn-off time is 43 μs.

Available in a compact, window-ended TO-5 style package, the CA3062 has 100 mA output current capability, and can be operated at supply voltages in the range of 5 to 15 volts dc. It is compatible with RCA's 40736R infrared emitter. Use it for counter and position sensors, optical tachometers, limit detectors, level scanners, paper web sensors, wheel balancers, and similar devices.

For further details, see your local RCA Representative or your RCA Distributor. For technical bulletin, File No. 421, write: RCA Electronic Components, Commercial Engineering, Section E52-2/CA26, Harrison, N. J. 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.



RCA Integrated Circuits

INFORMATION RETRIEVAL NUMBER 8

INFORMATION RETRIEVAL NUMBER 9 ►

Heads: You win.

Tails: You win again.

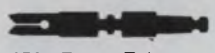
Elco rack-and-panel connectors give you a better head start.

And a choice of tails.

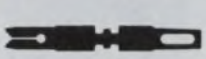
The head start is the connecting end of an Elco connector: the patented Varicon™ contact that fully meets the requirements of MIL-E-5400. The four mating surfaces of this unique contact are coined to an exceptional hardness and wipe clean with each make. Once the contacts are joined, the inherent springiness of the gold/nickel-plated phosphor bronze and the fork-like design make a superior, gas-tight fit.

Because the contacts are free floating, they align perfectly. A few contacts or 100 or more, all fit precisely together every time, over a long service life. There's no contact chatter. Nobody else gives you a contact head quite like the Varicon.

And nobody else gives you the choice of tails you get with Varicon. You can wire-wrap, crimp, clip, stake, or solder them. Whatever terminating technique or combination of techniques your assembly lines are set up for, we'll furnish the appropriate tail. If staking or crimping is your style, we can supply the equipment too. Manual or automatic. Purchase or lease.

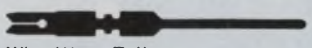


.078" Taper Tab

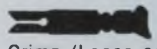


Solder/.098" Taper Tab

Wire Wrap Tail
.024" x .050" x .567"



Wire Wrap Tail
.024" x .050" x .760"



Crimp (Loose contact)

Elco rack-and-panel connectors come in standard rectangular models, or as miniature connectors, or in modular units. You can have them with 2 Varicon contacts, or up to 140, or anything in between.

In short, our line of Varicon rack-and-panel connectors has a lot going for it. Except price. Though it's a precision component, the Varicon contact is easily produced in high speed progressive dies. There's no expensive machining, no waste. When you can turn out millions of Varicons a week, you don't have to charge a fortune for them.

There's a lot more to be told about Varicon connectors. It's all in our 28-page rack-and-panel connector guide, and we'll be happy to send you a copy. Just write, wire, call, or TWX us.

Elco Corporation, Willow Grove, Pa. 19090.
(215) 659-7000.
TWX 510-665-5573.

ELCO Rack-and-Panel Connectors

Symbolic electronic signal undistorted by EMI—
photographed by Howard Sochurek

When you want radar as pure and coherent as a laser beam...

bring ERIE in early.

31,000 feet...heavy traffic...ugly weather over the Plains. This isn't the time for "noise" in the radar. But, no sweat! RCA's exciting new AVQ-30X Weather Radar is up front, sweeping the sky...protected from EMI by 39 special ERIE filters. No other airborne radar has ever approached the single or dual system reliability of the AVQ-30. From the start, RCA has called on the outstanding research and component capability of ERIE TECHNOLOGICAL to help in the development of this great new unit. Proof, once again, that it pays to bring ERIE in early.

ERIE TECHNOLOGICAL PRODUCTS, INC.
644 West 12th Street, Erie, Pennsylvania 16512
(814) 456-8592

INFORMATION RETRIEVAL NUMBER 10

Designer's Calendar

JUNE 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				

For further information on meetings, use Information Retrieval Card.

June 24-26
Joint Automatic Control Conference (Atlanta, Ga.) Sponsors: IEEE, et al. D. Lyons, Dept. of Textile Science, Clemson Univ., Clemson, S. C. 29631.

CIRCLE NO. 447

June 28-July 1
Consumer Electronics Show (New York City). Sponsor: Electronic Industries Association. Jack Wayman, EIA, Consumer Products Div., 2001 Eye St., N. W., Washington, D. C. 20006.

CIRCLE NO. 448

JULY 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	

July 14-16
International Electromagnetic Compatibility Symposium (Anaheim, Calif.) Sponsor: IEEE. Jim Senn, Lectro Magnetics, Inc., 6056 W. Jefferson Blvd., Los Angeles, Calif. 90016.

CIRCLE NO. 449

July 21-23
Conference on Nuclear & Space Radiation Effects (San Diego, Calif.) Sponsor: IEEE. Richard Thatcher, Battelle Memorial Inst., 505 King Ave., Columbus, Ohio 43201.

CIRCLE NO. 450


GOULD 4800
GOULD 4800

This is the fastest printer around.

It also produces both alphanumerics and graphics.

And printout is 132 columns wide on an 11 x 8-1/2 format! The practical continuous speed of the standard line printer is 600 lines per minute. But the new Gould 4800-II will deliver 4800 lines per minute. And it'll produce both alphanumerics and graphics — simultaneously — directly from any source of digital input as data transmission by telemetry, radio microwave, and/or land line.

There's a new character generator, too. With an ultimate capability of three 128 character fonts with dot matrices up to 15 x 15.* And because it has a 132 character buffer, you don't have to burden your computer's memory banks. The input control lines are built-in, too. Which makes it comparatively simple to interface the 4800 with almost any computer you have in mind.

The 4800 provides programmed control for a variety of output forms . . . line and letter spacing, paragraphing, columns and so forth. Plus a convenient capability to translate bit mode input into generalized graphics.

But speed and versatility are just part of our story. Because it's electrostatic, the 4800 is infinitely quieter than line printers. Because it has fewer moving parts, it's more reliable. And because it's a lot simpler, it's priced well below printers that can't come close to the performance.

So there you have it: the Gould 4800 electrostatic hardcopy printer. Isn't it time we talked? Graphics Division, Gould Inc., 3631 Perkins Avenue, Cleveland, Ohio 44114.

*Supplied standard with unit: One 64 character font with 5 x 7 dot matrix.

GOULD **CLEVITE**

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

INFORMATION RETRIEVAL NUMBER 12

A significant advance in silicon rectifier power handling capacity

3 new series of silicon rectifiers from Tung-Sol permit designers to meet extremely high power requirements.

- **Reverse voltage ratings to 5000 Volts**
- **Average forward current to 500 Amperes**
- **Surge overload ratings up to 8500 Amperes**

Controlled avalanche characteristics provide transient handling capability that results in increased reliability.

All units feature ceramic-to-metal seals, mount in any position and are supplied in either polarity.

1511 SERIES
Max. av. forward current at 120° C—420 Amperes
Surge overload rating, 1 cycle—6000 Amperes
Controlled Avalanche Voltage—1250-3500 Volts

1621 SERIES
Max. av. forward current at 120° C—500 Amperes
Surge overload rating, 1 cycle—8500 Amperes
Controlled Avalanche Voltage—1100-2300 Volts

1611 SERIES
Max. av. forward current at 120° C—470 Amperes
Surge overload rating, 1 cycle—5200 Amperes
Controlled Avalanche Voltage—2600-5000 Volts

Write for technical data bulletins—
Tung-Sol Division, Wagner Electric Corporation
630 West Mt. Pleasant Ave., Livingston, N.J. 07039
Twx: 710-994-4865 • Phone: (201) 992-1100; (212) 732-5426

TUNG-SOL
High Power Silicon Rectifiers

Trademark TUNG-SOL Reg. U. S. Pat. Off. and Marcas Registradas

INFORMATION RETRIEVAL NUMBER 13

We've just advanced the Q-meter 17 years.

For lab and production-line work, our new Model 4342A Q-meter measures Q faster and easier than its classic predecessor, HP's Boonton 260A.

It measures Q values from 5 to 1000 in a frequency range of 22 kHz to 70 MHz.

Automatic leveling of oscillator source eliminates need for Q-Multiplier controls.

Speedy GO/NO-GO selector reduces component testing time.

High impedance voltmeter virtually eliminates frequent zero reset.

New solid-state circuitry eliminates unreliable thermocouple.

Pushbutton controls give fast frequency and Q range switching.

All this means shorter measurement time and a big boost for high-volume testing and lab use.

It's versatile, too. You can detect extremely small changes in Q. Or measure coil, capacitor and resistor parameters. And the price? Just $1500.

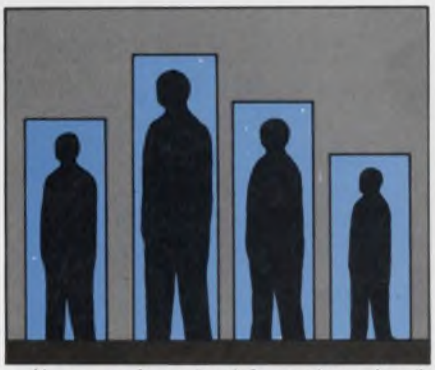
Okay. You want to measure up to peak production. Dial your nearby Hewlett-Packard field engineer. He'll give you all the specs on HP's newest Q-meter in 17 years. Or write: Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

IMPEDANCE INSTRUMENTS

18002

Highlighting
THE ISSUE



Are you bored with engineering?

Are you in favor of an engineering union?

Would you change your job title to match the work you do?

How much more money do you think you should be earning?

How much responsibility do you think your employer should assume for your continued education in technology?

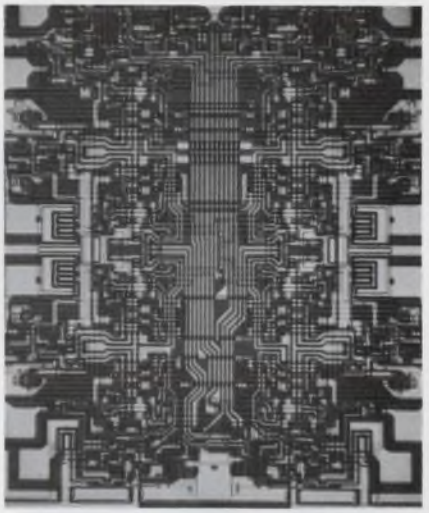
ELECTRONIC DESIGN has answers to these questions and many others as the result of a management survey conducted among a random sampling of 1000 of the magazine's subscribers.

Page 96

Electronic aids are infiltrating the world of sports—from spectator events like football and horse racing to field and stream activities like fishing and dog training. The most spectacular are the huge stadium scoreboards, ranging from a $600,000 computer-operated animated football scoreboard for the San Diego Municipal Stadium (see cover photo) to a new $4-million system now being installed at the Ontario (Calif.) Motor Speedway.

In addition, electronic timing systems have either completely taken over or are being used as backups in many sporting events.

Page 36



Two new monolithic arrays form a unique family of memory products known as content addressable memories (CAMs).

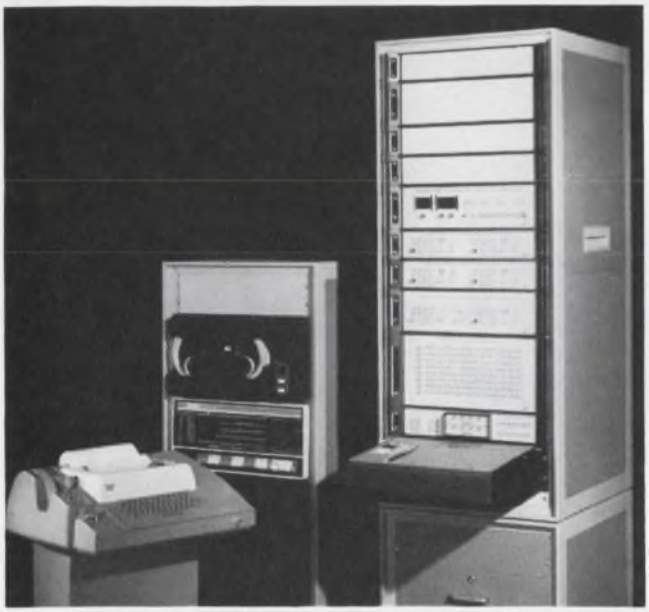
In content addressable memories data can be associated. That is any data placed at the input of the memory is matched against the memory's stored data. The memory responds with a match or mismatch answer.

With these two new CAMs, data can be written into them just like any other read-write memory and they then provide the association of input to stored data.

Page 117

Why Ragen Semiconductor tests C/MOS with a Teradyne J259

When you're testing complementary-MOS devices with two or three hundred transistors on a chip, you'd better be sure of your test equipment. Ragen Semiconductor, an acknowledged leader in C/MOS, has good reason to believe in its computer-operated test system: With thousands of C/MOS IC's tested and shipped, returns have been virtually nil.

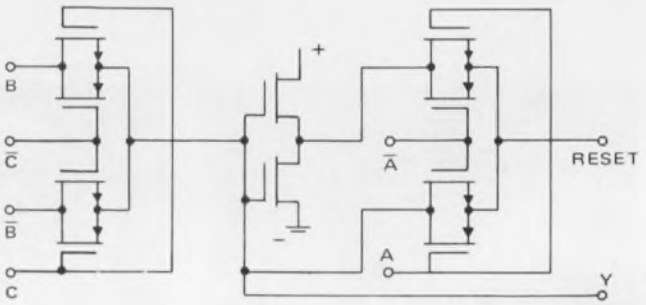


Ragen's test system? A Teradyne J259.

Ask Ragen President Al Medwin what he likes about his J259 and he may tell you that its high-impedance measurement system is perfect for the low-current measurements he has to make. Or he may tell you about the strong software Teradyne supplies with its systems. He may well mention speed because each Ragen device sees 450 parametric tests almost as soon as it's placed in the test socket.

He might also tell you some things the J259 *doesn't* do.

It doesn't force you to stop production once a week for recalibration adjustments.



It doesn't break down every time someone insults it. Ragen's J259 downtime has been less than *one percent.*

It doesn't leave you high and dry when your test load changes. When you expand, it expands, through the easy addition of multiplexers, magnetic-tape units, line printers, and all the software you need to go with them.

The J259 makes sense to Ragen Semiconductor. If you're in the business of testing circuits — integrated or otherwise — it makes sense to find out more about Teradyne computer-operated test systems. Just use the reader service card or write Teradyne, 183 Essex St., Boston, Mass. 02111.

Teradyne makes sense.

INFORMATION RETRIEVAL NUMBER 16

News Scope

Mini-machines and mini-firms marked this year's SJCC

Minicomputers, minicomputer peripherals, and graphic terminals were conspicuous among exhibits at the 1970 Spring Joint Computer Conference held in Atlantic City, May 5-7. Inexpensive digital cassette tape recorders and magnetic discs were also well represented.

Exhibitors, too, showed a trend to the small in size, according to David T. O'Brien, district manager of General Automation, Inc., Anaheim, Calif.

"The small people," he said, "gain credibility from attending shows. They can demonstrate to a dubious customer that they do, in fact, have working hardware available. The large companies have made their mark and their show expenditures are not returned in increased sales."

Some 360 exhibitors displayed computer hardware in 980 booths at Convention Hall. Among the missing were several manufacturers of large computers: CDC, XDS and Burroughs, for example. And software houses were not as heavily represented as in the past.

An informal survey of exhibitors showed that about 40% of those making inquiries at the booths were from upper levels of management or engineering management. About 20% were computer professionals —engineers and programmers. Fifteen to 20% were university affiliated, and some of the remainder were interested in investing opportunities.

The usual technical recruiting associated with trade shows was evident at the SJCC although at a much reduced rate. Two reasons for this were offered by Dick Wanamaker, who was managing the Career Center.

Wanamaker said, "The job seekers are not here in Atlantic City because it is relatively remote, and the jobs are not being offered by the employers." He added, "The market for computer professionals has only recently begun to soften. Large companies are now recruiting on a corporation-wide basis instead of the division basis in the past."

Wanamaker had another comment on today's applicants. He said, "They are waiting for agencies to call—they are not dropping in to look for jobs. They were spoiled by the booming demand for their skills in the past."

Some 27,000 attendees paid registration fees of $20 for sponsor AFIPS (American Federation of Information Processing Societies) members, and $40 for nonmembers. The previous $5 ticket for admission to exhibits only was not offered, thus making attendance comparisons to past joint computer conferences inconclusive.

Growing market seen for test equipment

The $260-million-a-year Government market for automatic test and checkout equipment will double by 1975, Frost & Sullivan predicts.

The New York market-research company also forecasts that noncomputerized systems for testing and checkout, now a $490-million-a-year Government market, will stay the same.

The biggest buys in automatic equipment will be to support aircraft, Frost & Sullivan reports. The B-1 manned strategic aircraft system will have a central, integrated test system as part of its avionics package. The Air Force's F-15 fighter plane will require from 15 to 20 field shops to maintain it, with $50-million worth of electronics in the shops.

The Army will buy automated equipment for the field to reduce personnel. The Navy, which also wants to reduce personnel, needs automated systems on board a ship —not only electronic equipment but everything that operates.

Eventually, the Frost & Sullivan report says, built-in test equipment will monitor each subsystem so it can be repaired with redundant components when something breaks down. The built-in equipment represents only 5% of the market now, but is expected to build up substantially by 1980. Built-in monitoring units for the space agency are expected sooner.

The findings, presented in a 175-page report, are available for $245 a copy from Frost & Sullivan, 106 Fulton St., New York City.

New ceramic promises to be useful in devices

Practical devices made of ferroelectric ceramics may soon be available, according to two technical papers, presented at last month's meeting of the American Ceramic Society in Philadelphia.

The peculiar electro-optic properties of ferro-electric ceramics have been studied for several years, but their application to specific devices, such as information storage and display systems, has been limited by materials problems.

An improved electro-optic ceramic material—lead lanthanum zirconate titanate (PLZT)—discovered at Sandia Laboratories, Albuquerque, N.M., was described at the Philadelphia meeting by a Sandia researcher, Cecil E. Land.

The ceramic differs from earlier materials in that it is more transparent, producing black-white contrasts of as much as 1000-to-1 and a complete range of colors.

In optical ferro-electric ceramics, voltage is applied across a portion of the plate to establish an electrical polarization vector and align (pole) minute dipoles within the material along this vector. Polarized light directed at the plate is modified as it passes through the ceramic, the degree of modification varying according to the wavelength of the light. The ceramic therefore separates colors much like a prism.

These optical effects remain even

after the electrical field is removed, giving the material a true "memory" capability. The image display may also be viewed directly or projected like a photographic slide.

The second paper, by A. H. Meitzler of Bell Telephone Laboratories, Murray Hill, N.J., described a number of experimental image-storage and display devices using fine-grain ferro-electric ceramics. Thin plates of lead zirconate-lead titanate in combination with transparent conductive and photoconductive films, are used to form device structures capable of storing high-contrast images under the control of electrical voltages.

Meitzler said that experimental devices had demonstrated a resolution of about 50 lines/mm in 50 μm thick ceramic material and had been able to hold the image with no apparent change for several months.

Motorola optimistic about MOS and ECL

"One-half of the ICs used in 1975 will be either MOS memory or ECL devices," according to Milton Laflen, group manager of digital IC product marketing for Motorola Semiconductor Products, Inc.

Speaking at a Motorola seminar on digital ICs, the Phoenix engineer said that emitter-coupled logic would be attractive to designers because of its high speed, while complementary MOS would offer low-power operation. Laflen saw the TTL market continuing to grow until 1972 or 1973, when he expects it to level off at high continued usage.

Another Motorola expert, Michael Callahan, agreed that MOS and ECL were headed for major growth. Callahan, who is operations manager for IC research and development in Phoenix, said that any semiconductor concern that wanted to be a leader would have to be involved in at least nine technologies. He listed them as follows: complementary MOS, silicon-gate technology, high-frequency bipolar circuits, multilayer metalization, beam-leaded chips, beam-lead laminates, computer-aided design, radiation hardening, and fusible-link ROMs.

Callahan said that future MOS products would have to be low-threshold circuits to be successful. Complementary MOS will give very low quiescent power dissipation, a feature much appreciated by designers, the researcher said, and the silicon-gate technology will yield smaller devices, lower Miller-effect capacitance and higher frequency of operation.

"Multilayer metal will be invaluable in random logic," Callahan said, "where interconnection layout problems are most difficult." And computer aids will be mandatory. "Any vendor that is not willing to invest in CAD will not be in a leadership position in the semiconductor industry of the future," he said.

Callahan predicted that fusible-link ROMs—which are programmed easily by the customer—would offer an easy way around the problem of system design errors. "System designers often make errors," he said, "and are faced with a three-month wait for new ROMs if a mask change is neecssary. The new programmable ROMs will make changes in memory programming easy."

And, surprisingly, the IC R&D expert saw a good future for the old RTL logic. "Motorola will introduce new RTL products in 1970," he said.

Laser radar to pinpoint details of moon's surface

Accurate mapping of the moon's topology from a spacecraft will be possible for the first time with a pulsed ruby-laser radar altimeter that measures altitude to within 6.6 feet at 60 nautical miles. The laser transmitter produces a 10-ns, 2-MW peak value. The system, being designed by RCA Aerospace Systems Burlington, Mass., under a $1.7 million NASA contract, is a special version of RCA's AN/GVS-1 portable Army range finder.

Measurements of the moon's surface using the new altimeter will be made from the orbiting Apollo 16 command and service module.

British urged to merge computer software firms

Within a few years, the expenditure in Britain on software will be twice that of hardware, according to Dr. Ernest Davies, Joint Parliamentary Secretary to Britain's Ministry of Technology.

In addressing the Computer Services and Bureaux Association in London last month, Davies stated that the computer software industry "could be strengthened by some grouping together of software houses to create more viable organizations."

The Ministry of Technology has been responsible for implementing a number of mergers of British firms over the past three years.

Last year in Britain the cost of software was $72 million while the hardware was worth $77 million.

Canon and TI develop LSI pocket calculator

A battery-powered calculator, appropriately called "Pocketronic," has been unveiled by Canon, Inc. Aimed for the mass consumer market, the calculator evolved from a joint development program between Canon and Texas Instruments. MOS/LSI helped achieve the small size—4 by 8-3/16 by 1-15/16 inches. The unit weighs 1.8 pounds.

The calculator will be available for sale in Japan later this year, and in the U. S. in January, 1971. Initially, prices are expected to be under $400, with production starting at 10,000 units per month. Eventually, it is rumored, the price may drop to $100.

The Pocketronic performs a full range of addition, subtraction, multiplication, division, credit balance and other manipulations of numbers as large as 12 digits.

All calculations are performed by three LSI chips built by TI. Total logic complexity for the three chips is 371 gates (with an average of 4.2 inputs per gate), 203 shift-register bits, and 10 flip-flops. A paper tape is used to provide the readout for the calculator.

Introducing Potter & Brumfield's unique

dual thin-line dry reed relays

An entirely new magnetic structure makes possible an exceptionally low seated height of only 0.275 inch for high density board packaging. Circuit boards employing JDT relays may be spaced on 0.5 inch centers.

This design minimizes magnetic flux dispersion, resulting in a very efficient magnetic circuit. This decreases coil power requirements and often permits direct operation of JDT relays in low-power semi-conductor logic circuits. An interfacing amplifier may be eliminated in many applications.

Terminals are similar to those on IC packages, permitting spot testing on either side of a circuit board. The dual in-line terminals on 0.1 inch centers simplify circuit board design. The reed switches are rated at 10 watts maximum resistive (50V or 0.5A DC maximum) switching.

A solid state time delay circuit may be incorporated in this small package. Or a Darlington amplifier can be included to compensate for low current applications. However, the number of available poles for switching is reduced by the addition of either of these circuits.

The JDT is completely encapsulated in epoxy, giving protection against environmental contamination. The Series is presently available in many combinations of Forms of A, B and C.

■■■

Get full information today by calling your local P&B representative or call direct to Potter & Brumfield Division of American Machine & Foundry Company, Princeton, Indiana. 812-385-5251.

Mounted height is only 0.275"

Power requirements: only 75mw per pole

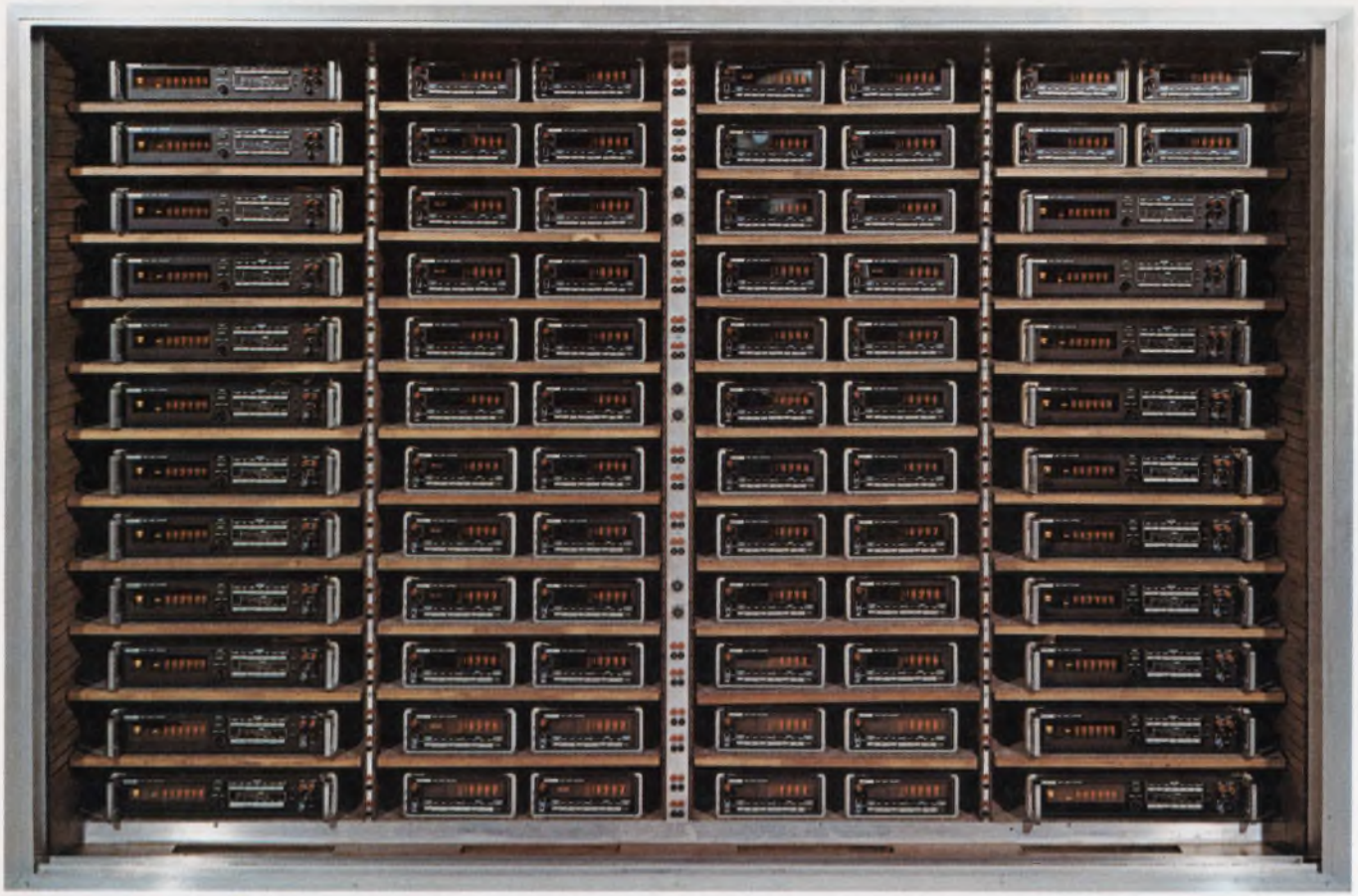
Combinations of Forms A, B and C are available

Single Lot Prices:

JDT 4000 Series (4-pole) $ 7.65
JDT 8000 Series (8-pole) $12.95
Quantity discounts apply.

AMF | POTTER & BRUMFIELD

Check 15



The seven day glitch killer

Every seven days we put another run of new Fluke digital voltmeters in the Fluke "hot box." Here, by continuously cycling the input voltage and "baking in" the instrument at 122°F, we catch the glitches and bugs caused by long term operation in a hot environment.

The "seven day glitch killer" is, of course, only one of the many check-out steps we go through. We control the critical parts by manufacturing all of our own resistors and printed circuit boards and by 100 percent dynamic testing of all active components.

Further, the new Fluke DVM's are designed from the ground up to give you long trouble-free life, low maintenance, and outstanding technical performance. For instance, the Model 8300A has only one-fifth as many components as comparable DVM's. And it's built to work in an 80 percent relative humidity.

In other words, the glitches go before you get the instrument. Another typical Fluke trick.

Model 8100A 0.02% Digital Multimeter with complete portability for only $695.

Model 8300A Digital Voltmeter with total built-in systems capability for only $1295.

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Fluke, Box 7428, Seattle, Washington 98133. Phone: (206) 774-2211. TWX: 910-449-2850/In Europe, address Fluke Nederland (N.V.), P.O. Box 5053, Tilburg, Holland. Phone: (04250) 70130. Telex: 884-50237/In the U.K., address Fluke International Corp., Garnett Close, Watford, WD2 4TT. Phone: Watford, 27769. Telex: 934583.

INFORMATION RETRIEVAL NUMBER 17

Invisible, corner-turning IR detects thieves

Solid-state laser system employs repeaters to ring an industrial area with a beam–for miles, if needed

Jim McDermott
East Coast Editor

Infrared-laser repeaters that can project an invisible beam around a corner and spot a burglar before he gets to work are making it highly unlikely that industrial crime will pay.

The solid-state repeaters—unique combinations of laser receivers/transmitters—are the main elements in a new security system that can wrap a protective beam around a building for miles.

Unlike most laser systems, precise alignment of the transmitter with the receiver is not critical. Also, the beam energy is low enough to be safe for the human eye—less than 10^{-7} joules/cm^2.

Interruption of the beam at any point sends a coded signal to a monitor station, locating the point where the beam was intercepted.

The transmitters in the system, developed by Holobeam, Inc., Paramus, N.J., use a gallium arsenide (GaAs) laser diode, driven by 30-A, 150-nsec pulses at a 30-Hz rate and radiating in the invisible region at 9050 Å. For maximum sensitivity, the receivers use a silicon photodiode that peaks close to the same wavelength.

For a typical fence system (Fig. 1), a master transmitter is placed at some control point, such as a factory gate. From here, the beam is projected along the fence to the receiver of the first repeater.

The receiver amplifies the pulsed signal and applies it to the repeater transmitter, sending it out at the same power level as from the master transmitter. The beam is thus passed on from repeater to repeater to the master receiver.

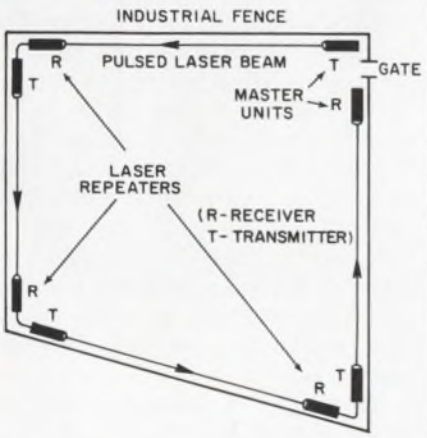
The output of the receiver is passed on to a master alarm and display panel, which, upon interruption of the beam, gives an audible or visual alarm and also indicates the interrupted repeater.

The most sensitive system spans 50,000 feet reliably in clear weather. There are also 5000-foot and 500-foot systems. Under heavy fog conditions, the capability of all systems is reduced.

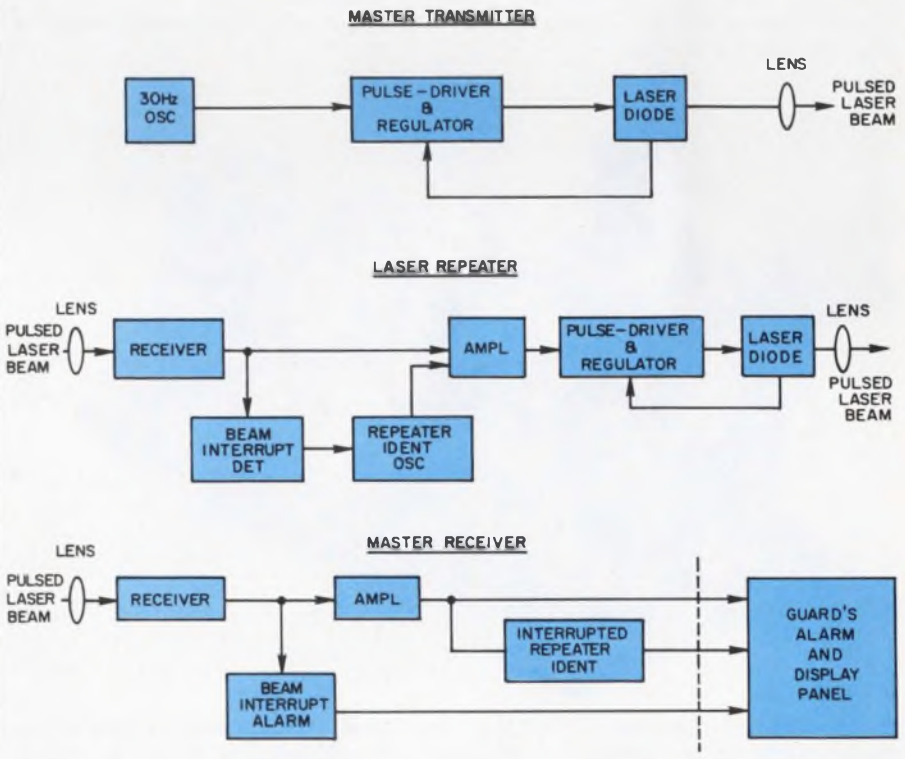
Brief interruptions of the beam caused by birds or leaves do not trigger the alarm, since the laser pulse rate has been specifically chosen to minimize this. In addition the master receiver signals an alarm only after a preset number of pulses have not been received.

If the beam is interrupted ahead of any receiver, a beam-interrupt detector triggers a local repeater-identification oscillator, which then sends pulses through the remainder of the system at a rate unique to that station. These pulses are decoded by logic that indicates where the interruption has occurred.

The system developed originally for the military, maintains a constant transmitter diode power output from −30° to 130° F through regulation of the laser-diode drive. This is accomplished by feeding back a signal from a subminiature thermistor, mounted on the diode, to the driver-regulator (Fig. 2).■■



1. **Transmitters and receivers** of the IR security system are small units—only a few inches long.



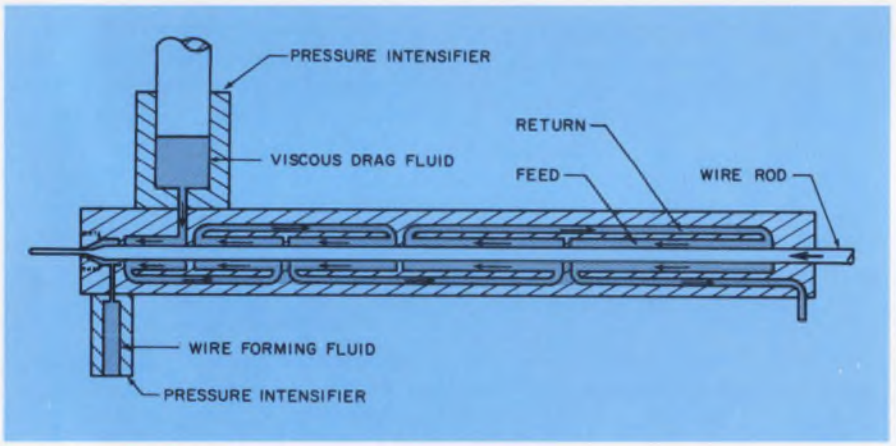
2. **Attenuation of the laser beam is overcome** in each repeater by amplifying the received signal and projecting the new transmitted beam at the original system level. Receivers and transmitters are separate units.

Process squeezes out wire like toothpaste

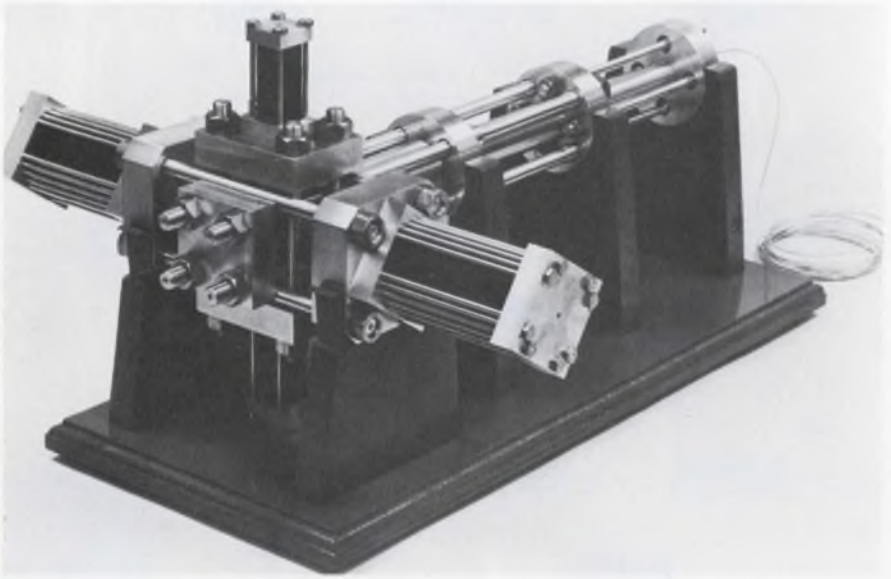
The first major change in wire making since jewelers in ancient Egypt began drawing gold wire through drilled stones is reported by Western Electric's Engineering Research Center in Princeton, N.J.

Instead of drawing the wire, as has been done for nearly 4000 years, the new process squeezes it out like toothpaste. Fluid under high pressure does the squeezing.

Known as continuous hydrostatic extrusion, the new process is said to offer a number of advantages over conventional wire drawing techniques. These include lower equipment costs, cheaper maintenance, greatly reduced space and power requirements, less wire breakage and reduced labor. There are also indications that wire made by hydrostatic extrusion is stronger than drawn wire of the same gauge, according to Western Electric researcher, Frank Fuchs, Jr.



A viscous fluid, such as beeswax, drags the wire rod through the chamber in the direction of the die. There, another fluid under very high pressure reduces the wire rod's diameter.



Scale model of continuous hydrostatic extrusion machine will be able to extrude aluminum wire at up to 4000 feet-per-minute in sizes as small as 0.02 inch (24 gauge). The actual machine being built by Western Electric will be about 14 feet long. Wire rod will be continuously fed into the rear of the machine (right) and will emerge from its front end (left) as wire.

Fuchs notes that engineers have been intrigued with the idea of using the process to manufacture wire for many years, but until now, nobody knew how to feed wire into a high-pressure chamber on a continuous basis.

Western Electric researchers, headed by Fuchs, solved the problem by "viscous drag feeding"—a method of using a fluid to force wire rod through the high-pressure chamber and out of the die. A fluid, such as warm beeswax, is pumped through the chamber in the direction of the die. Under high pressure, this fluid becomes sufficiently sticky to adhere to the rod and drag it along.

Another fluid is pumped into one end of the chamber under very high pressure to reduce the wire rod's diameter in the "die." Strictly speaking, Fuchs notes, this is not actually a die, since it serves only as a shaped container for the high pressure fluid. There is no metal-to-metal contact as there would be in a true die.

A prototype production machine incorporating all of these features is presently being designed and built by Western Electric for installation in their Atlanta, Ga., facility by the end of the year. The machine is designed to produce aluminum wire at speeds up to 4000 feet-per-minute in sizes as small as 0.02 inch (2 gauge).

Fuchs says that only one pass through a single "die" will be required, regardless of the size of wire being made. Conventional wire making, he notes, requires drawing the wire through as many as 24 dies in tandem on two different machines.

Although the process will initially be restricted to the manufacture of aluminum wire, it is ultimately expected to be used in the production of copper wire as well. ■■

BOURNS
bridges the generation gap in...

PANEL CONTROLS

...with CERMET

Bourns introduces a new generation of Panel Controls with cermet resistance elements for top performance in high-grade commercial, industrial and RV4, RV5, RV6 type applications.

The hang-up of the hot molded carbon element control (that's the older generation) is it weakens, can't stand the heat.

Bourns found a way to cool it . . . with cermet!

What you get is stability, a better temperature coefficient, a higher power rating in a smaller package.

One ½" and two ¾" diameter units constitute the basic model line which covers all RV4, RV5 and RV6 type applications. Their profiles are the thinnest in the industry. All models show excellent high frequency characteristics, extremely low noise and good setability.

COST? Less than a dollar for Model 3859 in production quantities. Then subtract the price of rejections, complaints and delays common with the older generation. Delivery is off the shelf.

Turn on with Bourns. Send for Data Packet on cermet Panel Controls or call your local Bourns sales office for a sample.

Model 3862, ½" dia., ¼" standard or locking bushing with or without panel seal, 1 watt at 125°C. **Model 3852,** ¾" dia., standard or locking bushing — ¼" with or without panel seal for Mil Spec type uses, ⅜" for industry; 2 watts at 70°C. **Model 3859,** ¾" dia., ⅜" tough plastic bushing; also snap-in version; 2 watts at 70°C.

BOURNS

BOURNS, INC., TRIMPOT PRODUCTS DIVISION • 1200 COLUMBIA AVE., RIVERSIDE, CALIF. 92507

Coming: portable thermoelectric power

For a long time, the Army has been looking for a quiet, lightweight, high-endurance power source, so its troops on patrol can operate portable radar, communication, data-terminal and other equipment without telltale noise.

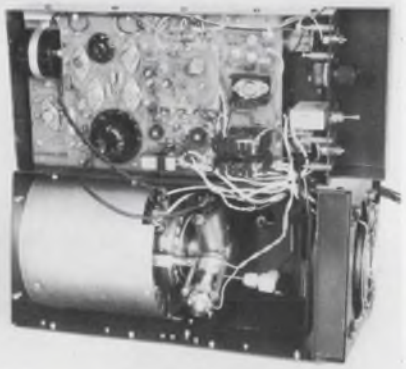
Now, with a few modifications, it may have just what it has been waiting for. A manpack thermoelectric generator—a developmental model, temporarily designated PP-6311—has been built by the Minnesota Mining and Manufacturing Co. in Saint Paul, under contract with the Electronic Components Laboratory, U. S. Army Electronics Command, Fort Monmouth, N. J.

The generator was described last week by two Army laboratory men—Joseph P. Angello and Stuart J. Shapiro—at the Power Sources Symposium at Fort Monmouth.

The manpack generator is only 12 inches high, 12 inches long and 5-1/2 inches wide. It weighs 15 pounds without fuel. And it operates 12 hours on one refueling.

Other points the Army likes:

- It starts easily—10 minutes after it's turned on, the system produces rated power.
- It has multi-fuel capability—diesel or jet fuels or combat gasoline can be used.



Manpack thermoelectric generator weighs 15 pounds. Top portion contains all electrical and electronic circuits for the power source. Bottom section contains the thermopile, burner, fuel, cooling systems and the battery (not visible).

- It operates quietly. The Army's goal of "inaudibility at 100 feet" hasn't been reached yet, but with more effort it will be, the two laboratory men say.

The generator produces power output by direct conversion of heat energy of the fuels to electrical energy. The process takes place within lead telluride thermoelectric couples that are contained in the thermopile. Heat is applied to one side of the thermopile by burning liquid fuel in a burner mantle. The other side of the thermopile is kept cool by forcing air, by means of a fan, across a row of heat-dissipating fins.

The fuel is fed to the burner from an internal tank by an electric pump. Fuel is conditioned for combustion by an ultrasonic atomizer.

The airflow necessary for combustion is supplied by a blower in the lower burner assembly.

Ignition is initiated with a glow coil, also in the lower burner assembly. The thermopile provides power for all accessory components as well as the external load.

To get the generator started, battery power is needed. But before three minutes have passed, the thermopile has sufficient power to support the operation alone.

More work on the generator is needed, the Army says. For example, heat from the combustion chamber is so intense it could ignite dry grass, or other flammable materials. Another problem is that the unit's 6-volt level is too low. The Army would like 24 to 28 volts dc, "to be consistent with Army equipment." ■■

Contactless magnetic counter has high accuracy

A magnetically settable counter that will produce any combination of precisely timed electrical pulses on command has been developed at Sandia Laboratories, Albuquerque, N.M.

The device is set without the need for electrical contacts and therefore is said to be more reliable and accurate than similar counters.

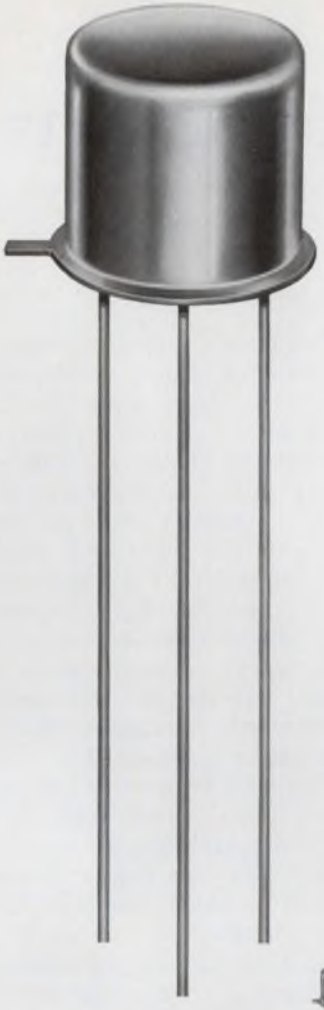
The output pulse combinations are set simply by moving a calibrated knob, which moves a magnetic coil, to various positions along a helical winding of nickel-iron wire. When voltage is applied to the coil, a magnetic reversal (domain) is stored in that particular part of the wire.

When the counter is set therefore, the nickel-iron wire contains one or more domains that may be arranged at linear or logarithmic intervals as binary numbers or as a predetermined code.

The counter's memory is "read" by activating a two-phase clock. The clock applies alternating electrical pulses to a series of paired conductive metal elements, which move the domains along the nickel-iron wire toward an output coil. The coil senses the arrival of each domain and produces an electrical output pulse.

The inventor of the device, Gordon R. Bachand, supervisor of Sandia's Advanced Test Instrumentation Development Div., says the number and complexity of pulses that can be stored by the counter is limited only by the length of magnetized wire.

Reliability and accuracy are high, he says, because there are no ohmic contacts, whose characteristics would change with time. ■■



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INFORMATION RETRIEVAL NUMBER 19

The 1971 watch: No hands, no moving parts

John F. Mason
News Editor

Press a button on your all-electronic, solid-state wristwatch, and the time appears on a face that looks like a miniature TV screen. An array of small dots, called the dot matrix, lights up to form the numbers for the hour and minutes.

By touching the button once, the wearer programs the hour and minutes to remain visible for 1 1/4 seconds. If pressure is maintained on the button, the hour and minutes disappear, and seconds appear and continue to count off time for as long as the button is depressed.

Release the button, and your wristwatch screen goes dark.

Prototype models of this watch without hands or moving parts have been developed jointly by the Hamilton Watch Co. of Lancaster, Pa., and Electro/Data, Inc., of Garland, Tex. Production units are scheduled to hit the market next year.

There's no problem about seeing the numbers in poor light. A built-in light sensory mechanism detects ambient light conditions and automatically adjusts the intensity of the dot matrix through four levels of brightness. On a sunny day the light is eight times brighter than when the time is displayed in a poorly lighted room.

Development of the watch was made possible by the recent availability of ICs that draw only 18 microwatts of power and a high-energy, rechargeable silver zinc battery.

Hamilton's research director, John M. Bergey, alluded to the need for ultra-low-power ICs and the high-energy battery in an interview earlier this year with ELECTRONIC DESIGN (see "Time Marches On—but Electronically Now," ED 7, April 1, 1970, p. 25).

Digital display in all-electronic watch that will sell for $1500.

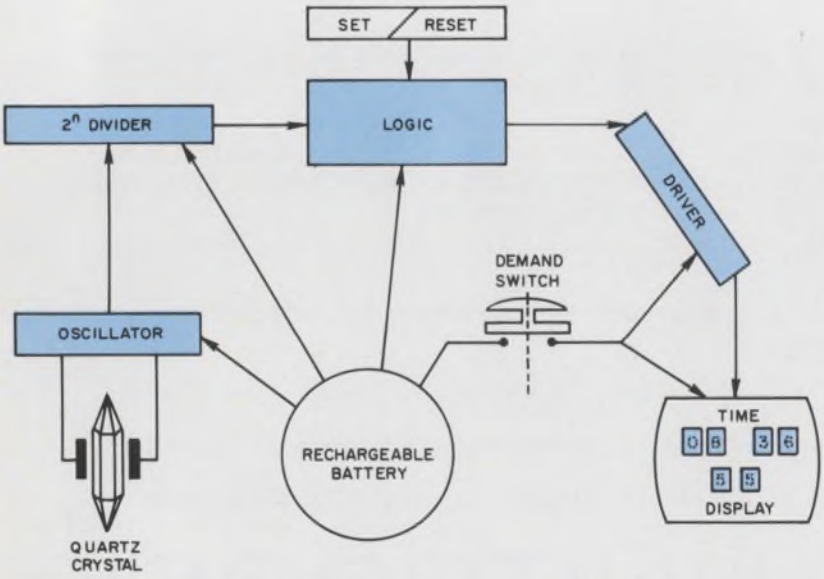
Hamilton will distribute the new wristwatch for $1500 retail.

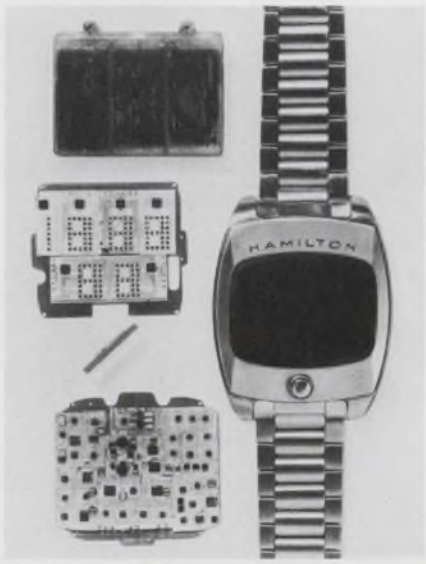
Logic circuitry used

Called Pulsar, the watch computes and displays time electronically utilizing computer logic circuitry and gallium arsenide phosphide light-emitting diodes. The unit consists of three major components: a time computer module with microminiature logic and display circuit substrates, a 3-cell, 4-1/2-V battery and a high-frequency, quartz crystal time base.

The operation begins with the battery stimulating the quartz crystal, which vibrates at precisely 32,768 cycles a second. The vibrations are then reduced to one pulse a second by a multi-stage, integrated circuit binary counter, which passes the pulses through the time computer module to time-display circuitry.

"The high rate of vibration, or frequency, is four times greater than in electro-mechanical quartz crystal watches and enables us to achieve an unprecedented degree of accuracy," says Bergey. "Units we've been wearing have not deviated more than three seconds a month."





The battery in this solid-state watch stimulates a quartz crystal, which passes pulses through the time-computer module to the time-display stations. Components in photo are (from top to bottom): the battery, the display side of the computer module, quartz crystal and the module's logic side.

So far only six of the wristwatches have been built.

"We not only had to create our own battery," Bergey says, "but to reduce it to operable size, we equipped it with a demand button, so that time would be displayed only on request."

This was done to conserve energy.

Supplying the power

The high-energy main battery, occupying 80% of the volume of the case, performs the dual functions of exciting the quartz crystal and maintaining the charge in a similar, internal sustaining battery —actually a capacitor—that continuously drives the logic circuitry of the computer module. The main battery is 1.035 by 1.4 by 0.196 inches. It operates for six months and can be recharged 50 times.

Spent batteries are replaced by unscrewing the back of the case and inserting a fully charged spare.

"No accuracy is lost during the exchange," explains George Thiess, president of Electro/Data. "We have equipped the timepiece with a second energy source, permanently located on the underside of the logic circuit, to supply sufficient power to operate it during this brief period."

The watch contains 44 complementary-symmetry, metal-oxide semiconductor (MOS) integrated circuits. The circuitry, equivalent to 3474 npn and pnp transistors, is thousands of times more conservative of power than the more conventional bipolar and noncomplementary MOS-ICs, says Hamilton's president, Richard J. Blakinger.

The logic circuitry consists of seven individual hybrid circuits on alumina oxide substrates 0.020-inch thick.

The ICs, the hybrid-circuit logic substrates, display substrates and all wiring are utrasonically bonded and mounted on separate gold-plated shim plates of 0.015-inch-thick beryllium-copper. The shim plates, with their circuitry, are screwed together back-to-back and constitute a fixed-program computer approximately 1/10-inch thick. The computer and its internal sustaining battery are potted in epoxy and cannot be jarred out of order, Hamilton says. ■■

Laser makes air visible to aircraft designers

Fog moving past model plane in a wind tunnel at 4000 mph is illuminated to reveal the turbulence

Strange things happen to air rushing past an aircraft at six times the speed of sound. To design aircraft to travel at such speeds, aerodynamic engineers have long needed to "see" the airflow and turbulence clearly.

To help them examine both, wind-tunnel operators have often introduced smoke and water vapor into the air-stream and illuminated the area around the model aircraft with high intensity lights while photographs were taken. The airflow becomes visible under these conditions because areas of low temperature contain more water particles, which in turn reflect light. Hotter areas contain less water particles and are therefore less visible.

Now, using essentially the same principle—but with the big addition of a laser—engineers are getting better results.

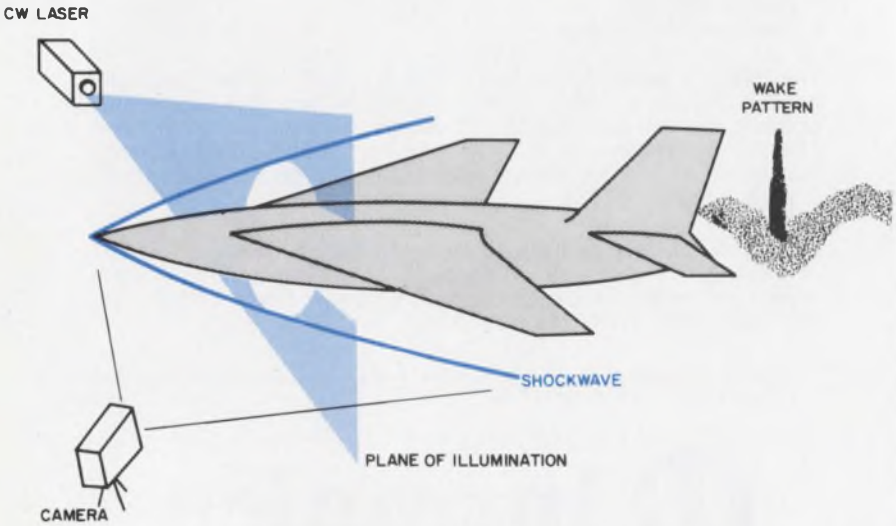
Laser illuminates moisture

A continuous-wave, helium-neon gas laser was installed on one side of a wind tunnel and a camera on the other. The laser illuminates the natural moisture in the air—which, when the air is pushed to speeds of 4000 mph, turns to fog—and the camera records the whole show.

The results with the laser are superior to those obtained with conventional lights, according to engineers at the Air Force Systems Command's Arnold Engineering Development Center at Tullahoma, Tenn. The work is being carried out by ARO, Inc., for the System Command's Flight Dynamics Laboratory, Wright-Patterson Air Force Base, Ohio.

The laser-painted picture has much more resolution than the one illuminated by the high intensity light, the test engineers say. And, by placing the laser on one side of the tunnel and the camera on the other, they are obtaining a better perspective.

"When the laser looks back at the model aircraft from an angle of less than 90 degrees and the camera on the opposite side does the same, you get an almost three-dimensional effect," one engineer notes.



Laser and camera collaborate to show aerodynamic engineers shock waves when wind rushes past a model aircraft at six times the speed of sound. The turbulence behind the tail structure here is so pronounced that it looks like a vertical steel rod emerging from a horizontal layer of smoke.

Portability a feature

The laser is also portable. It can be moved around to provide varying perspectives.

The laser was built by Spectra Physics, Inc., Mountain View, Calif. Using 15 milliwatts of power, it operates at 6328 Å. It is mounted on a swivel arrangement that permits it to beam through a verticle slit and across the test section, scanning the model from nose to tail.

Besides the laser tests, an oil-film technique is also used to study the flow of air over the surface of the model. This involves painting the model with viscous oil. As oil flows over the surface, the oil shapes itself to the airflow.

The oil stays in place even after the model is removed from the air stream. ■■

INFORMATION RETRIEVAL NUMBER 300 THRU 306 ►

Component and Circuit Design

IDEAS

FROM SYLVANIA

MICROWAVES

How microstrip designs solve microwave problems.

We've spent over four years in research and development to come up with some very interesting solutions to microwave miniaturization problems.

Our microwave people have spent a lot of time developing techniques for miniaturizing microwave circuitry. They have done microwave projects for both military and commercial applications and have the experience to turn your microwave project into a hybrid package that will fulfill your demands at minimum cost and in minimum size.

We have pioneered the development of beam-lead technology to give us a new and powerful technique for mounting semiconductor devices on microstrip circuitry. For example, we use Sylvania-developed low-noise, beam-lead silicon Schottky diodes in mixer applications, and we use beam-lead PIN diodes for many switch and phase-shifter applications. All of these devices meet the stringent military environmental specification.

To give you an example of our capability, we can list at least three microwave systems that have been developed around our hybrid microwave capability.

These developments include an integrated man-pack radar, an integrated K_u band transceiver and an integrated mixer assembly for a highly specialized application.

For the integrated man-pack radar system we developed a lightweight X-band system almost completely in hybrid integrated circuit form. The radar transmits a pseudo-random phase-coded CW signal. All functions of the radar, including

This issue in capsule

the low-frequency analog and digital circuitry, with the exception of a miniature coaxial avalanche oscillator and the antenna, are made in microstrip integrated form.

These units include an RF phase modulator, high speed RF switches, an oscillator that uses a Sylvania silicon avalanche diode, a balanced mixer using a beam-lead Schottky barrier diode, ferrite circulators and other passive transmission line components.

The hybrid integrated K_u band transceiver is in development under Air Force sponsorship (Contract No. 33616-67-C-1896). In this project we are developing techniques for integrating a large number of functional components on a single alumina substrate at 13.3 GHz. The system, designed to operate as a doppler navigator transceiver, includes: master oscillator using a varactor-tuned avalanche diode that is frequency-stabilized by an integrated phase discriminator; a cascade of avalanche diode power amplifiers producing 100 mW CW output at 13.3 GHz; a frequency shift-key modulator using beam-lead Schottky barrier diodes; T-R switch using beam-lead PIN diodes; a balanced mixer using beam-lead Schottky barrier diodes; and an IF amplifier having a 1.5 dB noise figure at 120 MHz. The third project that demonstrates Sylvania's capability in miniaturized microwave circuitry is an integrated mixer subassembly designed and developed for a highly specialized military application. The subassembly consists of a bandpass filter, 3 quarterwave contradirectional couplers, and four balanced mixers. All of the units are integrated on four alumina substrates. The individual substrates are interconnected with gold ribbons.

Design goals included minimum cross coupling between mixers, and packaging design that minimizes damage from shock and vibration. Semiconductor devices used in the subassembly include beam-lead Schottky diodes in the mixer circuits.

This integrated subsystem, specially packaged to withstand stringent environmental requirements, is now in volume production.

Among the other components that can be integrated by Sylvania into complex subsystems are limiters, detectors, circulators and isolators.

Circuits can be supplied unpackaged for assembly by the user, or can be packaged by Sylvania in rugged, hermetically sealed enclosures with coaxial connectors or other types of input-output connections.

If you have a microwave design problem, why not talk to our experienced microwave design engineers? You may be surprised at what they can do for you.

CIRCLE NUMBER 300

CRTs

Get high-speed printouts with these monoscopes.

Simple CRT system can generate over 30,000 characters per second from magnetic tape.

A monoscope is simply a cathode-ray tube which converts digitally coded information into video type signals. Because of this, it is a very valuable interface between computers and output display devices. And because we can tailor the target characteristics to the users' specifications, there is no problem in generating special symbols for chart, diagram and map displays as well as alphanumeric characters.

In its simplest form, a monoscope resembles a conventional CRT with electrostatic focus and deflection, with the exception that a solid metal disk replaces the phosphor screen. A typical monoscope of this type is shown in Fig. 1.

The metal disk has a surface which possesses good secondary emission characteristics. The alphanumeric characters or symbols are printed on the disk with a material having poor secondary emission characteristics.

When the electron beam scans a single character in a raster-like pattern, a video signal corresponding to the shape of the character is produced. An identical raster scans the display tube. The beam intensity of the display tube is modulated by the monoscope's video output and the character is produced on the phosphor screen. Used in this manner, the monoscope can produce up to 30,000 symbols per second.

The cathode of the monoscope is generally operated at 1200 to 1800 Volts below ground so that the anode can be run at or near ground potential. This simplifies the design of character selection circuitry from the information source.

A second type of monoscope is shown in Fig. 2. This type uses a stencil-type target where the characters have been chemically etched through the disk. The principle of operation is exactly the same as the first type described.

However, the stencil provides some advantages. Since the beam proceeds unhindered through the stencil openings, it can be displayed on a phosphor screen deposited on the face of the tube. This provides an easy means of visually checking what is being scanned and is very useful in setting up the tube for operation.

The third type of monoscope is shown in Fig. 3. It also makes use of a stencil target, but it is used in a different manner. In this case, surface condition of the stencil is not important. We only use that part of the raster that gets through the stencil and impinges on the front plate. This type of monoscope has many advantages. No target surface preparation is required. It can be mass produced at low cost.

A typical monoscope target format is shown in Fig. 4. An 8 x 8 matrix is fairly standard, but 8 x 12 or 10 x 10 formats can also be used to obtain both upper and lower case characters.

Targets can be custom-designed to meet your requirements and can be fitted to any of the three types of monoscope tubes. Some of the applications for these monoscopes include computer display, airline status boards, stock quotation boards, teaching machines, address label printers, command control center displays, or anywhere that a high-resolution electronic information readout system is required.

CIRCLE NUMBER 301

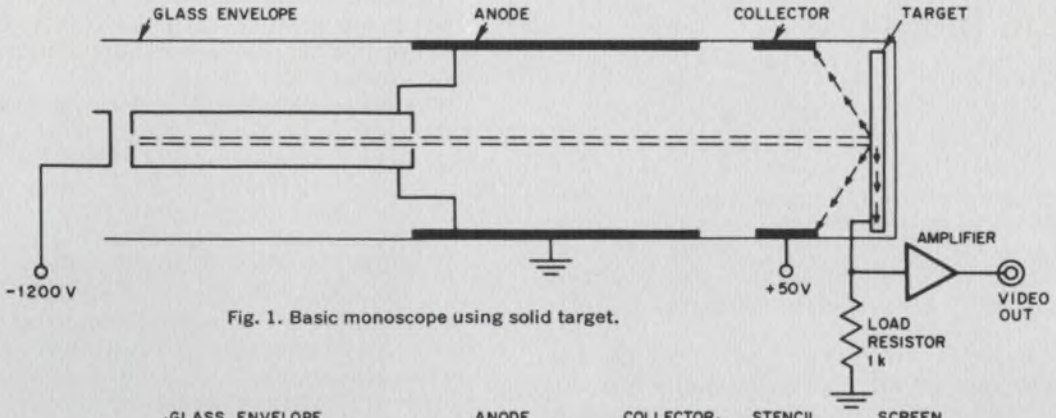


Fig. 1. Basic monoscope using solid target.

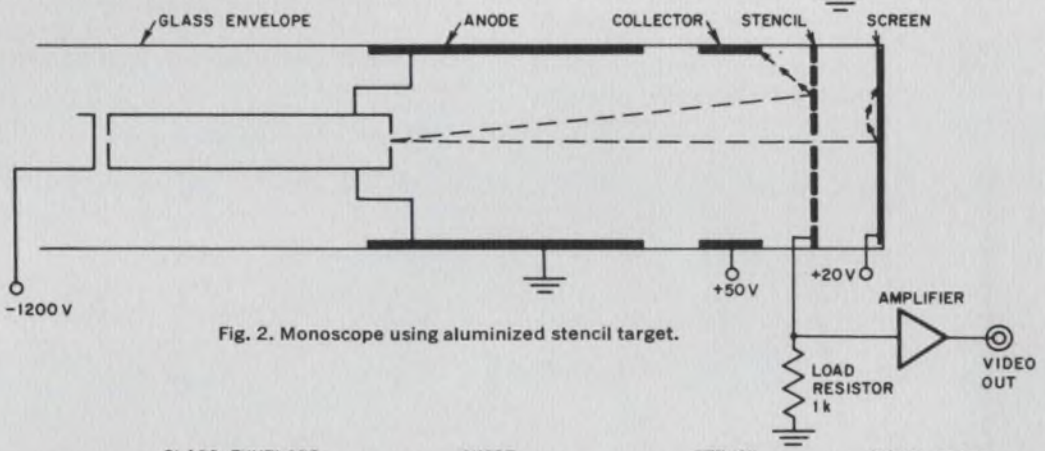


Fig. 2. Monoscope using aluminized stencil target.

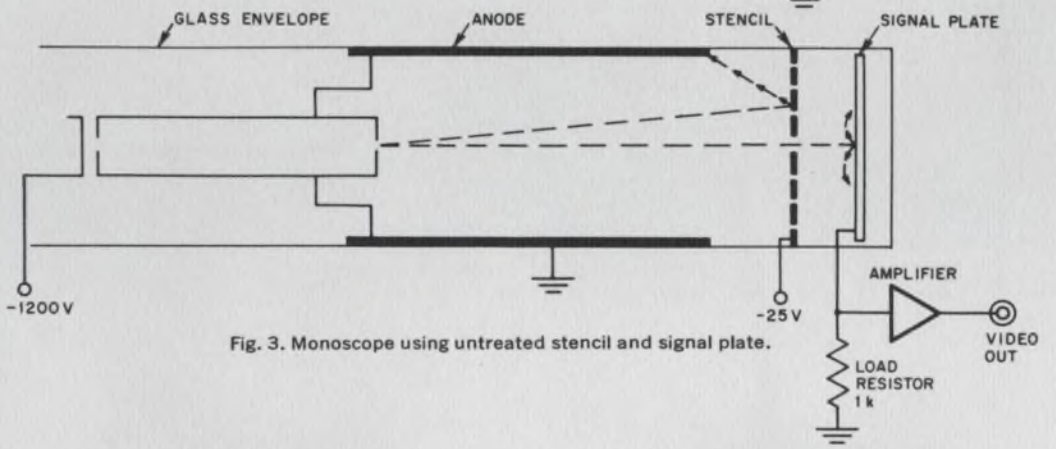


Fig. 3. Monoscope using untreated stencil and signal plate.

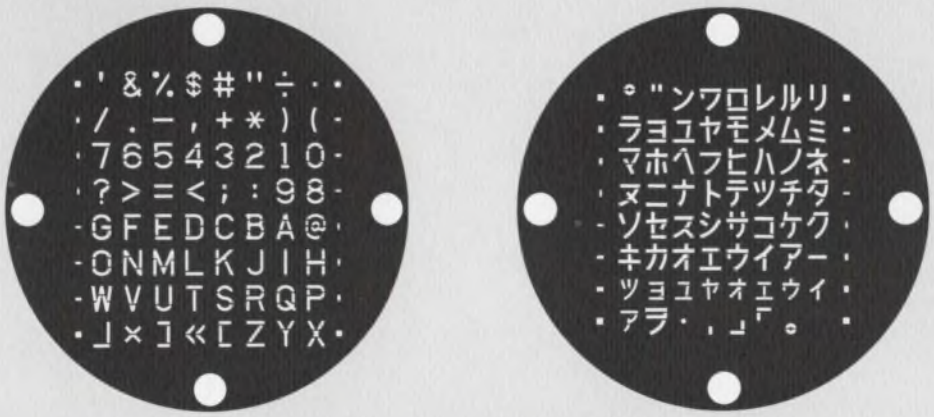


Fig. 4. Typical target stencil for alphanumeric readout.

HYBRID MICROELECTRONICS

Diode matrix modules give you design flexibility.

Our semiconductor and hybrid microelectronics groups team up to offer a wide range of module designs.

Because Sylvania is both a manufacturer of semiconductors and a maker of hybrid microelectronic assemblies, we can offer you a wide range of diode types packaged to your specifications. Using our thick-film packaging approach we can design diode arrays incorporating precision thick-film resistors.

Take, for example, our diode array module. This module is a 13 x 32 diode array containing both pull-up and load resistors. The diodes are high-speed, low-capacitance types. The thick-film resistors are stable cermet elements having low temperature coefficients. These resistors can be trimmed to a tolerance of 0.2% for weighted-network applications.

Other matrix forms are available that will let you increase the efficiency of your logic system design without getting involved in the use of more complex monolithic structures.

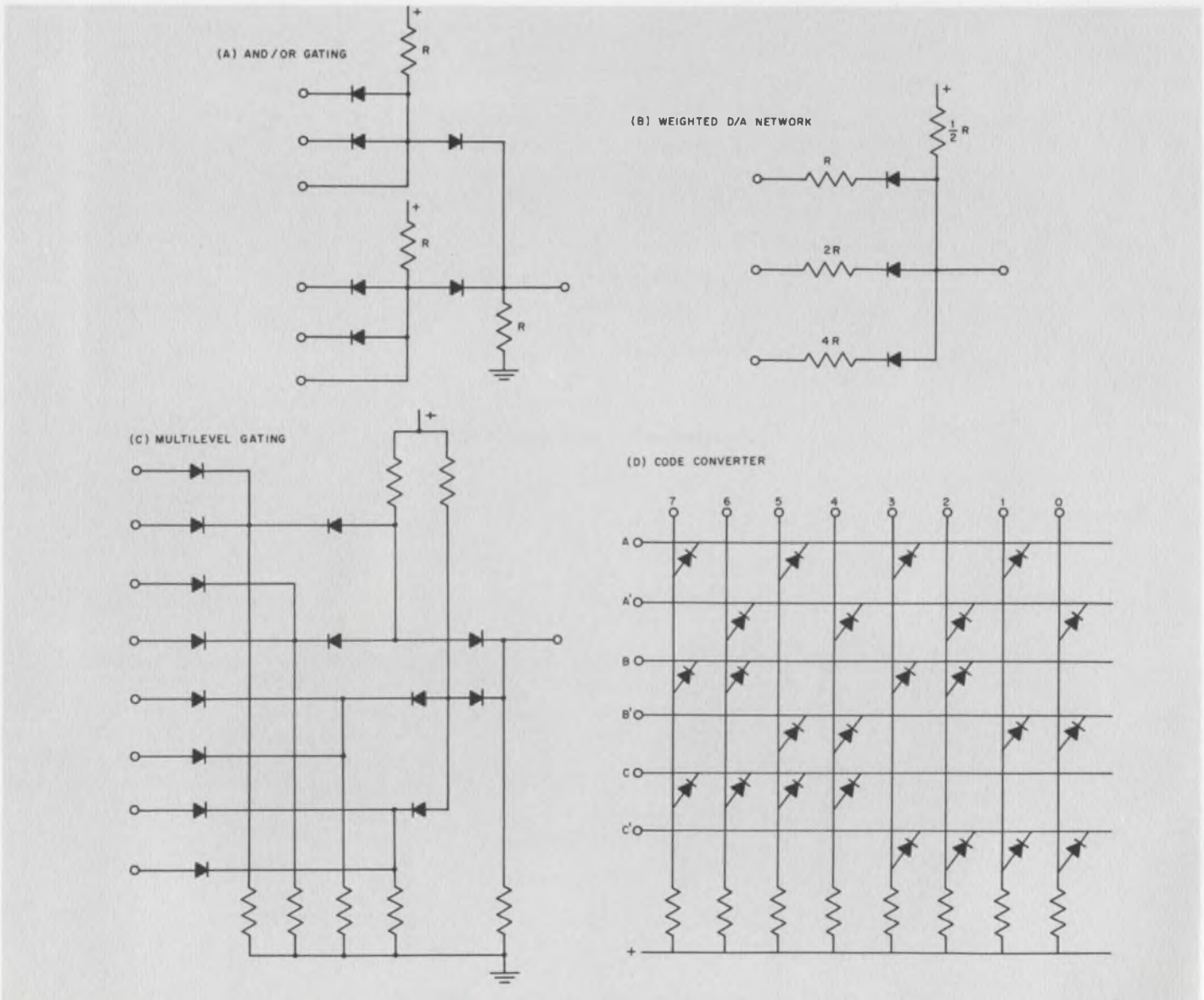
Up to 512 diodes can be provided in a single package. The custom matrix design can provide address arrays in 20 x 25, 16 x 32, or in any subcombination that the design might require.

The diode matrix and resistor module can be used in many applications including: code-to-code conversion, multilevel gating structures, AND/OR gating, decoding networks, nondestruct permanent memories, and weighted networks. Some typical applications are shown in the diagrams.

The wide flexibility of our design approach allows us to offer you any combination of diode arrays with or without resistor elements. The final package configuration can be determined by the system application. Flat packs and dual in-line packages can be provided as well as hermetically sealed or encapsulated modules.

You'll be surprised at what our semiconductor hybrid microelectronics teams can come up with to meet your logic system needs.

CIRCLE NUMBER 302



Four examples of how our diode matrix modules can be used.

TELEVISION

We've squared-off the color bright 85® tube for 1970.

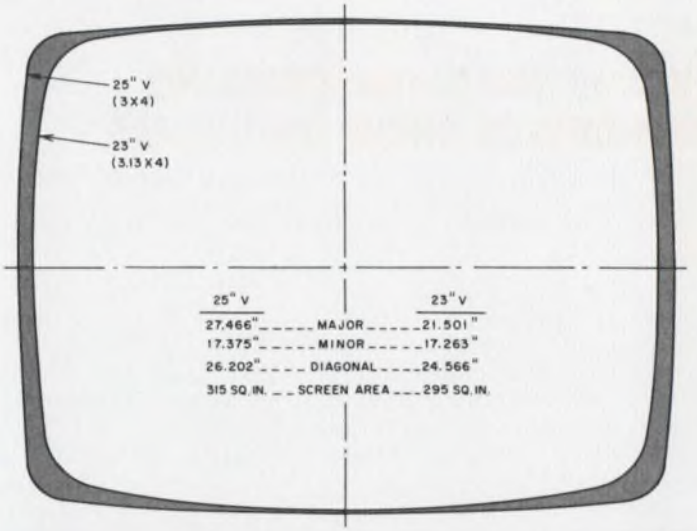
New color-tube design gives more usable area with a 3 x 4 aspect ratio.

Here's your chance to become a real "square" in your next color TV set design. We've come up with a new family of *color bright 85* picture tubes that give you squared corners and straighter side lines. The new tubes also feature a 3 x 4 aspect ratio which closely matches the configuration of the transmitted TV signal.

The new tubes are available in 19", 21" and 25" sizes and, of course, all of them feature Sylvania's new improved MV phosphor system that is 30% brighter than previous designs. An outline drawing of our new squared-corner 25" tube is shown in comparison with a conventional 23" tube in the illustration. Note that screen area is increased to 315 sq. in. in the new tube as compared to 295 sq. in. in the conventional design.

As in other *color bright 85* picture tubes, the new squared-off line features an aluminized screen for highest brightness. In addition, these tubes are available with a system light transmittance of 51%. The face panel is a neutral gray filter glass to improve picture contrast.

The new tubes also have a new front panel and funnel design that increases X-ray absorption. When tested in accordance with standard JEDEC procedures, the X-radiation of these tubes does not exceed 0.5 mR/hr. for the useful life of the tube even when operated beyond the design-maximum ratings of the tube.



Faceplate outline of new squared-off 25" color picture tube as compared with conventional 23" picture tube.

As with all *color bright 85* tubes, a temperature-compensated shadow mask is a standard feature to prevent loss of purity by uncontrolled thermal expansion. A sharp-focus electron gun that achieves tighter beam bundling, and integral kimcode implosion protection are also features that make the new squared-off *color bright 85* the tube to plan your next color set around.

CIRCLE NUMBER 303

DIODES

TV high-voltage diodes minimize X-radiation.

Solid-state diode tripler and quadrupler assemblies cut down on radiation from high voltage section of TV sets.

One of the major sources of X-radiation in color TV sets is in the high-voltage cage. You can minimize this radiation by switching over to our high-voltage silicon diode multipliers.

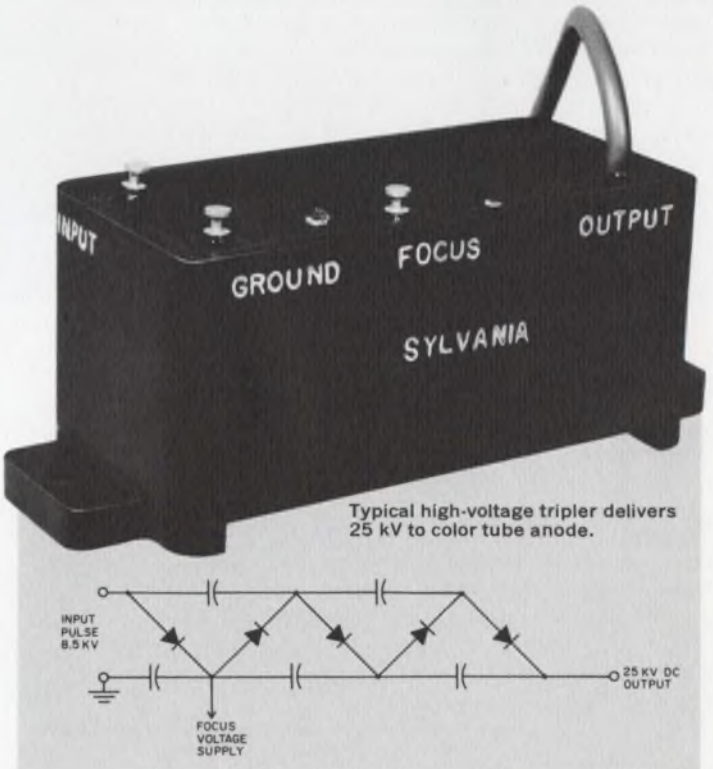
In addition, you'll save money by eliminating the high-voltage cage and its associated hardware. High-voltage regulation is also improved since the loosely-coupled tertiary flyback winding is eliminated.

Since each application of these high-voltage multipliers is unique, we don't offer them as off-the-shelf items. Our engineering staff will work with you to tailor a unit to fit your design needs.

One of our typical designs is shown in the illustration. It's a tripler circuit that takes an 8.5 kV input from the flyback transformer and puts out 25 kV DC to the color tube anode. Loading can be as high as 2.5 mA with minimal drop in output voltage. This circuit also provides a tap for the focus supply voltage.

The diode stacks used in our high-voltage multipliers are all carefully matched. They are then molded into a plastic package along with their associated capacitors. The plastic package will more than meet the environmental requirements of solid-state and hybrid color TV sets.

These requirements include such things as over-voltage surges, arcing and ambient temperature conditions.



Typical high-voltage tripler delivers 25 kV to color tube anode.

Why not discuss your high-voltage requirements with our diode engineers. They'll show you how to reduce radiation and save money at the same time.

CIRCLE NUMBER 304

INTEGRATED CIRCUITS

How to use programmable dividers as pulse-train gates.

Simple circuit can be programmed to provide N consecutive output pulses on command.

Here is an application of our functional arrays that shows the flexibility of these devices. The SM-143 and SM-153 are both programmable, synchronous down-counters with a built-in decoder that gives a logic "1" output when the counter is in the 0000 state. These programmable dividers are identical in operation except that the SM-143 is programmed by binary numbers and the SM-153 accepts a BCD input.

These dividers are ideal for use as programmable pulse-train gates. The strobed data entry (SET ENABLE) makes it easy to program the counters without adding external logic circuits. The four-input clock gate reduces clock loading and allows logic flexibility. The internal decoder gate and single output cut down on package count and, in addition, power drain is significantly reduced since the four flip-flop outputs are not brought out of the package. A four-bit counter with similar features would use about 100 mW more power.

The circuit diagram and timing waveforms for a programmable pulse-train gate are shown in Fig. 1. For purposes of illustration we are assuming that there is a binary 17 on the input lines.

Grounding the CLEAR input resets the counters to 0000 and causes their decoded outputs (A and B) to go high. (The CLEAR pulse must be at least 150 ns wide.) The high outputs from the counters are applied to the NAND gate (G1) whose "0" output now inhibits the CLOCK input to the system, thus maintaining a static condition.

When the START input is raised to a logic "1", the binary number (in this case, 17) is set into the proper counter flip-flops and decoded outputs A and B go low. The output of G1 now goes high and enables the first SM-143. (The second is still inhibited by decoded output A.) The START pulse must occur when the CLOCK input is low.

The system now allows 17 clock pulses to go through G2 in the following manner: The output of the first SM-143 (output A) goes high as the first clock pulse counts it from 0001 to 0000. This high input enables the clock gate of the second SM-143. The second clock pulse causes the second SM-143 to go from 0001 to 0000 thus setting output B high, at the same time changing the count in the first SM-143 from 0000 to 1111 and causing its output (A) to go low.

The logic "0" at A now inhibits the clock gate of the second SM-143 so that it remains at 0000 while the first SM-143 is counted down from 1111 to 0000 by the next 15 clock pulses (pulses 3 through 17). At this point output A goes high again. Outputs A and B are now both high, forcing the output of G1 to go low inhibiting the entire system. The system is now in the same condition that occurred after the CLEAR pulse. It will remain in this condition until another START pulse occurs.

If an asynchronous START pulse is desired, additional logic can be added as shown in Fig. 2. In the static condition, both counters are at 0000 and their outputs A and B are high, setting the output of G1 low. Gate G1 now inhibits the output gate G2 and the inputs to both counters.

When the start input goes high it allows the programmed number to enter the counters. This will cause the counter outputs A and B to go low. The high START input is inverted by G4 which resets FF1 and disables the J and K inputs. The Q output of FF1 then maintains the inhibit condition on G2 and both counters. This condition is static as long as the START input remains high.

When the START input goes low, G4 output goes high. This enables FF1. The first positive clock edge to occur, after the START input goes low, is inverted by gate G3 and clocks FF1. The Q output goes high, enabling the output gate G2 and both counters. This and succeeding clock pulses are gated and counted as explained previously, the Q output of FF1 which is now low is connected to the K input, thereby preventing resetting of the flip-flop by the clock pulse output from G3 until the next START pulse re-initiates the cycle.

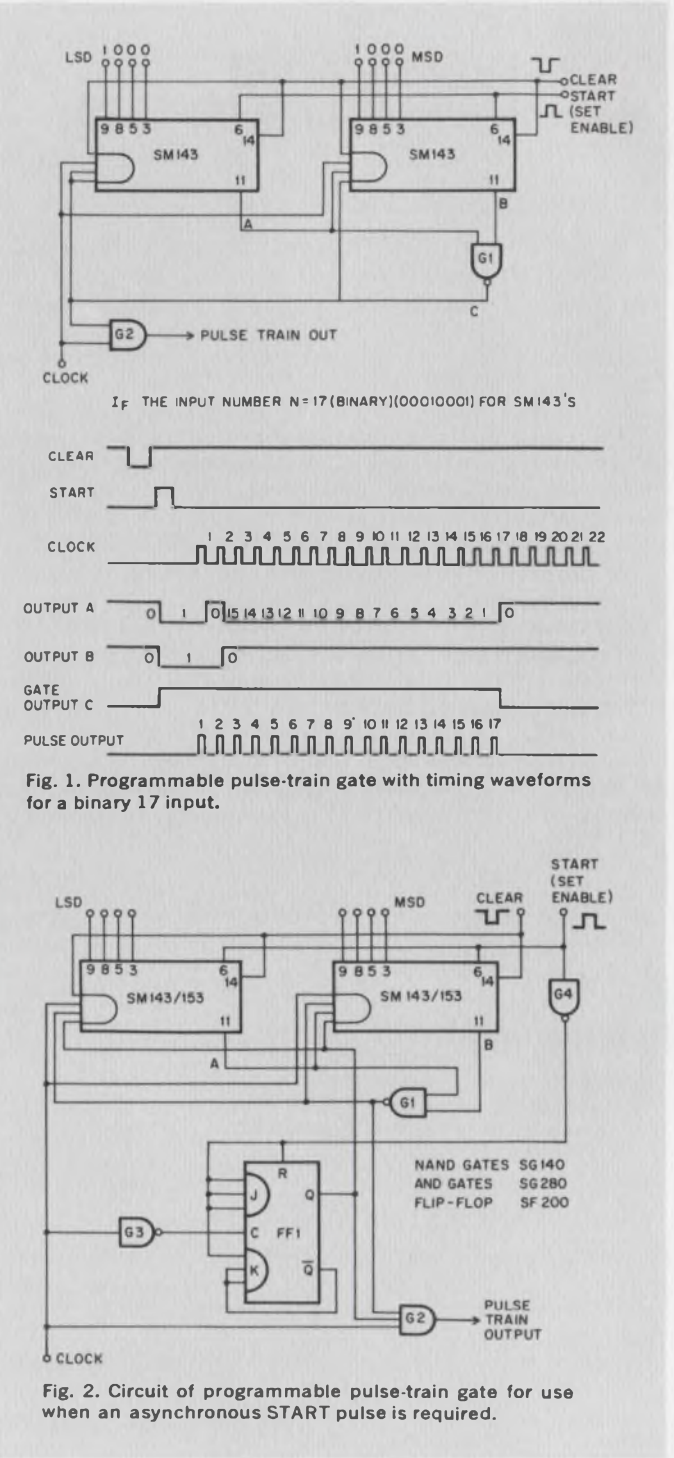


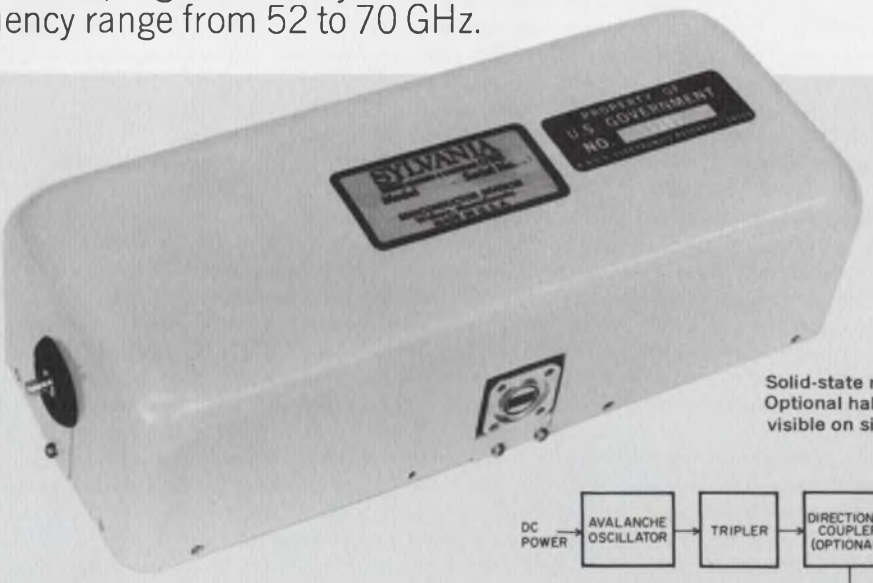
Fig. 1. Programmable pulse-train gate with timing waveforms for a binary 17 input.

Fig. 2. Circuit of programmable pulse-train gate for use when an asynchronous START pulse is required.

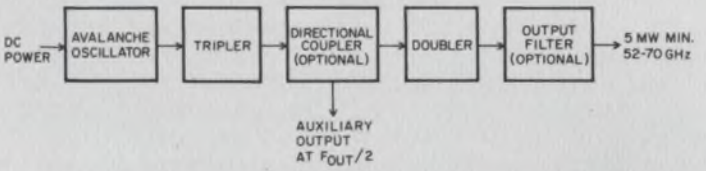
MICROWAVES

Millimeter-wave source puts out up to 50 mW CW.

Fixed tuned, high efficiency source is available in frequency range from 52 to 70 GHz.



Solid-state millimeter-wave source. Optional half-frequency output port is visible on side.



Block diagram of SYG-2040 showing the basic options available.

Our SYG-2040 series solid-state millimeter-wave source is a new component that is particularly suited to applications including local oscillators, paramp pumps, and low-power transmitters where long life is required. It also comes with a number of options that make it easy to fit it into a specific system requirement.

Basically, the SYG-2040 uses a high-power avalanche diode oscillator to drive an efficient tripler-doubler multiplier chain. The output frequency may be specified anywhere in the 52 to 70 GHz range.

Among the options available are a low-loss cavity output filter for applications requiring minimum noise sideband power, and an optional sampling port that provides a 5 mW (min.) signal at half the final output frequency. In addition, the fundamental oscillator can be modified to enable either phase or injection locking techniques to be employed where frequency stability is important.

The basic SYG-2040 solid-state source comes in a 2" x 2" x 6" package. Models with the optional attachments are housed in a slightly larger package. A constant-current DC supply between 70 and 100 V and 60 to 110 mA (10 W max.) is required to drive the avalanche oscillator.

CIRCLE NUMBER 306

MANAGER'S CORNER

Will the real Schottky barrier please stand up?

Several years ago, when Schottky barrier diodes using evaporated metal contacts were introduced, many engineers began to call the older point-contact types "the poor man's Schottky". Now that we have had time to compare both types, we wonder if it is entirely fair to use the connotation "poor man's" in referring to point-contact diodes.

Both diode types have really come of age within the past two years. Only now are we really beginning to find out the true differences between them in laboratory circuits and in operating radar systems. And strangely enough, the point-contact mixer/detector, with its tungsten whisker wire and pressure contact to epitaxial silicon, does not always come out as the underdog when compared to the more sophisticated Schottky barrier types. Perhaps even more significant, several distinct advantages and disadvantages of each type of diode can now be clearly seen.

Both types of devices are now made to cover the frequency bands from L to K_A. Point-contacts do have a slight edge in being commercially available to meet requirements up to 100 GHz.

Generally speaking, in mixer applications, Schottky barrier diodes are available with up to 0.5 dB improvement in noise figure over equivalent-frequency point-contact types.

Above X-band, however, this advantage disappears and the noise figures are equal. For other important parameters such as RF and IF impedances, somewhat tighter controls can be maintained for Schottky barrier types.

If you consider local oscillator power level degradation with time, or situations where local oscillator power must be varied, you should take a careful look at the Schottky diode. In general, you'll find it is not the better choice of the two. On the other hand, the dynamic range of the Schottky barrier device is better than that of the point-contact diode, making it the device of choice where this is an important parameter.

Also, in Doppler radar systems using the homodyne principle, the inherent low audio-frequency noise of the Schottky barrier device gives it an advantage over the point-contact diode in noise figure. In addition, microphonics are almost nonexistent in Schottky barrier devices.

Possibly one of the most important criteria to be considered when choosing between Schottky and point-contact diodes is resistance to "burnout" or degradation caused by external pulse power, spike energy, or CW power. Here the data are not sufficient to fit every circuit but, generally speaking, point-contact types are certainly to be favored under these conditions.

With rare exception, point-contact diodes made by the latest fabrication techniques can withstand 3 to 10 dB more incident power than an equivalent Schottky type. On the other hand, where burnout resistance is not a problem, the Schottky device has sufficient advantages to be the leading contender for new circuit designs.

Although it was originally assumed that the Schottky barrier diode would be superior to the point-contact type in environmental tests, such as shock/vibration, this has not proven to be true. Point-contact devices have passed the most stringent MIL-STD tests successfully. Here we have equality but no superiority.

Although we've been working hard to replace the grandfather of all diodes (really, of all semiconductor devices) the point-contact is not yet ready to retire. At the age of 27, he still has many good working years left. The Schottky barrier, by comparison, is still a baby and is just beginning to face the world.

We, as manufacturers, still have a long way to go before we can announce that a choice no longer exists between Schottky and point-contact devices.

Eugene J. Feldman

Manager, Microwave Products

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.290	.02	5.0	.015	65.0	.01	1000
.390	.033	3.0	.022	45.0	.015	1000
.405	.05	2.0	.033	30.0	—	—
.485	—	—	—	—	.022	1000
.515	.068	1.5	.05	20.0	.033	1000
.590	0.1	1.0	.068	15.0	.047	1000
.690	0.15	0.65	0.1	10.0	.05	1000
.760	—	—	—	—	.068	1000
.820	0.2	0.5	0.15	6.5	—	—
.920	0.3	0.33	0.2	5.0	0.1	1000

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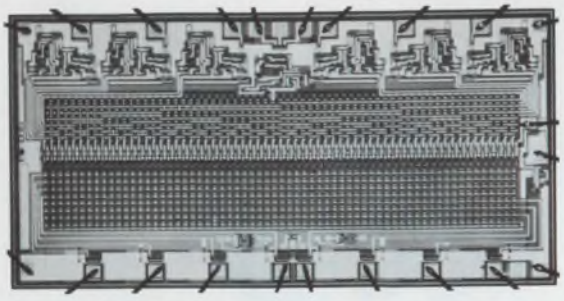

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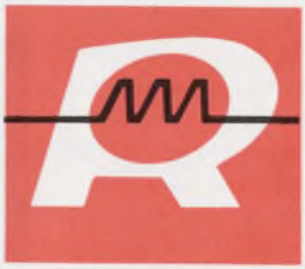

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INFORMATION RETRIEVAL NUMBER 22

Electronics scores

Jim McDermott
East Coast Editor

Electronic aids are infiltrating the world of sports—from spectator events like football and horse racing to field and stream activities like fishing and dog training. The most spectacular are the huge stadium scoreboards, ranging from Cubic Corp.'s $600,000 computer-operated, animated football scoreboard for the San Diego Municipal Stadium (see cover photo) to a new $4-million system now being installed at the Ontario (Calif.) Motor Speedway. The latter will be the world's first all-electronic timing, scoring and display system for keeping track of up to 50 autos in a 500-mile race.

Cubic's scoreboard, 29 feet high and 80 feet long, has 31,400 lamps, each 40 W and dc-energized. The board is organized in a matrix of 110 rows by 310 columns and employs silicon controlled rectifiers. The design of heat sinking and cooling is critical in these systems, because the fully illuminated board consumes over a million watts. An advantage of the SCRs is that they are essentially a dc memory element, remaining on

Ignition noise, corrosion and vibration are enemies of marine electronics. So the electronics on the control bridge of this Christ-Craft Commander Fiberglas yacht has noise-suppression circuitry and watertight, gold-plated avionics connectors. The equipment includes: a depth sounder, AM (2-5 MHz) and vhf-FM (156-162 MHz) radiotelephones, automatic pilot, automatic direction finder (200-1500 kHz) and radar. Special grounding is also provided.

The **newest electronics in small-boat navigation is a space-age version of an aircraft unit,** by Radon, Inc., Cos Cob, Conn. It uses vhf (108-118 MHz) Visual OmniRange (VOR) stations for obtaining bearings, Traditionally, boat owners favor 200-kHz-to-1500-kHz direction finders, which are subject to a variety of errors caused by static, interference and propagation-effect fading. Vhf eliminates these, but the signals from coastal VOR stations to boats are usually attenuated by intervening terrain. Borrowing aerospace phase-lock and digital-filtering techniques, Radon has produced a hundred-fold increase in sensitivity over standard VOR receivers. The new equipment reaches down into the noise to extract a useful navigational signal.

in sports

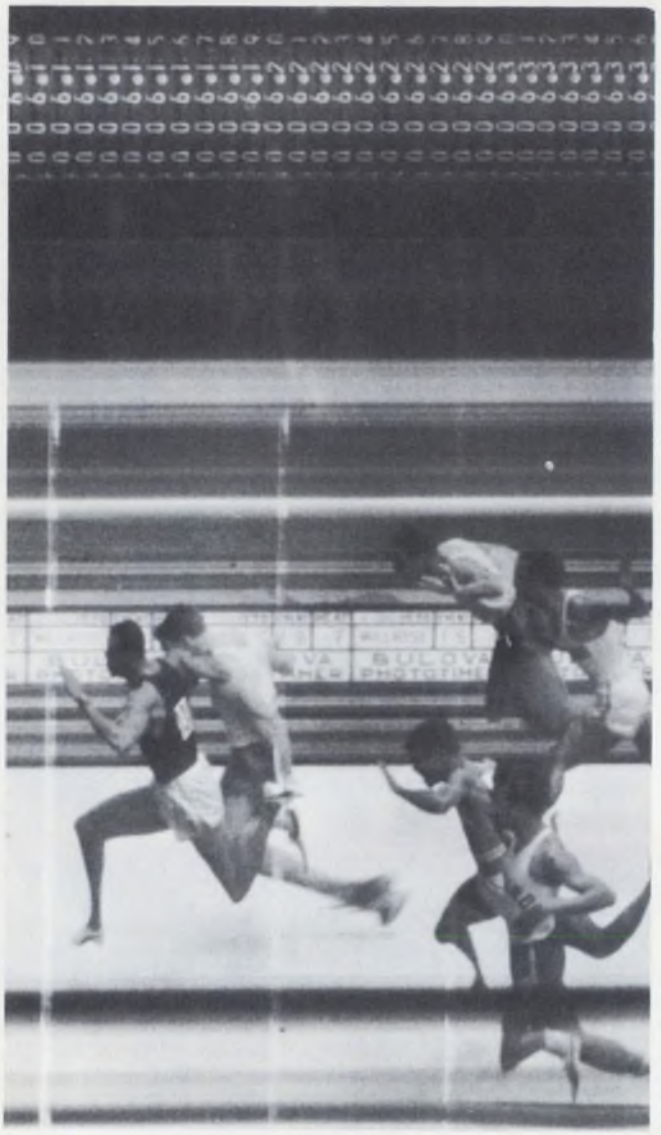
once triggered. But to update information, all conducting SCRs must be cut off and re-energized as new information is inserted.

Electronic timing systems have either completely taken over or are being used as backups in many sporting events traditionally timed by stop watch, such as ski, ice-skate and bobsled racing, track events, swimming competitions, horse and dog racing, and automotive events. These timing systems can be simple or complex versions of a time base operating a mechanical or electronic counter and display. The time-base output is counted down to provide an accuracy of hundredths or thousands of a second.

For the time base, Heuer Time Corp. of New York City uses a 2000-Hz tuning fork, while Bulova Watch Co. depends on its Accutron. The Longines Watch Co.'s equipment for use with TV pickups has a quartz crystal time base with an IC binary countdown. Instead of requiring a separate TV camera to monitor the time display, the Longines system generates the numbers electronically and feeds them into the raster of a camera scanning the sports activity.

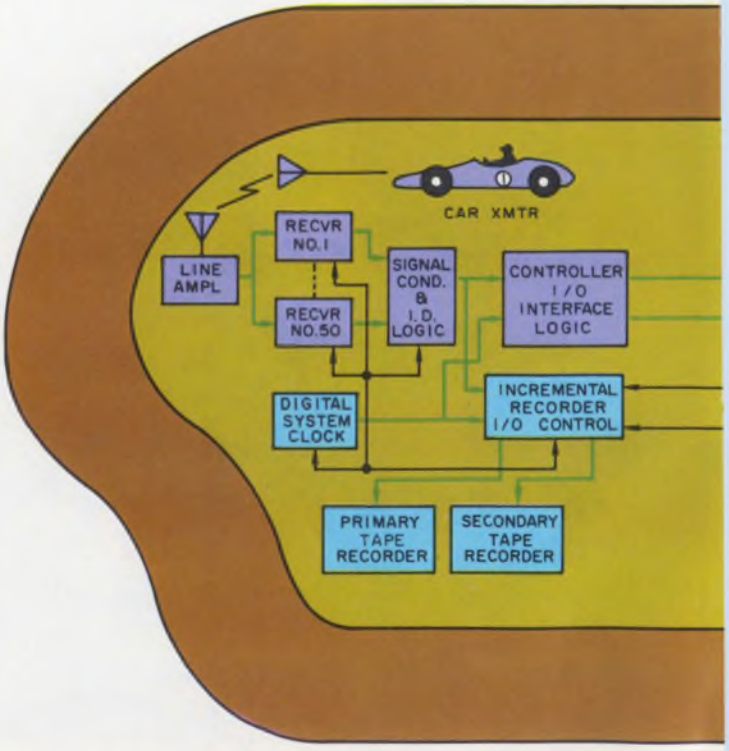
Conversation 100 feet down, without earphones and using only milliwatts of power, is like talking on the beach, thanks to a unique speaker-transducer design in Yack/Yack scuba diver communication sets (orange in the photo). The manufacturer, Y Square, Inc., of Santa Ana, Calif., says the transducer is exceptionally efficient because of an oil-filled chamber that produces a very close impedance match between the driving element and the water around it. Sound is transmitted by vibrating the entire case of the unit.

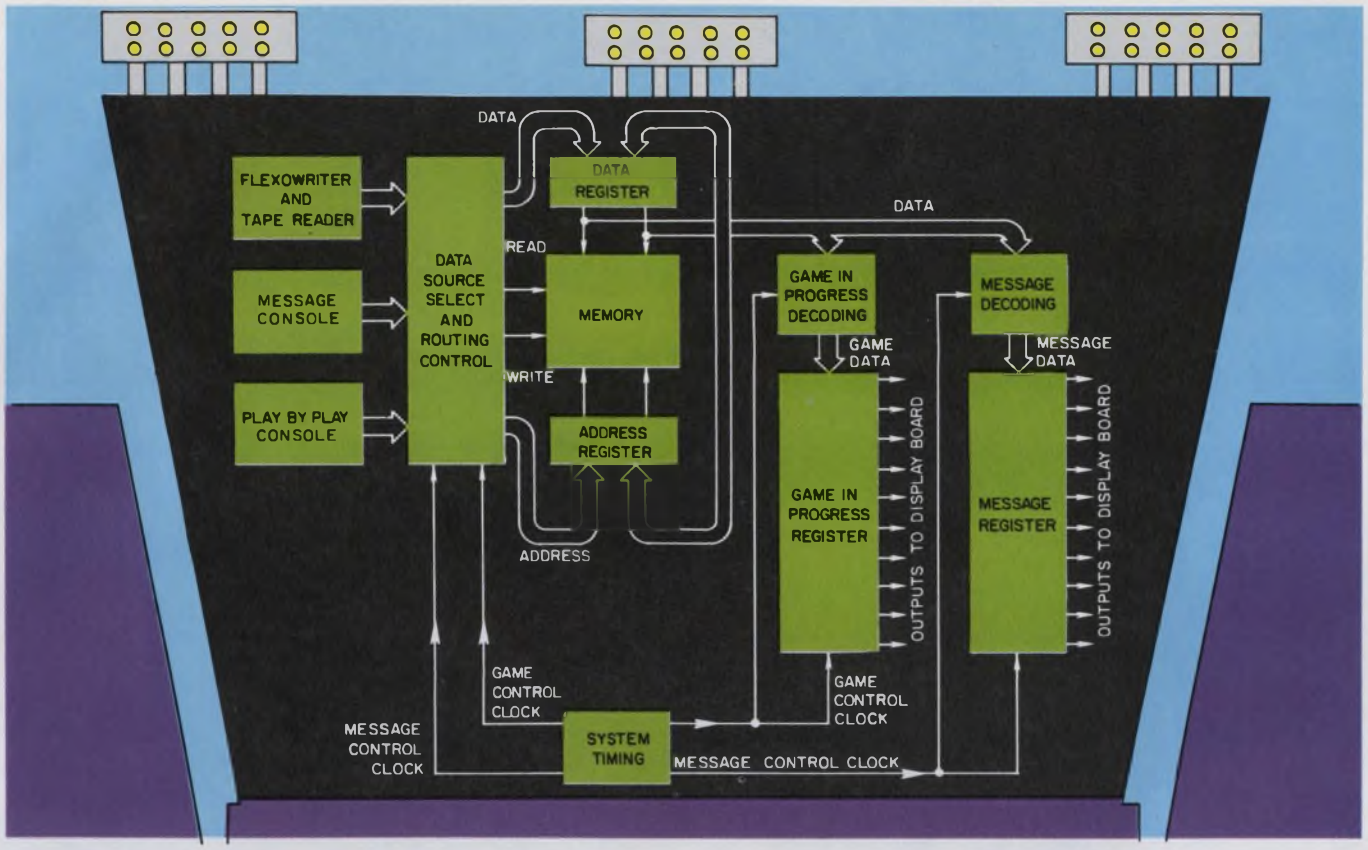
By building a plastic case and then designing the electronics to fit the case, Hartmann, Inc., of Newark, N.J., has cut costs on four products: a fish finder (top), a hand-held direction finder with a compass (center), a wireless tachometer (bottom) and a depth sounder with a meter indicator (not shown). The Cycolac plastic is substantially superior to an aluminum case for withstanding abuse. By using the same case for all four products, Hartmann has reduced packaging costs from $3 to $5 for each item to about 75 cents.



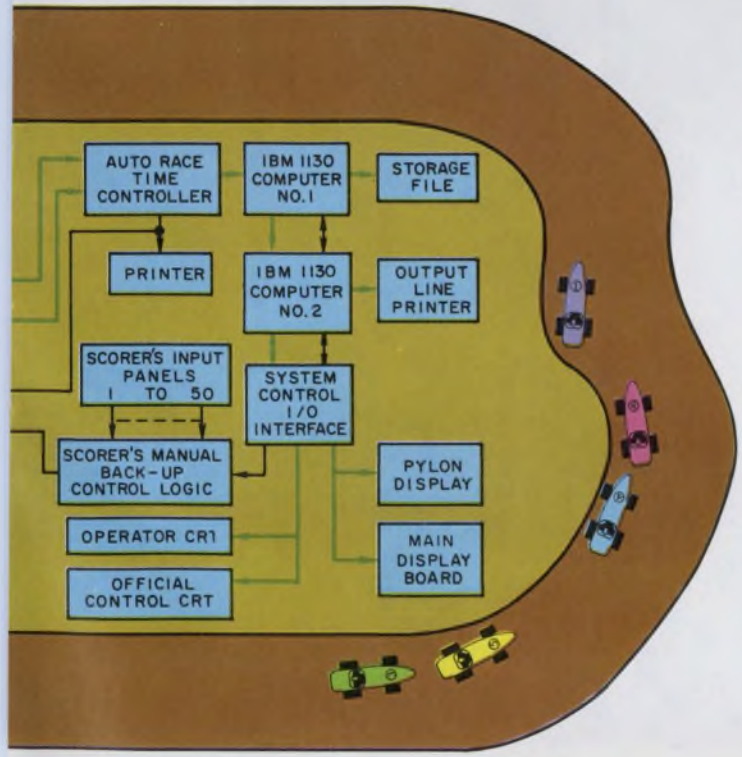
For timing sports events, special systems have been designed. They include the Accutron Phototimer, developed by Bulova Watch Co. for track meets. Above, Bob Richards, Phototimer crew chief, mans a special slit camera at a Madison Square Garden track event. The slit is focused on the finish line, while the film moves by at a speed that freezes the racer's motions. Figures on a digital counter inside the camera are strobed by a flash lamp and exposed on the film, as at left. Digital timing is controlled by a time base driven by an Accutron tuning fork, accurate to 1 part in 10^5. Timing starts when a photocell transducer attached to the starter's pistol is triggered by the infrared energy of the fired blank. The photocell output is radioed to start the time-base counters at the camera.

Courtesy ABC TV





Cubic Corp.'s giant football scoreboard (see cover photo, as well as this block diagram) is divided into three "game-in-progress" areas and an "animation" area. All sections can be controlled either independently or simultaneously by the operator. The system has a special computer with a 4-k, 30-bit word structure and double-addressing for words. Double-addressing allows the updating of information on one line while another is held constant. In operation, every location on the board does not correspond to a location in memory. Instead, the information is placed on the board in a column of lights and moved across the board in shift-register fashion. All data that flows through the system goes through the computer main frame, and in this fashion can be constantly up-dated.

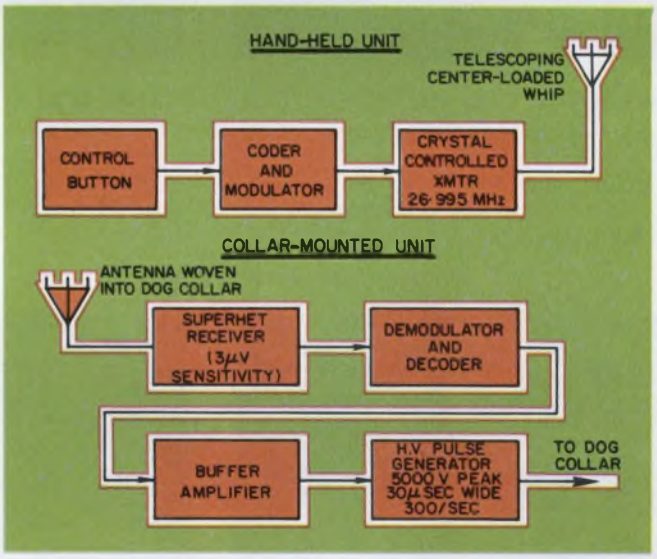


The world's first electronic timing and scoring system for auto racing, complete with a giant display board and four 50-foot pylons that show the numbers of the top 10 cars, is a $4-million installation now being completed at Ontario (Calif.) Motor Speedway. For timing, radio transmitters are installed in up to 50 cars (compared with the present method at Indianapolis of sending hundreds of timers scrambling over the track with stop watches, eying assigned cars). Loop antenna arrays in the new system are buried at the start/finish line and at the entrances and exits of the pits. As a car passes over the loops, the receiver tuned to its frequency passes a signal to identification logic and to a controller clocking its time to 1/1000th of a second. Two IBM computers control the entire operation. Computer No. 1 receives all the timing data, verifies it and stores it as a complex file, which computer No. 2 then searches to obtain updated race statistics. The statistics are available as a paper printout, on CRT monitors, or on big-board displays in any of a number of formats.


VIDEO TAPE REPLAY

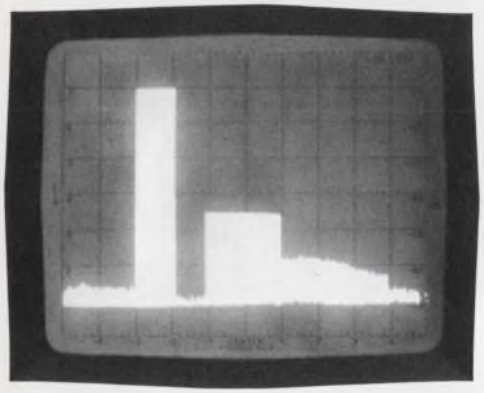
Now race-track fans can watch what once only the racing stewards saw—photo finishes and film playback of races to determine if any fouls were committed. TV monitors are placed in the clubhouse, stands and other points within the parks—like the closed-circuit color TV system shown here at the Aqueduct track in New York City. These systems, engineered and installed at leading tracks throughout the country by Video Projects, Inc., of New Hyde Park, N.Y., use five to 10 cameras. Still photos of close finishes are transmitted directly from the track's photo-finish room to 23-inch TV monitors within 30 seconds after the race is run. The video tape of a race—unlike the camera film, which takes five to 10 minutes to process— can be played back for immediate viewing by the judges and fans. Special-effects equipment allows the system director to add such touches as split screens, lap dissolves and the insertion of text across the bottom of the TV picture.

Color TV coverage of sports brings the thrills home, particularly with close-ups from the backpack camera. But behind the scene, problems are crying for solution, according to LaVerne Pointer, director of broadcast engineering for the American Broadcasting Co. For example, the cables for field color cameras have 82 conductors and weigh a pound a foot. Golf matches require two or three mobile vans with up to 16 cameras and 2000 feet of cable. For field use, the cable is made up in 200-foot sections. Connector reliability is a headache, particularly when the cable lies buried under roads or fairways for days. If it is laid in the open, it is subject to rain, moisture and golf spikes. A much smaller and lighter cable, possibly with use of a multiplexing scheme or some other reliable method of camera-to-van transmission, is needed. ABC uses microwave links between the backpacks and field stations, but only when cable can't be used. The microlinks (12-13 GHz) suffer from multipath interference and random, variable attenuation.



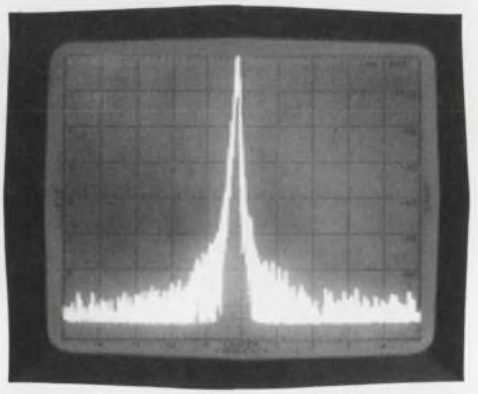
A coded modulation signal is the key to success of a radio-controlled dog trainer, by Tri-Tronics, Inc., Tucson, Ariz. The dog wears a "shock collar" with a woven antenna, plus a receiver and shocking circuits that produce 5000-V pulses across two neck electrodes. In use, the dog is allowed to pursue an undesirable behavior pattern. For example, a setter to be trained for pointing birds may chase a deer, with the trainer observing. When the trainer presses his transmitter button, the shock halts the dog in his tracks. The dog associates the shock with deer and then avoids those animals. The biggest problem with this type of equipment is accidental shocks due to random interference picked up by the dog's receiver from Civilian Band transmitters, auto-ignition systems or power lines. This can ruin a $500 hunting dog in short order. To avoid this, the Tri-Tronics transmitter is modulated with a coded signal that is decoded in the collar unit.

If you're designing frequency-sensitive circuits, aren't these the measurements you should be making?



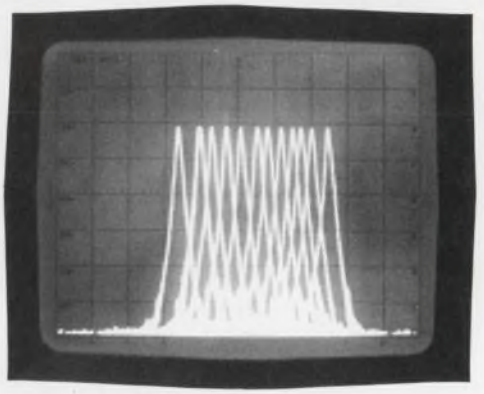
Oscillator Output Spectrum
Frequency scan: 0-100 MHz. Log display (LOG REF = 0 dBm).

Oscillator output is flat at −10 dBm, 20 to 30 MHz. Second harmonic is 35 dB down and flat; third harmonic goes from 50 to 55 dB down.



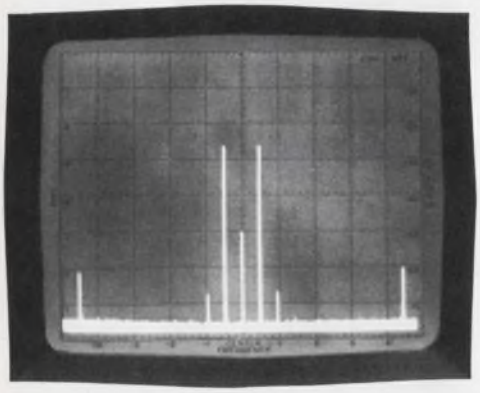
Spectral Purity Center frequency: 100 MHz. Scan width: 5 kHz/div. IF bandwidth; 300 Hz. Log display (LOG REF = 0 dBm).

Major noise sidebands are approximately 55 dB below carrier.



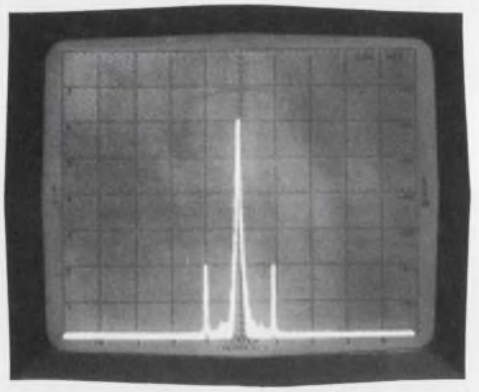
Frequency Drift Center frequency: 800 MHz. Scan width: 10 kHz/div.

Scans are triggered at 10 second intervals and stored on CRT. Drift = 42 kHz in 2 minutes.



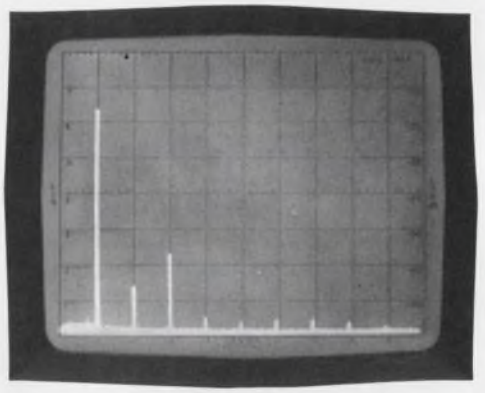
Conversion Efficiency Center frequency: 50 MHz. Scan width: 5 MHz/div. Log display (LOG REF = −10 dBm).

Double-balanced mixer with 0 dBm drive at 50 MHz and −30 dBm at 5 MHz. Display shows 45 and 55 MHz sidebands at −36 dBm; i.e., 6 dB conversion loss. (Display also shows signal feed-through at 50 MHz and harmonic distortion products at 40 and 60 MHz.)



AM Modulation Index Center frequency: 60 MHz. Scan width: 10 kHz/div. Log display (LOG REF = +10 dBm).

Low level 10 kHz modulation of 60 MHz carrier shows sidebands 40 dB down, i.e., 2% AM. Sidebands as low as −70 dB or 0.06% modulation can be measured.



Harmonic Distortion Frequency scan: 0-50 MHz. Log display (LOG REF = 0 dBm).

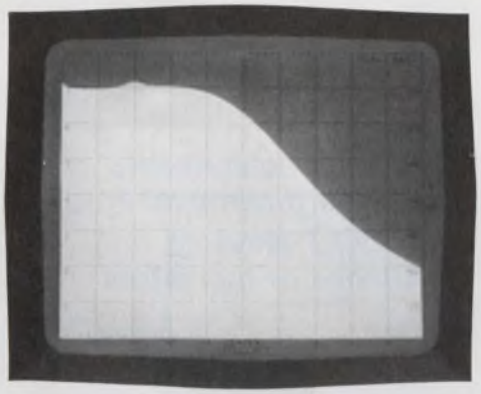
Harmonic content of −16 dBm 5 MHz signal is displayed: 2nd harmonic −50 dB, 3rd harmonic −40 dB, others < −60 dB. Harmonic content as a function of absolute fundamental level can be observed.

There's only one lab tool that gives you the complete, accurate picture of measurements in the frequency domain: HP's series of fully calibrated spectrum analyzers. One covers 1 kHz to 110 MHz; the other goes from 500 kHz to 1250 MHz. Either is a convenient, easy-to-operate basic instrument for general circuit design that enables you to make all the measurements you see on these pages, plus many more. Use it as a tuned voltmeter, a wave analyzer, distortion meter, frequency meter and power meter. Its absolute amplitude calibration, low distortion, high sensitivity, wide sweep capabilities and wide dynamic range make it a true multi-purpose frequency domain measuring instrument.

The analyzer displays absolute signal levels both in dBm and volts from +10 dBm to <—120 dBm (0.8V to 0.1 μV). And > 70 dB distortion-free dynamic range permits exceptional accuracy in measuring complex signals.

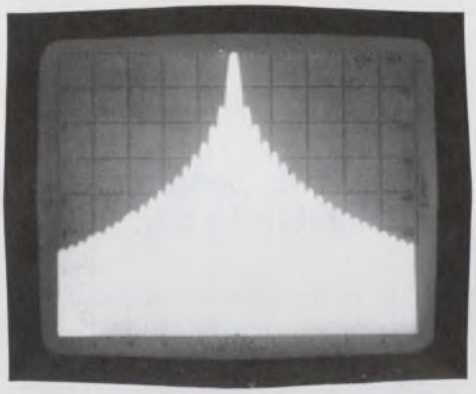
Sweep the entire frequency range, then reduce the scan width for a closeup view of any portion down to .0002% of the initial sweep. Selectable bandwidths let you get down to 50 Hz resolution with the lower frequency RF unit and to 300 Hz with the 1250 MHz unit. A variable persistence display shows the full trace even at the slow sweeps necessary to achieve high resolution.

You can perform all these measurements as easily as you operate your bench scope. Using HP's lab spectrum analyzers is simple and results are easy to interpret. The cost of the 8553B 110 MHz RF section is $2100; the 8554L 1250 MHz RF section is $3300. Either can be used with the basic 8552A IF section ($2050) and 141T Variable Persistence Display section ($1700). There's a normal persistence display unit available, too. Your Hewlett-Packard field engineer has the complete details; or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.



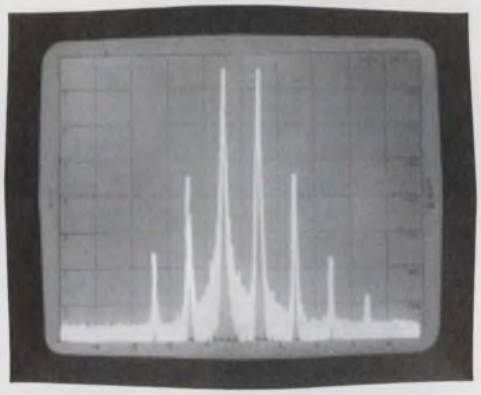
Amplifier Response Frequency scan: 0-500 MHz. Log display (LOG REF = +10 dBm).

With flat input at —20 dBm, gain and frequency response are read directly from CRT (20 dB gain, ±2 dB to 200 MHz, 0 dB gain at 320 MHz).



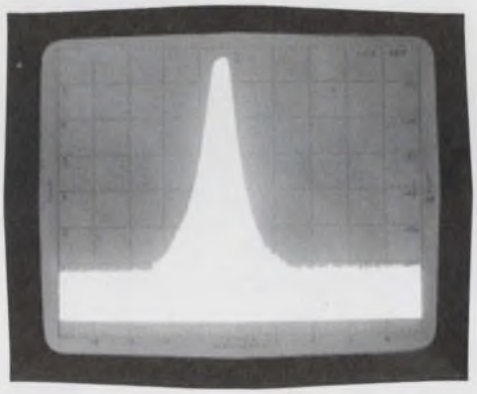
Transmission Bandwidth Center frequency: 800 MHz. Scan width: 0.5 MHz/div. Log display.

Spectrum of pulsed 800 MHz carrier shows 2.2 MHz frequency range between —40 dB lobes, which is bandwidth required to pass 99% of energy.



IM Distortion Center frequency: 60 MHz. Scan width: 100 kHz/div. Log display (LOG REF = +10 dBm).

Two-tone test using 59.95 and 60.05 MHz signals at +5 dBm each shows third-order sidebands 30 db down. Higher order IM products can also be measured.



Filter Response Frequency scan: 0-100 MHz. Log display (LOG REF = 0 dBm).

With 0 dBm test signal, passband insertion and stopband rejection of 50 MHz bandpass filter are displayed. Insertion loss is 3 dB, 3 dB bandwidth approximately 4 MHz and 60 dB bandwidth is 36 MHz (Shape factor = 9).

HEWLETT hp PACKARD

SIGNAL ANALYZERS

Letters

You will be the ones out of step—not us

Sir:

Mr. Jack Jones, in Letters, in the March 15, 1970 issue (ED 25), represents the myopic, narrow-minded sort of individual who, I fear, typifies the over-30 engineer. People like this, who can't see beyond the end of their slide rules, are precisely the reason why the engineering community has such a bad reputation among a talented, socially aware younger generation.

The United States is today in the midst of a revolution which must succeed if America or, for that matter, humanity itself is to survive. Whether this revolution is peaceful or violent, orderly or chaotic, will to a large extent depend on how well established institutions respond to the crying need for extensive change. Recent experience, however, indicates that our established institutions—the electronics industry among them—either cannot or will not respond to this need.

Despite the ballyhoo over token efforts to attack real problems, the electronics industry remains heavily committed to weapons development. The reign of terror inflicted upon the Vietnamese people in the name of freedom is a direct result of American technology's eagerness to supply the Pentagon with every conceivable engine of destruction—at a handsome profit, of course. As long as the electronics industry insists on maintaining its current cozy relationship with an arrogant, mindless military establishment, it will become increasingly difficult to recruit talented young people into the engineering profession.

Yes, Mr. Jones, today's youth *is* idealistic. And, as you suggest, we're also out of step. We are out of step with a war-based economy that squanders billions of dollars annually on useless, unreliable weapons systems for the Pentagon sandbox. We're out of step with so-called professional magazines and societies that glorify this toy-soldier nonsense as being good business, or with the limp excuse that it furthers scientific and technical "progess." We're out of step with an economic philosophy that recognizes conspicuous consumption as the only valid measure of national success. I could go on, but I think you get the idea.

Gentlemen, the days of "What's good for General Motors is good for the country" are numbered. The revolution is coming, and when it does it will be you who are out of step and not us.

Douglas Abbott
University of California
Berkeley, Calif.

Patent is pending—we hasten to say

Sir:

A minor, though urgent problem, occurred with the release of your feature article in Evaluation Samples, ED 6, March 15, 1970, p. 268, on our new packaging system. Our intent with this article was to *go on record* that the product was exclusive and that we had patents pending in the United States and many countries outside the U. S. as well.

It would be a great help if you could publish something as soon as possible, making it clear that the product line and product concept are exclusively that of Circuit-Stik, Inc., and that a world-wide marketing line is planned.

Donald E. Harper
Marketing Director
Circuit-Stik, Inc.
Gardena, Calif.

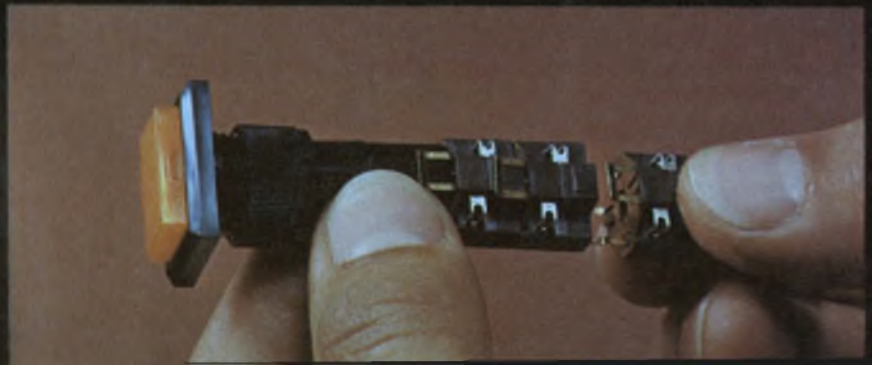
He calls attention to a lack of inversion

Sir:

With regard to the article "Diagram sequential logic on a cube" in the 1 Mar. 1970 issue, page 55, I believe you DID FORGET to ɹǝʌuı the rear-left "A" CONSTANT in your D cube in Fig. 3.

Wayne E. Snow
Member Technical Staff
North American Aviation
Columbus Division
North American Rockwell Corp.

Meanwhile, back on earth. Arrow-Hart scores a breakthrough in lighted push-button switches. Snap-on contact blocks make up to 4-pole double throw form Z switches. 31 stock components = 25,344 different variations. Six colored lenses in three shapes. Is your imagination beginning to run away with you? Write or wire for folder. We call all this Adapt-a-Switch. You'll call it ingenious.



Arrow Hart

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THE "INTERMEDIATE" SYNTHESIZER

160 MHz for $5900

Buying a frequency synthesizer has been something like buying a car. There's a confusion of models, options, and price ranges. Except – there has never been a so-called "intermediate"-model synthesizer. That's because price and performance ranges of synthesizers have tended to cluster just at both ends of the spectrum. The choice was between lower-cost, limited-frequency-range models and those with everything, including a sky-high price tag. So, the buying decision was one based on either trade-off or over-capability.

This is not true any longer! GR has filled the price-capability gap with the new 1165 Frequency Synthesizer. Frequency range is wide, 0.01 to 160 MHz in 100-Hz steps. The price is only $5900, less than half the price it used to cost to get 160 MHz. If you can furnish your own frequency reference signal (5 or 10 MHz), you can get a model for only $5300. In the $5900 model, frequency accuracy is maintained either by an internal precision 10-MHz oscillator (1×10^{9} per day) or by an external drive or lock source. Output is 0.1 to 1 V into 50 ohms. Both frequency and level can be externally programmed; the 1165 is ideal for applications requiring remotely-programmed local oscillators. Harmonics are typically down 30 dB (at maximum output into 50-Ω load); spurious, discrete non-harmonic signals are typically down 60 dB.

For complete information, write General Radio, West Concord, Mass. 01781; telephone (617) 369-4400. In Europe: Postfach 124, CH 8034, Zurich, Switzerland.

GENERAL RADIO

INFORMATION RETRIEVAL NUMBER 25

Washington Report

DON BYRNE, WASHINGTON BUREAU

Destroyer contract delayed again

Bath Iron Works and Litton Industries, which have been expecting for months to hear that one of them won the award to build six DD-963 class destroyers, may have to wait two more months for their answer.

The House approved $506.8-million for the ships but a rider was attached to the overall $20-billion defense authorization bill requiring that the ships be built by two ship yards instead of one. The provision may be removed—as it was last year—by the Senate or later in joint House and Senate sessions. Meanwhile, the rider is holding up the contract award.

Action on the authorization bill may not be completed before late June or July because it includes money for the Safeguard ABM, a program that will undoubtedly be delayed by a filibuster.

House votes $200-million for Lockheed 'contingency'

The House has approved $544.4-million for the C-5A program, $200-million of which is to be used by Lockheed to cover expenditures during the next fiscal year. Lockheed told the Defense Dept. several months ago that it would need $600-million over the next three years to meet expenses. The House Armed Services Committee recommended the $200-million for the coming year, stating that it was "doubtful" that Lockheed could cover these expenditures.

Deputy Defense Secretary David Packard told the committee that if the money was not approved, the C-5A program would have to be terminated under confusion and uncertain circumstances, without any clear picture of just what the Government would get for its large investment in the program.

Safeguard streaking toward trouble in Senate

The planned expansion of the Safeguard antiballistic missile system is in deep trouble in the Senate—and perhaps the entire ABM program along with it.

Senate supporters of the ABM system are not sure they can salvage any of the the program, let alone the $404-million earmarked for extra Safeguard sites. The House passed a $1,026,000,000 authorization for Safeguard in fiscal 1971, which included $305-million for construction of a new site at Whiteman AFB, Mo.; $35-million for additional Sprint missiles at Grand Forks, N. D., and Malmstrom, Mont.; $40-million for long-lead-time preparation of five additional sites, and $24-million for related work.

Last year deployment of the ABM squeaked through the Senate on a tie vote. This year proponents feel they will be lucky if they can even get a tie vote. One Senate supporter told ELECTRONIC DESIGN: "If they get us on the run, they'll kill the whole program."

Proponents point out that Sen. Everett Dirksen, a supporter, is dead and that Sen. Karl E. Mundt (R-S.D.), another supporter, is hospitalized and not expected to be on hand for a vote. In addition there is little be-

lief in the Senate that Chinese attack capabilities call for extra ABM spending at this time. The plan within the Senate Armed Services Committee at the moment seems to be to bring out a modified bill that would kill the expansion but keep alive the basic program. Hopefully, say the proponents, this would get through the Senate and give the House a bill that it could live with.

Better planning sought in earth satellite program

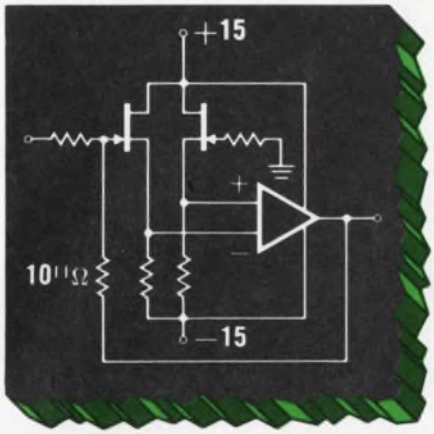
The Senate Space Committee has instructed NASA to undertake immediately a study of other Government agency needs in the proposed Earth Resources Technology Satellite Program. The Committee told NASA it would like to see a formal agreement between Government agencies to improve planning and coordination. The recommendation came in the report of the Space Committee on NASA's fiscal 1971 authorization. The committee chopped $284.9-million from the $3.6-billion the House had approved. The bulk of the cut was in the manned space program, where the House had added almost $300-million more than the Admistration had requested.

AWACS contractor selection delayed

A contract award for the Airborne Warning and Control System (AWACS), expected in early June, has been postponed four to six months, Defense Dept. sources say. No reason was given for the delay. But it's believed that a contractor for AWACS can't be selected until one is chosen for the B-1 advanced manned strategic aircraft. Announcement of the B-1 contract is imminent, and several of the bidders are involved in both contracts. Boeing and General Electric, for example, are both very much in the running for both contracts, and it's highly unlikely that one company would get both awards.

Capital capsules:

The Federal Aviation Administration (FAA) is taking a look at a proximity warning device for general-aviation planes that costs less than $400 and weighs only two pounds. The device, manufactured by General Aviation Electronics, Inc., of Indianapolis, reacts to the transponders normally installed in military and airline aircraft . . . . Adm. Thomas H. Moorer, Chief of Naval Operations, has revealed that **two North Vietnamese MIG fighters were knocked down in 1968 by Talos missiles.** Both planes were outside the 65-mile range of Talos. News of the downings was held up for security reasons, Moorer said . . . . **The Australian Parliament has agreed to lease U. S. Phantom F-4E fighters as stand-ins for the 24 F-111C planes it has on order,** pending tests on the grounded F-111s. The U. S. Air Force has announced, meanwhile, that the F-111 wing under test at General Dynamic's San Diego facility failed at 3,000 hours—1,000 hours short of its life expectancy. The Air Force says, however, that the test has proved that the aircraft has many years of use during which a fix can be devised . . . . **The leading candidate for the director of the new Office of Telecommunications Policy is said to be William A. Niskanen,** 37-year-old Pentagon economist and former director of program analysis in the Institute of Defense Analysis. His deputy may come from the communications industry.



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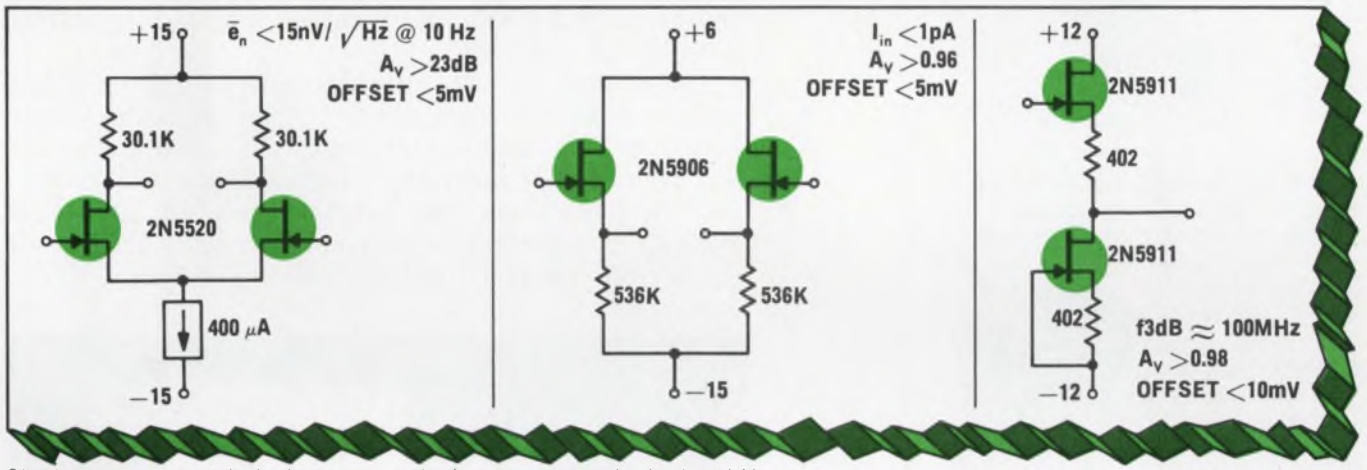
Are these your requirements?– Less than 1 pA I_{in} *and* low noise (for electrometer, Op Amp, or diff amp) or high slew rate (for sample and hold). Use FETs at the input in either long-tailed pair or differential source follower circuits. Another possibility – the temperature compensated source follower for unbalanced circuits.



Which FETs to use? ■ General Purpose: 2N5196-99; ■ Low Noise: 2N5515-24; ■ Low Leakage: 2N5902-09; ■ Wide Band and/or High Gain: 2N5911-12.

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Shoot golf with pros – by computer

How'd you like to play an 18-hole round of golf on the famous course of your choice—without leaving your hometown? Our East Coast Editor, Jim McDermott, came across such an invention, called Golf-O-Tron. (Golf-O-Tron Corp., New York, N. Y.) while gathering material for a story on the use of electronics in sports (page 36).

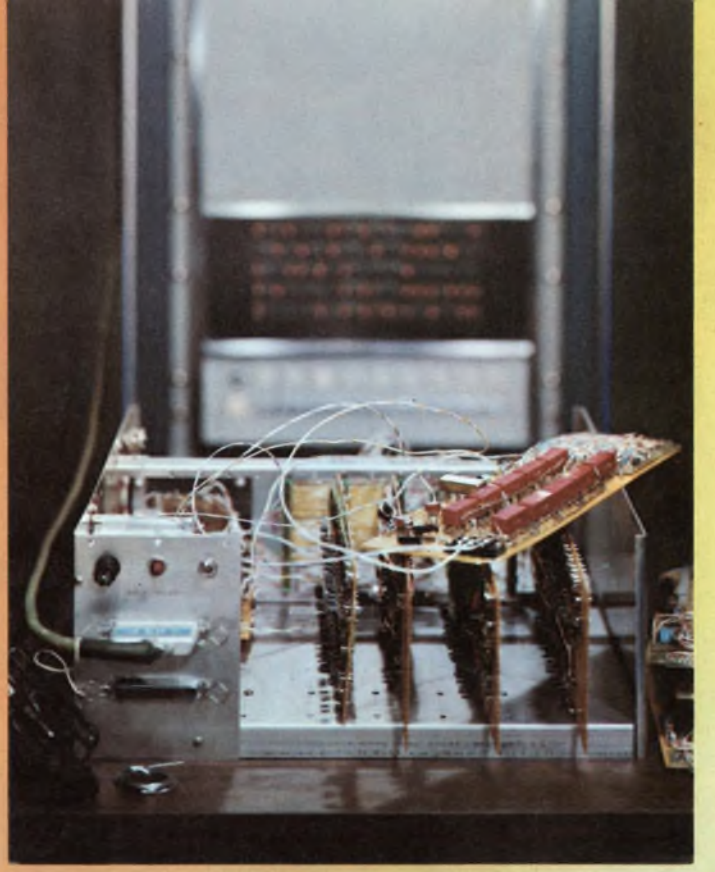
An interesting hybrid—digital/analog—computer is used to control the practice game. The fairway is projected in color on a large screen in front of the player, who drives off the first (and succeeding 17 tees). His ball hits the screen, and from the impact, a computer calculates the trajectory the ball would have taken had our golfer been playing on the real course.

An image of the golf ball following this trajectory is projected on the screen. The computer measures the velocity of the ball and calculates the yardage driven. The projector, controlled by the computer, automatically changes the pictures, as he progresses up the fairway, to correspond with the new position. Once the ball reaches the green, the player putts out on a grasslike surface with the real ball.

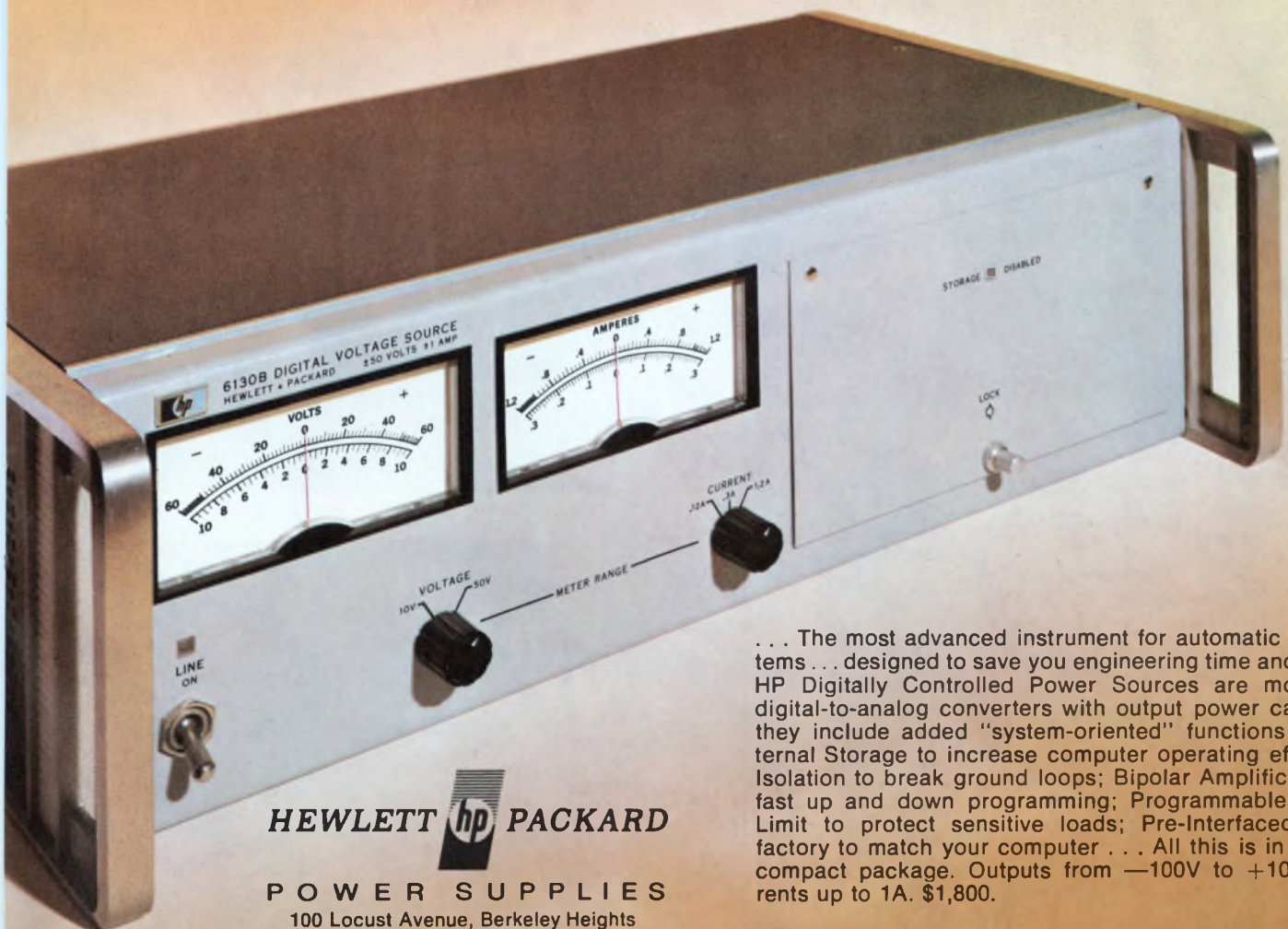
Other jobs the computer is undertaking in sports include picking new players for teams. It evaluates the prospects that team scouts report on. And computers are used also for analyzing opponents' games and players. In these cases, the machine makes a statistical analysis of important factors, and the results are printed out for the managers' and coaches' evaluation.

With the Golf-O-Tron practice machine, a player is about to make an iron shot to the hole 50 yards away—on the screen.

TRIAL and ERROR



eliminated with digitally controlled power



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NET WT. 2 oz/57 g
ELECTRONIC MATERIALS
DOW CORNING®
3145 RTV
adhesive
sealant
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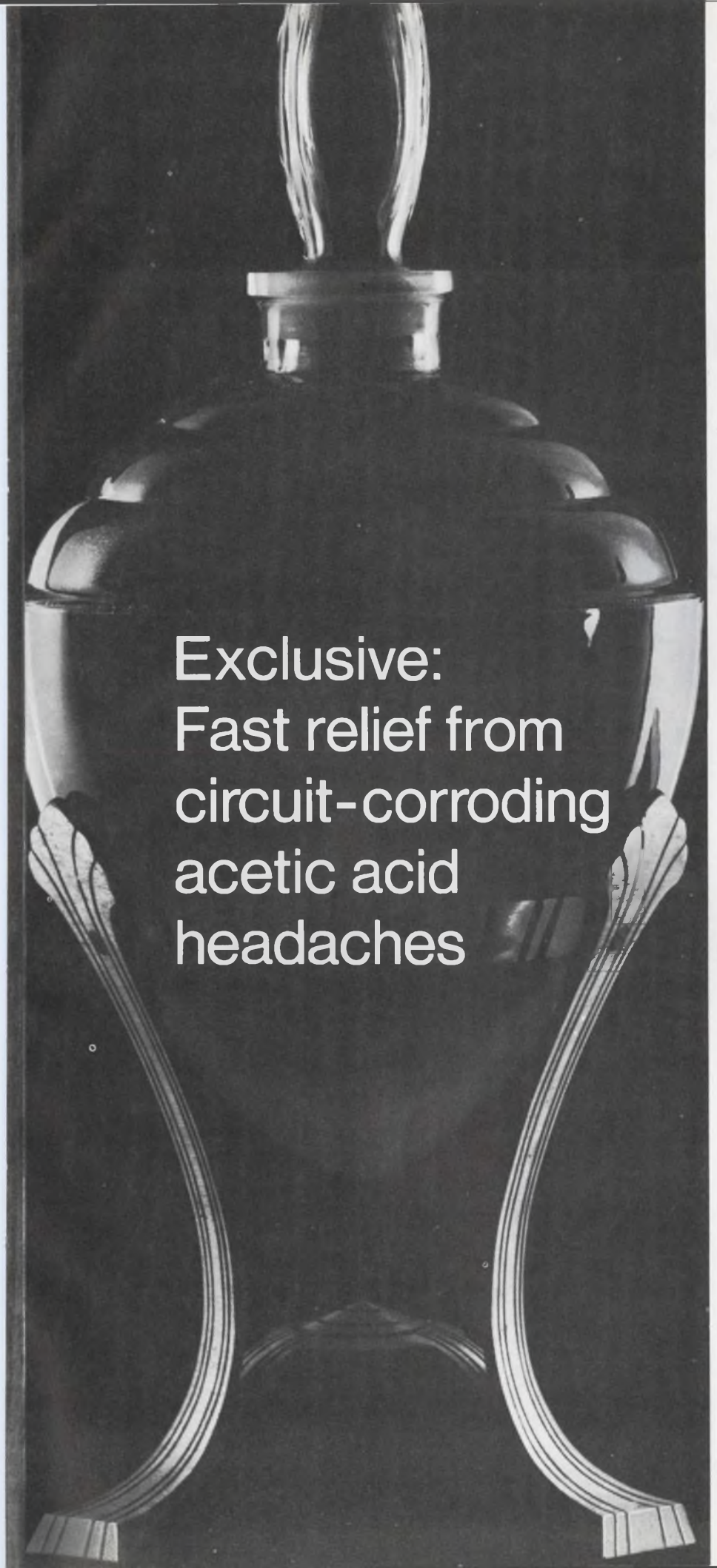

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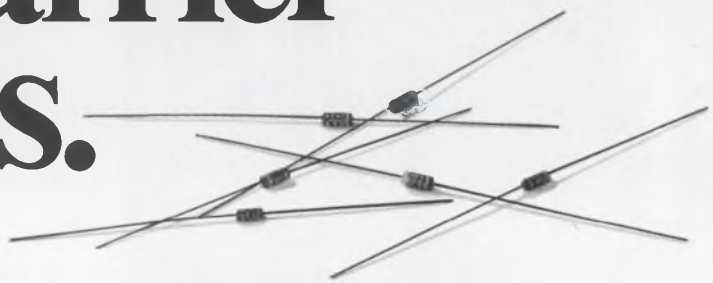
INFORMATION RETRIEVAL NUMBER 28

Process more information faster and cheaper with HP hot carrier diodes.



Now you can think about circuit switching speed in terms of picoseconds instead of nanoseconds, for digital logic systems, data handling and peripheral equipment and other applications where you're designing circuits for mixing, clipping, clamping, A/D conversion, gating and sampling.

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Check your HP sales office for prices, which are as low as 32¢ each in 100,000 quantities for the HP 5082-2800. Ask about specs and prices on the HP 5082-2810 and 2811, too.

.01008

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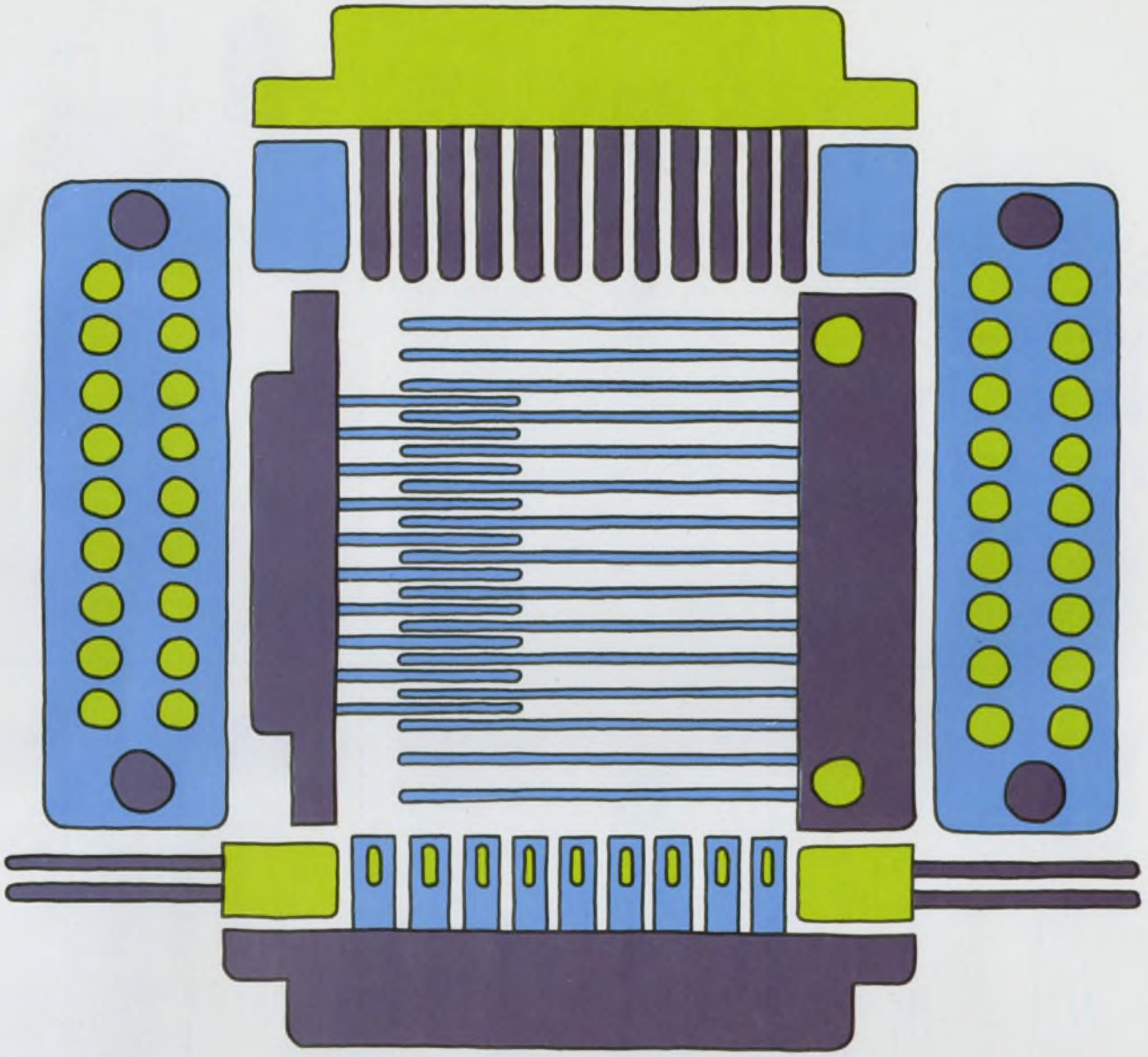
SOLID STATE DEVICES

INFORMATION RETRIEVAL NUMBER 29



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Typical of Winchester Electronics' capabilities in printed circuit connectors are our lines of card edge and board joiners pin and socket connector. And for even more exacting applications, our military approved HB/HBD series.

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So, before you go to the expense of ordering a special printed circuit connector, look into the in-stock selection at Winchester Electronics. Just write Winchester Electronics, Main Street and Hillside Ave., Oakville, Conn. 06779.

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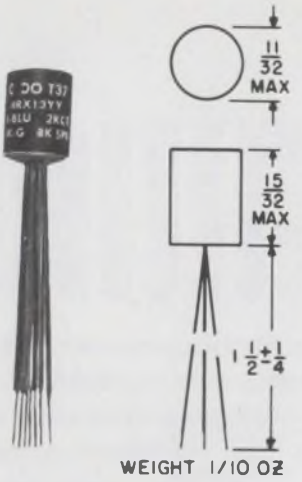
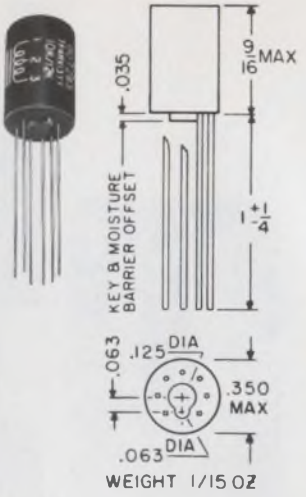
INFORMATION RETRIEVAL NUMBER 30

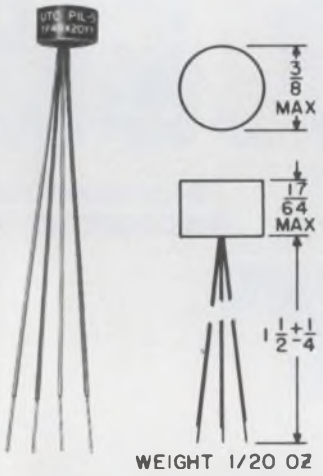
5 fast ways to design-in transformers.



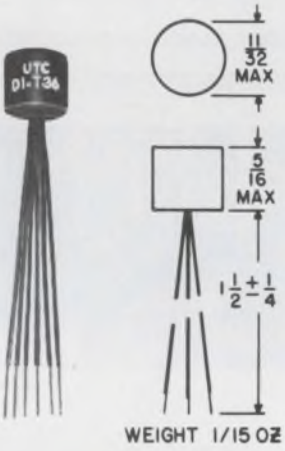
DO-T™ Transistor Transformers & Inductors with frequency response of ± 3db, 300 Hz to 20 kHz. Primary impedance ranges from 80 CT to 200,000 CT; secondary impedance from 3.2 to 20,000 split. Mw levels from 25 to 500. Inductors from .15 Hys @ 20 maDC to 6 Hys @ 2 maDC.



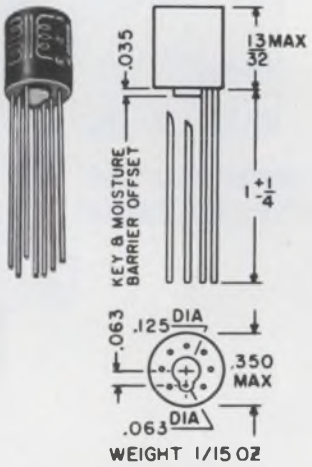
New DO-T200™ Series Transformers & Inductors. Termination patterns conform with TO-5 cased microcircuits. Frequency response: ± 3db, 300 Hz to 20 kHz. Primary impedance ranges from 1,000 CT to 200,000 CT; secondary impedance from 50 to 12,000 CT. Mw levels from 25 to 100. Also available in all standard DO-T specifications.



PIL™ Ultraminiature Audio and High-frequency Transformers & Inductors. Frequency response at 1 mw is ± 3db, 800 Hz to 250 kHz. Primary impedance: 500 CT to 10K CT; Secondary impedance: 500 CT to 2K CT. Max. Mw level: 100. Inductors from .020 Hys @ 10 maDC to .66 Hys @ 0 maDC.



DI-T™ Series Transistor Transformers & Inductors. Frequency response of ± 3db, 400 Hz to 100 kHz. Primary impedance ranges from 80 CT to 30,000 CT; secondary impedance from 3.2 to 12,000 CT. Mw levels from 50 to 500. Inductors from .08 Hys @ 10 maDC to 4.5 Hys @ 2 maDC.



DI-T200™ Transistor Transformers & Inductors. Termination patterns conform with TO-5 cased microcircuits. Frequency response: ± 3db, 400 Hz to 100 kHz. Primary impedance ranges from 80 to 30,000 CT; secondary impedance from 32 split to 12,000 CT. Mw levels from 50 to 500. Inductors from .02 Hys @ 20 maDC to 4.5 Hys @ 2 maDC. Also available in all standard DI-T specifications.

Here is the entire UTC DO-T family.

Pick any one of these transformers—you'll combine maximum performance characteristics, unusual power handling capability and high reliability in a tiny package. Their parameters greatly exceed those of conventional transformers, making them ideal for a wide range of applications.

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Polarity	$\lvert V_{BE_1} - V_{BE_2} \rvert$		$\left\lvert \frac{V_{BE_1} - V_{BE_2}}{\Delta T_A} \right\rvert$			Matched Duals	Pinning BN	Pinning BP
	5mV	10mV	10μV/°C	20μV/°C	30μV/°C		E B C	E C B
NPN/NPN	TD-100 TD-200 TD-250	TD-101 TD-201	TD-250	TD-100 TD-200	TD-101 TD-201	TD-2219	TD-200 TD-201 TD-202 TD-250	TD-100 TD-101 TD-102 TD-2219
PNP/PNP	TD-400 TD-500 TD-550	TD-401 TD-501	TD-550	TD-400 TD-500	TD-401 TD-501	TD-2905	TD-500 TD-501 TD-502 TD-550	TD-400 TD-401 TD-402 TD-2905
PNP/NPN	–	–	–	–	–	TD-600 TD-601 TD-602 TD-700 TD-701 TD-702	TD-700 TD-701 TD-702	TD-600 TD-601 TD-602

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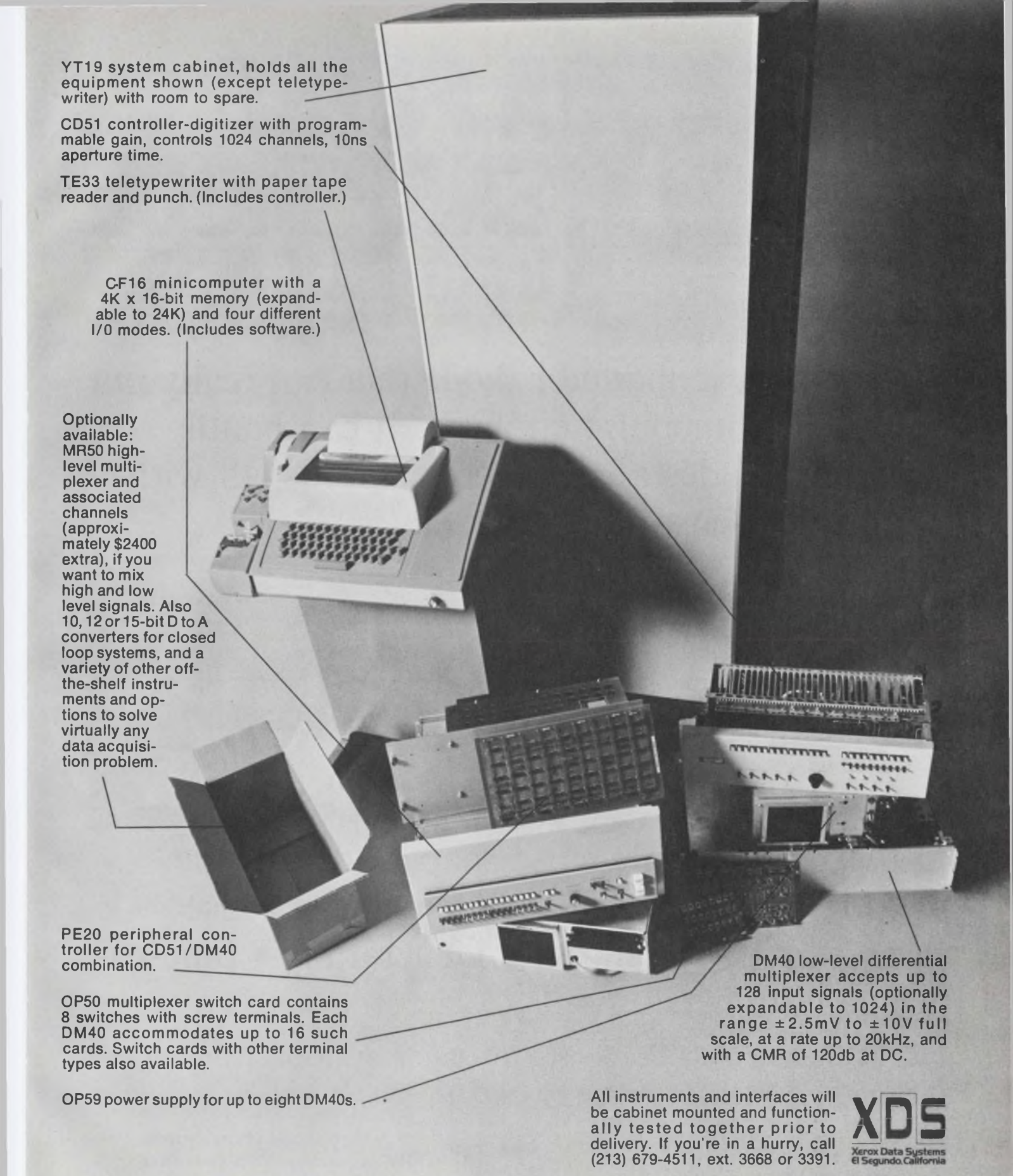

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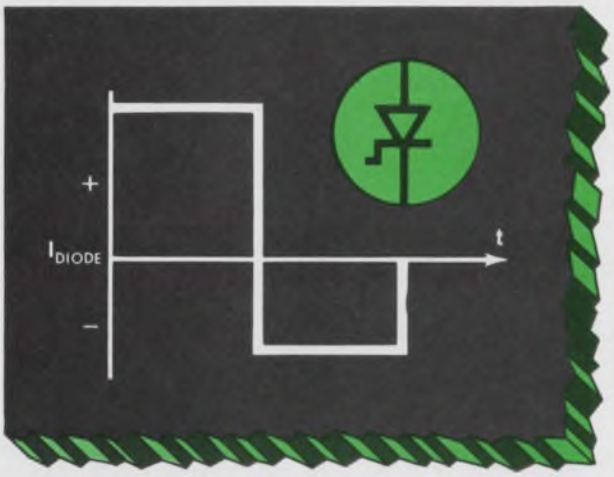

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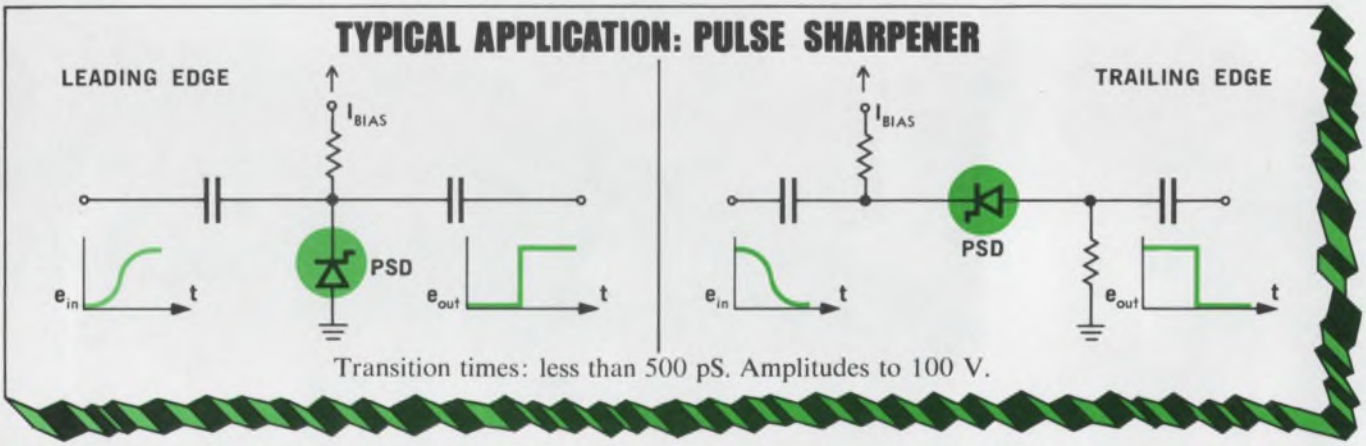

Transition times: less than 500 pS. Amplitudes to 100 V.

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INFORMATION RETRIEVAL NUMBER 35 ►

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For more information on the Direct Function Processing technique write:

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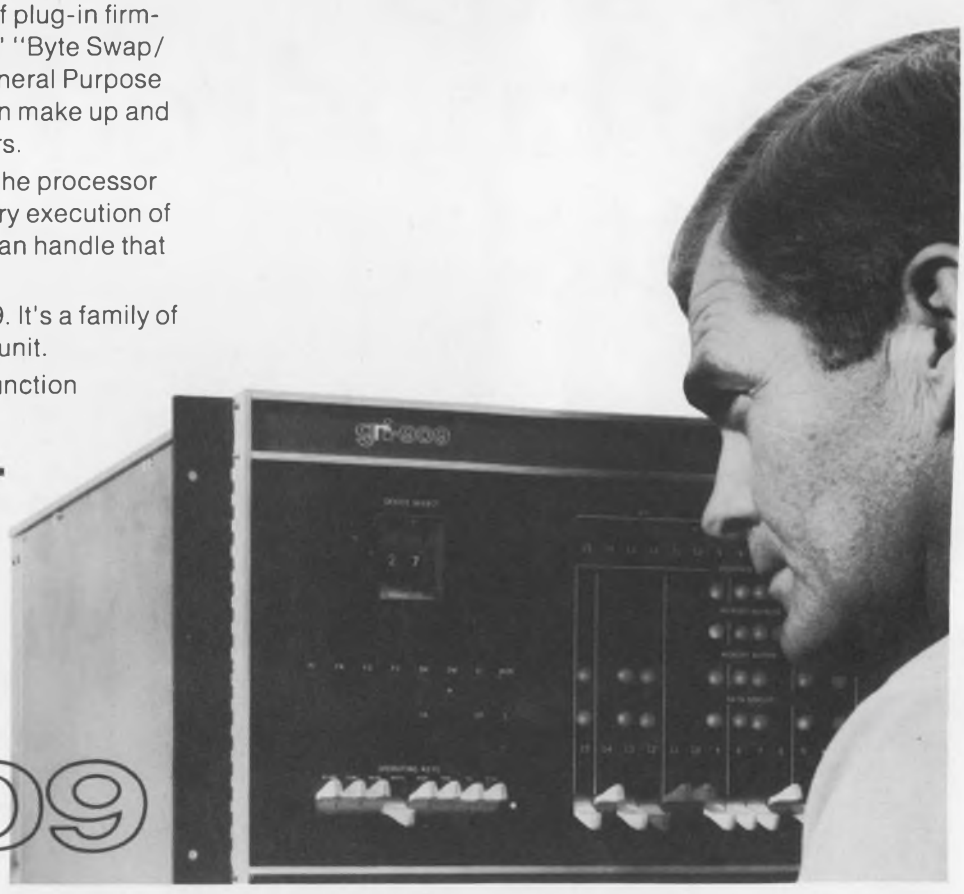
* EXPANDABLE PROCESSOR UNIT



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Whiteness. We make Celanese nylon in a continuous, patented process—so it has a shorter heat history. That's why it's whiter in the pellet. Whiter in your products. And it's whiter through successive regrinds.

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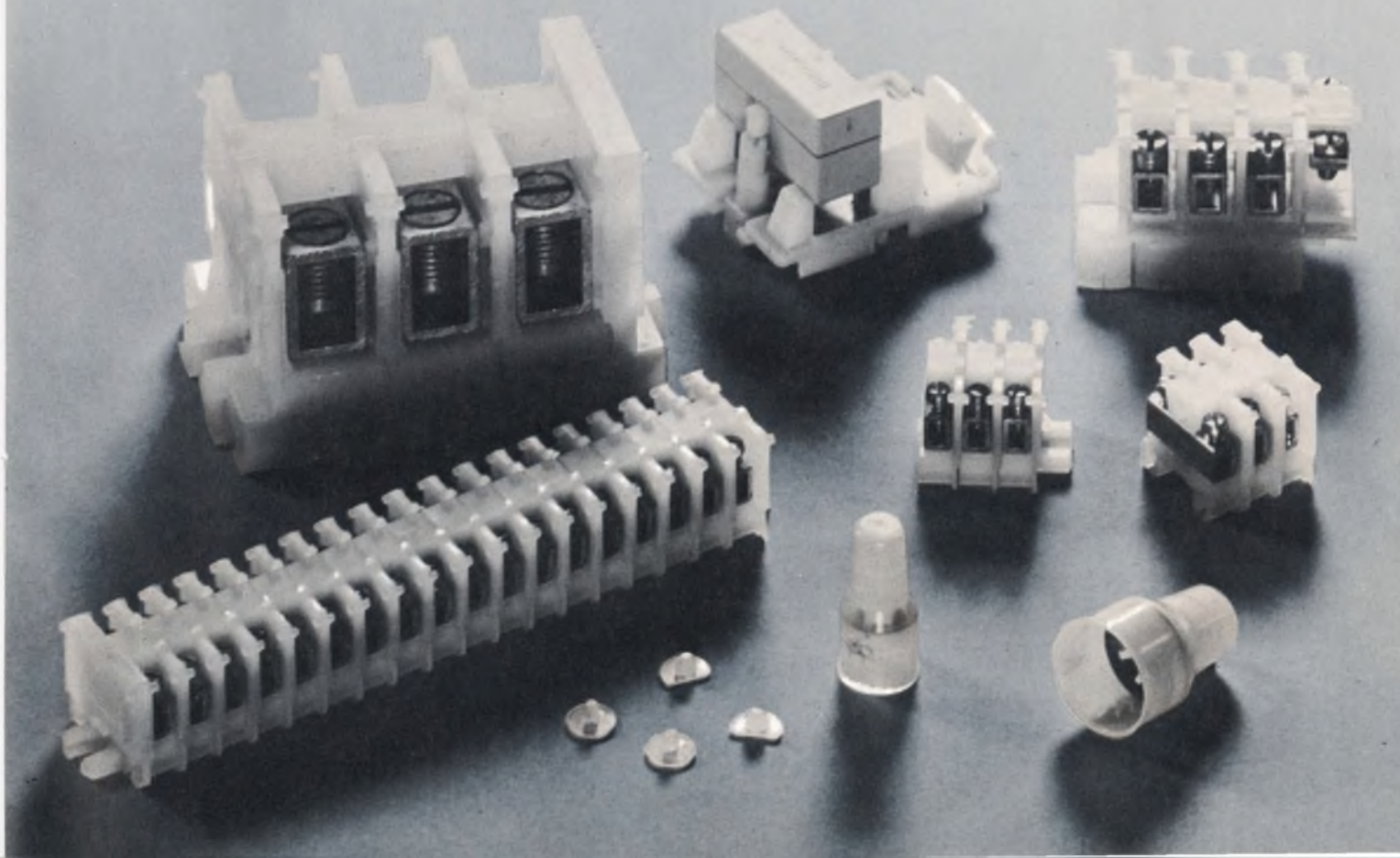
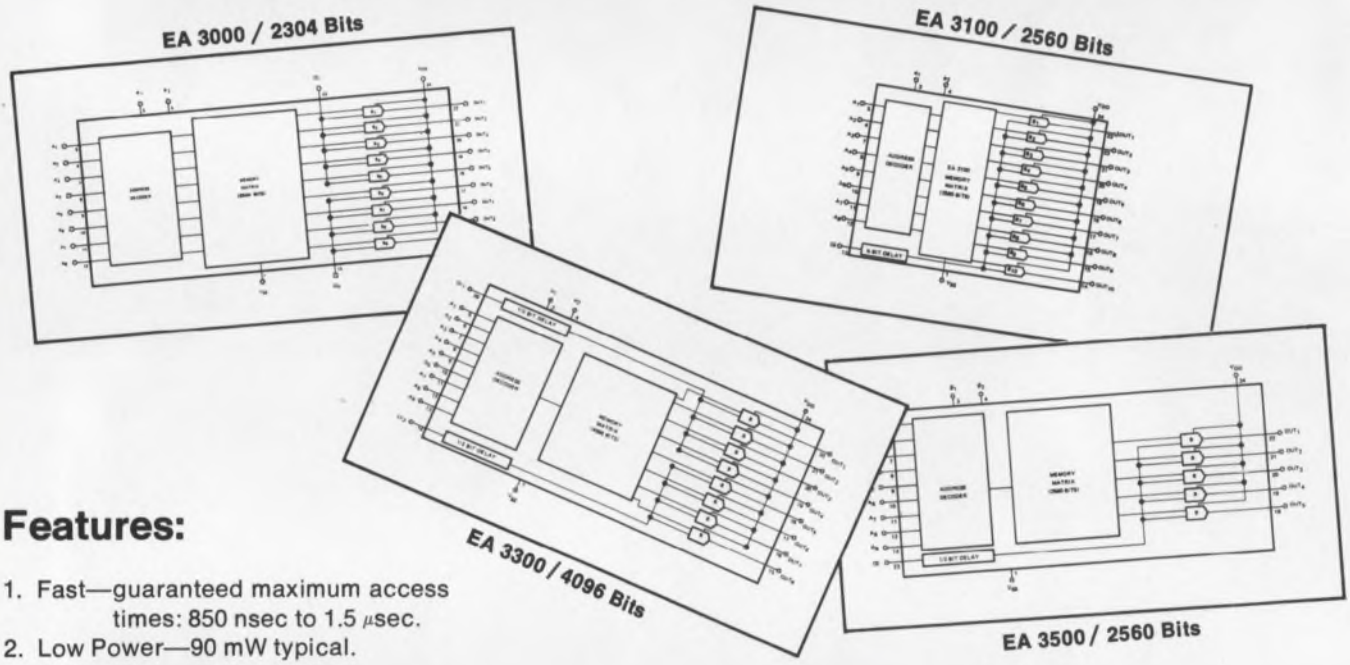


For ≈1¢/bit – production quantities of YOUR CHOICE



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INFORMATION RETRIEVAL NUMBER 38

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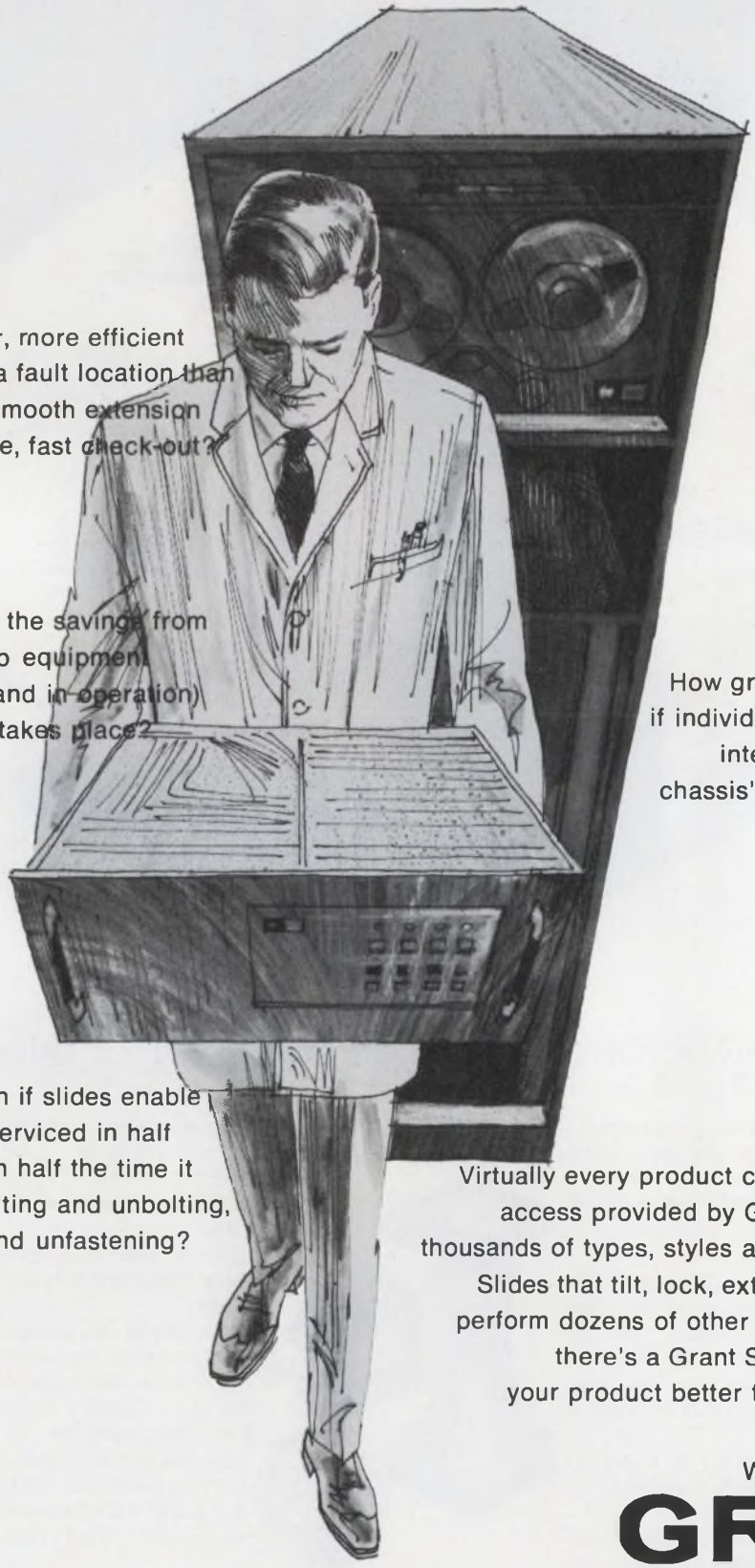

Is there a quicker, more efficient way to get to a fault location than by immediate and smooth extension of the unit for simple, fast check-out?

Would you guess the savings from being able to keep equipment connected (and in operation) while maintenance takes place?

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

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

Virtually every product can use the ready access provided by Grant Slides. There are thousands of types, styles and sizes available. Slides that tilt, lock, extend and lock and perform dozens of other functions. Undoubtedly, there's a Grant Slide that can help make your product better too.

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INFORMATION RETRIEVAL NUMBER 39

INFORMATION RETRIEVAL NUMBER 40 ►

Each Sylvania 7400N package is guaranteed to meet a hermeticity specification of 1×10^{-7} cc/sec, 2% AQL.

We make this guarantee because of the superior construction of our Cerdip package.

And you don't pay anything extra for this added feature; in fact you pay less. The price on our Cerdip 7400N devices is no higher than competing plastic units.

This guarantee of hermeticity applies to all 14 devices in our present off-the-shelf line and will apply to 13 additional 7400N TTL devices we will announce in the near future.

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This is a major commitment to improved reliability.

Sylvania 7400N devices are at your distributor right now. You don't have to worry about problems with plastics when you can get our guaranteed Cerdip packs, and save money, too.

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Guaranteed* hermeticity in every package.

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GaAsLITE Update

Being a quick and thorough survey of what's available in solid state displays.

The MAN 1:

A seven-segment light-emitting all-semiconductor alphanumeric readout.

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

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

The MAN 2:

An alphanumeric display made up of 36 discrete LEDs which can form 64 ASCII characters and a decimal point.

The IC-compatible 5 x 7 X-Y array gives you a bright red (peak emission 6500Å), high contrast display suitable for keyboard verifiers, avionics or computer terminals or other displays. Since the 36 dots can make 2^{36} bits available, the MAN 2 can be very useful in film annotation work.

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

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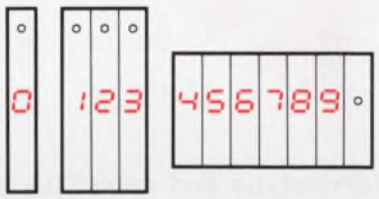
The MAN 3:

The world's first commercially available planar monolithic display. Low cost, besides!

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

- Brightness: 200 foot-Lamberts @ I_F=5 mA, 1.7 volt, per segment.
- Total cont. forward current: 80 mA.
- Pulsed forward current=50 mA, 10% duty cycle per segment.
- Price: 1,000 quantities, $7.55.



MPC 1 MPC 2 MPC 3

We've mounted the MAN 3 for you

Our MPC-series are simply the new MAN 3 numerics carefully soldered to NEMA-grade G-10 copper-clad glass/epoxy laminate pc boards.

The MPC 1 and MPC 2 boards let you address each segment of the numeric independently. The MPC 3 holds six MAN 3's which are multiplexable (X-Y addressable). There are two major benefits in doing your prototype work with our MPC units:
1) they're a heck of a lot easier to breadboard and 2) you can use them for fast turnaround into full production. Send for complete details. Fast! Price, MPC 2: 1 to 9, $35.80 ea.

Monsanto

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

INFORMATION RETRIEVAL NUMBER 44

It decodes, level shifts and gates! It's in stock! Right now! Order for your requirements now. Computer Microtechnology Inc. is shipping from stock the CM1400 3 bit binary to one of 8 line decoders. It is a bipolar integrated circuit with standard TTL inputs and special output circuitry with high level signals for driving MOS devices.

Many of your system functions can be performed by using the CM1400 decoder. You will find it ideally suited for address decoding and level shifting in MOS memories, gating low level MOS multiplexers and general high speed decoding applications. Two chip inhibit inputs are provided for easy expansion.

Computer Microtechnology Inc. continues to supply products that increase the capability of memory systems. The CM1400 decoder illustrates this with its high speed and other excellent characteristics. Check the specs.

CM1400 3 BIT BINARY TO ONE OF 8 LINE DECODER

Propagation Delay	50 nsec typ, 100 pf load
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Output High Voltage	9.5 V typ, −0.1 mA
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Price	$15.25, 1–24
Delivery	Stock

Order yours today! They're in stock!

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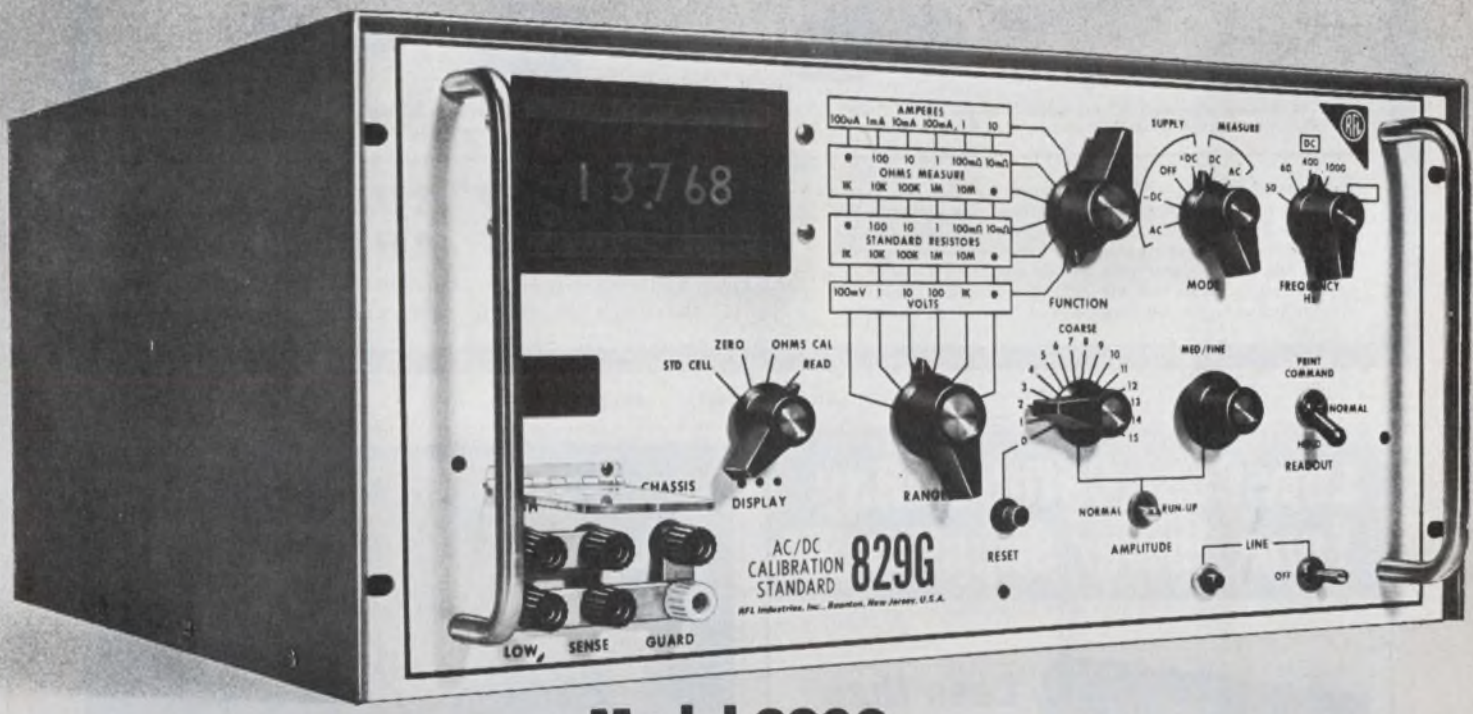
INFORMATION RETRIEVAL NUMBER 45

calibration and measurement in one instrument.



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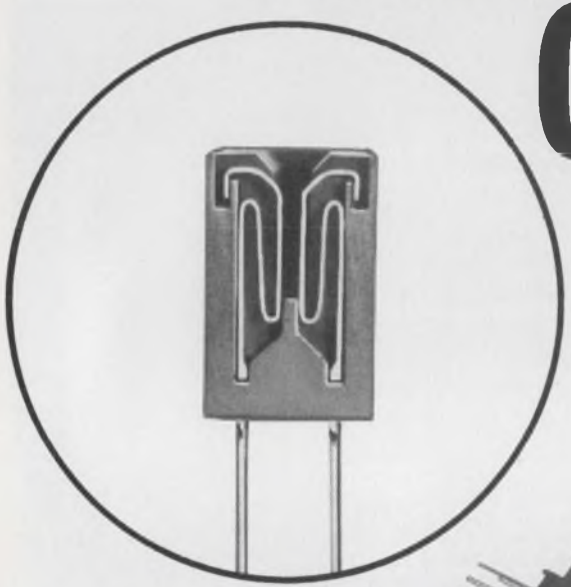

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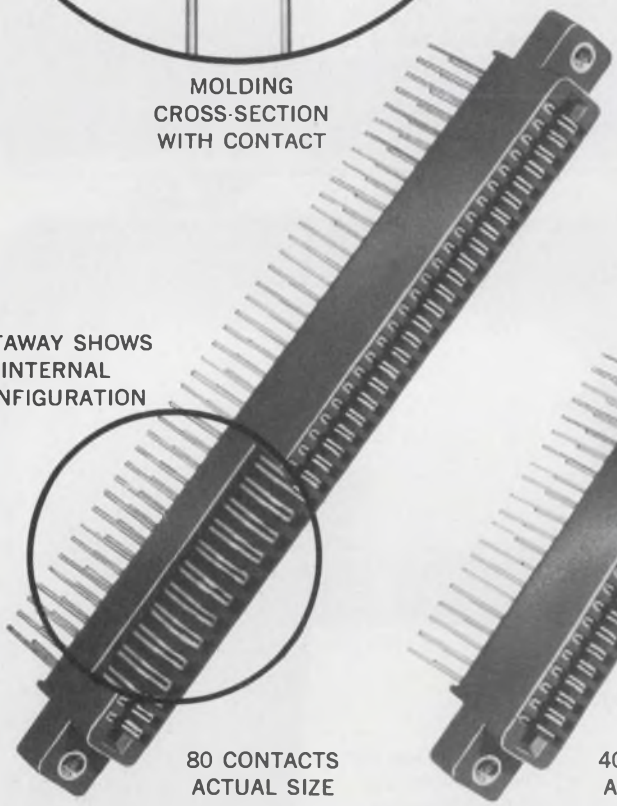

80 CONTACTS ACTUAL SIZE

40 CONTACTS ACTUAL SIZE

Write for printed circuit catalog on our entire line of receptacle type connectors.

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INFORMATION RETRIEVAL NUMBER 52 ►

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M150

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Call RCA for tunnel diodes. They're stable, they're available off the shelf.

RCA tunnel diodes offer prime advantages of immediate availability plus remarkable stability proved by over a million device-hours of testing.

Note these outstanding characteristics: low capacitance, high I_p/I_v ratios, mechanical ruggedness, improved thermal resistance, uniformity — all achieved through an RCA process of epitaxially-grown junctions. Check the chart for key parameters.

Added features: the gold-plated leads require no pretinning for soldering efficiency. And the package lends itself well for high-volume PC-board mounting operations. Use RCA tunnel diodes especially in your high-speed switching and high-frequency signal-processing applications.

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Type	I_p (mA) Min.	I_p (mA) Max.	I_p/I_v Min.	C (pF) Max.	tr (ps) Typ.
40561	4.5	5.5	6/1	25	1800
40562	9	11	6/1	25	900
40563	18	22	6/1	30	600
40564	45	55	6/1	40	350
40565	90	110	6/1	40	150
40566	4.75	5.25	8/1	15	1200
40567	9.5	10.5	8/1	15	600
40568	19	21	8/1	20	400
40569	47.5	52.5	8/1	25	200
40570	95	105	8/1	25	100
40571	4.75	5.25	8/1	8	600
40572	9.5	10.5	8/1	8	300
40573	19	21	8/1	10	200
40574	47.5	52.5	8/1	12	100

RCA

INFORMATION RETRIEVAL NUMBER 53

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Lesson from Apollo: plan for contingencies

When it all works well, everyone is doing a great job. When things go wrong, we find out how competent people really are. Competent designers always design margin into their systems and plan for contingencies. Lesser designers merely try to meet the specs, with little or no margin, and hope that nothing goes wrong.

The true value of contingency planning really showed up during the difficult moments following the explosion on Apollo 13.

It was about two years ago, at the North American Rockwell Corp., that the solution was worked out for the problem of what to do if two of the fuel cells failed aboard the service module of the lunar spacecraft. A remarkable calm prevailed at the Manned Spacecraft Center in Houston, and also on board Apollo 13, when the explosion occurred. These men knew that the situation, while extremely dangerous, had a workable solution that had been practiced for many hours while the astronauts were training for the mission. It was but one of many contingencies for which the astronauts had drilled. And Astronaut Jack Swigert had recently completed the writing of a manual concerned with what to do if any malfunctions occurred in the command module.

What better example of the value of designing in margin than that of Grumman's outstanding lunar module? A vehicle designed to fly merely from an orbit around the moon to the lunar surface and back again actually guided the command and service modules around the moon and all the way back to earth. This vehicle far exceeded the expected demands upon its navigation and life-support systems, its power supplies and its engines.

Yet it wasn't always so in the beginning of the Apollo program. Witness the disastrous fire that cost the lives of three astronauts and the weight problems that the early lunar module had at Grumman. Each of these shortcomings cost the nation heavily. But the final design was excellent.

A lesson must be learned from the extremely competent design engineers who put together the Apollo system. Never fail to plan for major contingencies. Always assume that Murphy (whoever he was) was right when he postulated his law: "If it can fail, it will."

DAVID N. KAYE

Liberate your FET amplifier design from tight device specifications by using this combination bias technique. Transfer curves greatly simplify the job.

Engineers often design FET amplifiers that are unnecessarily sensitive to device characteristics because they may not be familiar with proper biasing methods.

One way to obtain consistent circuit performance in spite of wide device variations is to use a combination of constant-voltage and self biasing. The combined circuit configuration turns out out to be the same as that generally used with bipolar transistors, but its operation and design are quite different.

Three basic circuits

Let's examine three basic common-source circuits that can be used to establish a FET's operating point (Q-point) and then see how two of them can be combined to provide greatly improved performance. The three basic biasing schemes are:

- Constant-voltage bias, which is most useful for rf and video amplifiers employing small dc drain resistors.
- Constant-current bias, which is best suited to low-drift dc amplifier applications such as source followers and source-coupled differential pairs.
- Self bias (also called source bias or automatic bias), which is a somewhat universal scheme, particularly valuable for ac amplifiers.

The Q-point established by the intersection of the load line and the $V_{GS} = -0.4$ V output characteristic of Fig. 1 provides a convenient starting point for the circuit comparison. The load line shows that a drain supply voltage, V_{DD}, of 30 V and a drain resistance, R_D, of 39 kΩ are being used.

The quiesent drain-to-source voltage, V_{DSQ}, is 15 V, allowing large signal excursions at the drain. Maximum input signal variations of ±0.2 V will produce output voltage swings of ±7.0 V —a voltage gain of 35.

The constant-voltage bias circuit (Fig. 2) is analyzed by superimposing a line for V_{GS} = constant on the transfer characteristic of the FET.

The transfer characteristic is a plot of I_D vs V_{GS} for constant V_{DS}. Since the curve doesn't change much with changes in V_{DS}, it is quite useful in establishing operating bias points. In fact, it is probably more useful than the output characteristics because its curvature clearly warns of the distortion to be expected with large input signals. Furthermore, when a bias load line is superimposed, allowable signal excursions become evident and input voltage, gate-source signal voltage, and output signal current calculations may be made graphically.

The heavy vertical line at $V_{GS} = -0.4$ V establishes the Q-point of Fig. 1. No voltage is dropped across resistor R_G because the gate current is essentially zero. R_G serves mainly to isolate the input signal from the V_{GG} supply.

Excursions of the input signal, e_i, combine in series with V_{GS} so that they add algebraically to the fixed value of −0.4 V. The effect of signal variation is to instantaneously shift the bias line horizontally without changing its slope. The shifting bias line then develops the output signal current as shown in color in Fig. 2.

The constant-current bias approach (Fig. 3) for establishing the Q-point of Fig. 1 requires a 0.39-mA current source. For an ideal constant-current generator, input signal excursions merely shift the bias line horizontally and produce no resultant gate-source voltage excursion. This bias technique is therefore limited to source followers, source-coupled differential amplifiers, and to ac amplifiers where the source terminal is bypassed to ground at the signal frequency.

If an ac ground is provided by a bypass capacitor across the current source, a vertical ac bias line will be established. Input signal variations will then translate the ac bias line horizontally, and signal development will proceed as with constant-voltage biasing (Fig. 3, color).

Should the bypass capacitor not provide a sufficiently small reactance at the signal frequency, the ac bias line will not be vertical. It will still intersect the transfer curve at the Q-point but with a slope equal to $-(1/X_c) = -\omega C$ (Fig. 4). This will lower the gain of the amplifier because of signal degeneration at the source. The input

James S. Sherwin, Applications Manager, Siliconix, Inc., Santa Clara, Calif.

signal, e_g, is reduced by the drop across the capacitor:

$$v_{gs} = e_g - v_s = e_g - i_s X_c \qquad (1)$$

It is clear from Fig. 4 that the input signal only shifts the operating point by an amount equal to v_{gs}, the effective input signal. As the signal frequency is decreased, the slope of the ac bias line decreases, causing the effective input signal to approach zero.

Self bias needs no extra supply

The self-bias circuit (Fig. 5) establishes the Q-point by applying the voltage dropped across the source resistor, R_S, to the gate. Since no voltage is dropped across R_S when $I_D = 0$, the self-bias load line passes through the origin. Its slope is given by $-1/R_S$. Therefore, the desired Q-point is established by setting $-1/R_S = I_{DQ}/V_{GSQ}$.

Signal development is the same as in the case of the partially bypassed constant-current scheme except that the load line is a dc bias line. Signal degeneration is described by Eq. 1 with X_c replaced by R_S. The ac gain of the circuit can be increased by shunting R_S with a bypass capacitor, as in the constant-current case. The ac load line then passes through the Q-point with a slope $-(1/Z_S = -(\omega C + 1/R_S)$.

The circiut is biased automatically at the desired Q-point, requires no extra power supply and provides a degree of current stabilization not possible with constant-voltage biasing.

A fourth biasing method, combining the advantages of constant-current biasing and self biasing, is obtained by combining the constant-voltage circuit with the self-bias circuit (Fig. 6). A principal advantage of this configuration is that an approximation may be made to constant-current bias without any additional power supply. The bias load line may be drawn through the selected Q-point and given any desired slope by properly choosing V_{GG}. (The bias line intercepts the V_{GS} axis at V_{GG}). The larger V_{GG} is made, the larger R_S will be and the better will be the approximation to constant-current biasing.

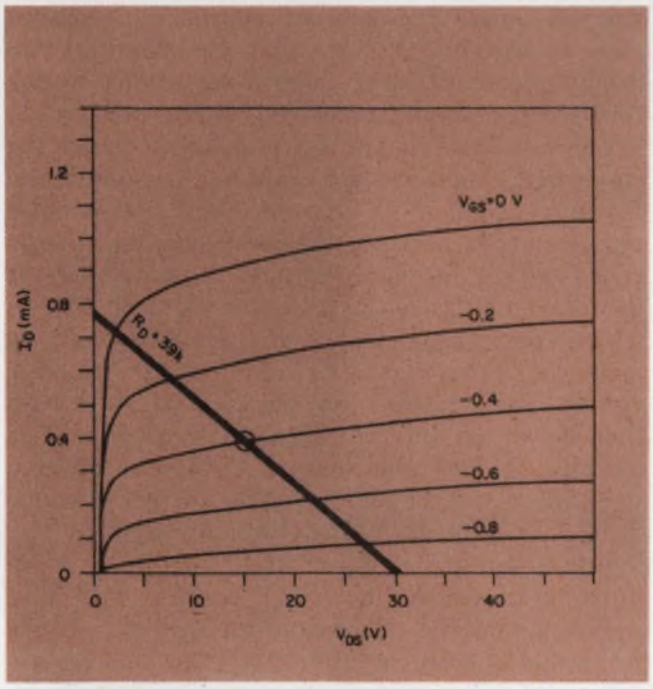
All three circuits in Fig. 6 are equivalent. Circuit 6a requires an extra power supply. The need for an additional supply is avoided in 6b by deriving V_{GG} from the drain supply. R_1 and R_2 are simply a voltage divider. To maintain the high input impedance of the FET, R_1 and R_2 must both be very large.

Very large resistors cannot always be found in the exact ratio needed to derive the desired V_{GG} in every circuit application. Circuit 6c overcomes this problem by placing a large R_G between the center point of the divider and the gate. This allows R_1 and R_2 to be small, without lowering the input impedance.

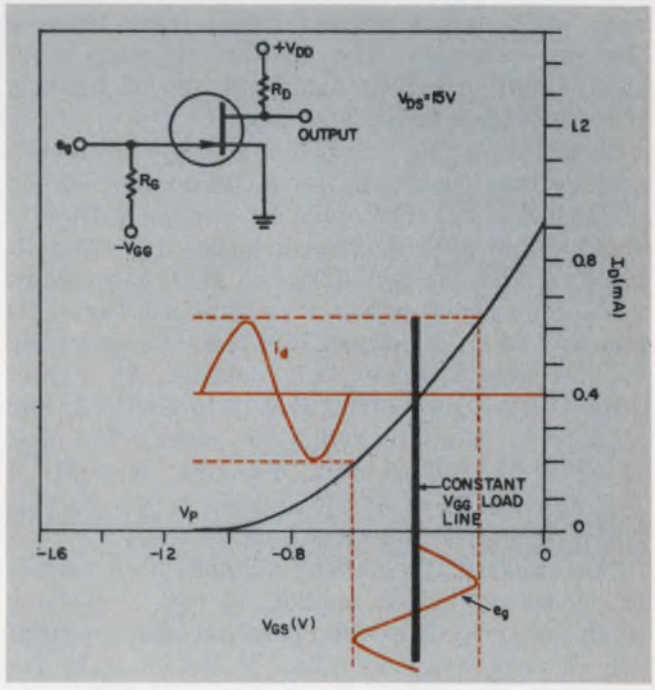
One point of caution worth remembering is that as V_{GG} is increased, V_S increases, and V_{DS} decreases. Therefore with low V_{DD}, there may be a significant decrease in the allowable output voltage swing.

Biasing for device variations

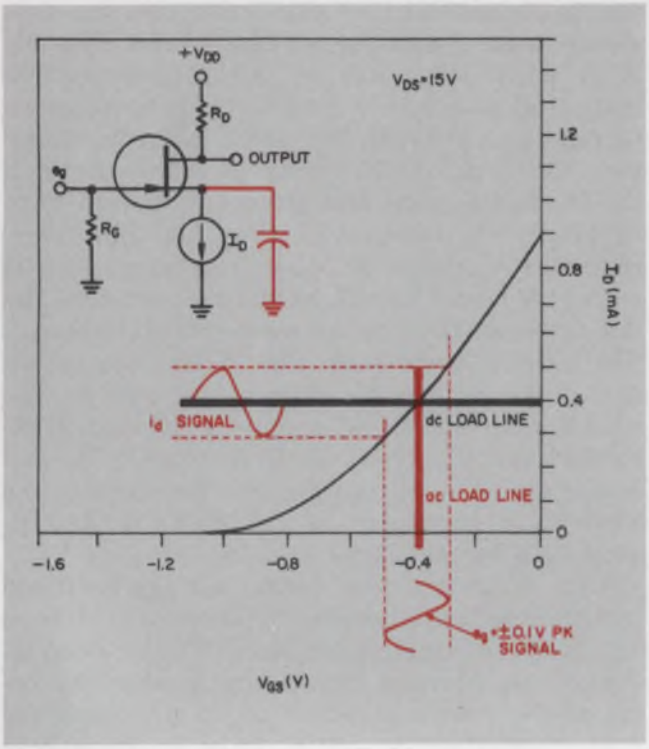
The value of the combination-bias technique becomes apparent when one considers the normal



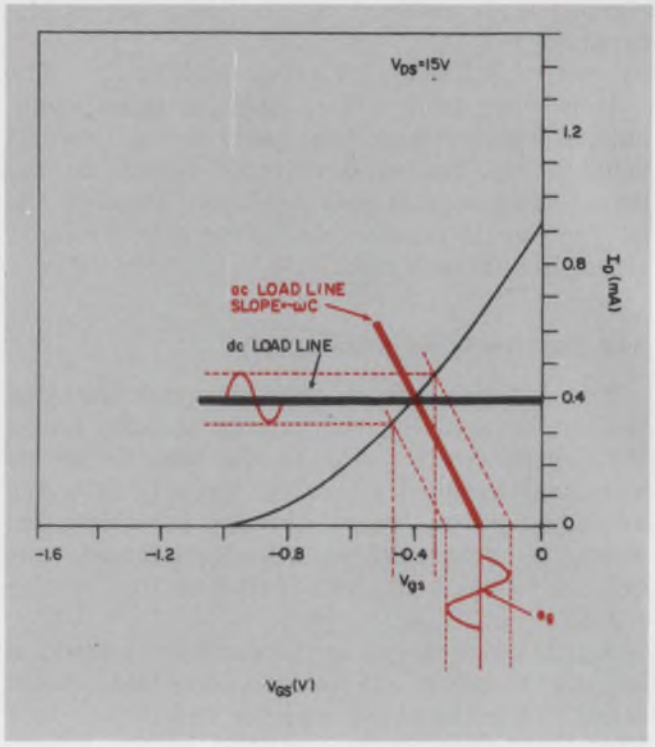
1. **A large dynamic range is provided** by the operating point at V_{DSQ}= 15 V, I_{DQ} = 0.39 mA and V_{GSQ} = −0.4 V. The output characteristics are for a typical 2N4339.



2. **Constant-voltage bias is maintained** by the V_{GG} supply as shown on this typical 2N4339 transfer curve. Input signal e_g moves the load line horizontally (color).



3. **Constant-current bias** fixes the output voltage for any R_D. Hence, input signals cannot affect the output unless the current source is bypassed (color).



4. **Partial bypassing of the current source** (Fig. 3) lowers the circuit gain by tilting the ac load line from the vertical. The capacitor drop subtracts from e_g.

production spread of device characteristics. The problem is illustrated in Fig. 7 where two limiting sets of output characteristics, representing the actual min-max spread of the Siliconix 2N4339, are presented. Limiting characteristics like these are not normally available. Even if they were, however, they'd be of little help in establishing operating points suitable for all devices with output characteristics lying between the two extremes. The problem is much more easily approached by using the set of limiting transfer characteristics of Fig. 8.

Attempting to establish suitable constant-voltage bias conditions for a production spread of devices is practical only for circuits with very small values of dc drain resistance—for example, circuits with inductive loads. As the constant-voltage bias plot of Fig. 8 reveals, constant gate bias causes a significant difference in operating I_{DQ} for the extreme limit devices. At $V_{GS} = -0.4$ V, the range of I_{DQ} is 0.13 to 0.69 mA, and V_{DSQ} for a given R_D will vary greatly for most resistance-loaded circuits. For the example of Fig. 1, with $R_D = 39$ kΩ and $V_{DD} = 30$ V, V_{DSQ} varies from near saturation (5 V) to 25 V.

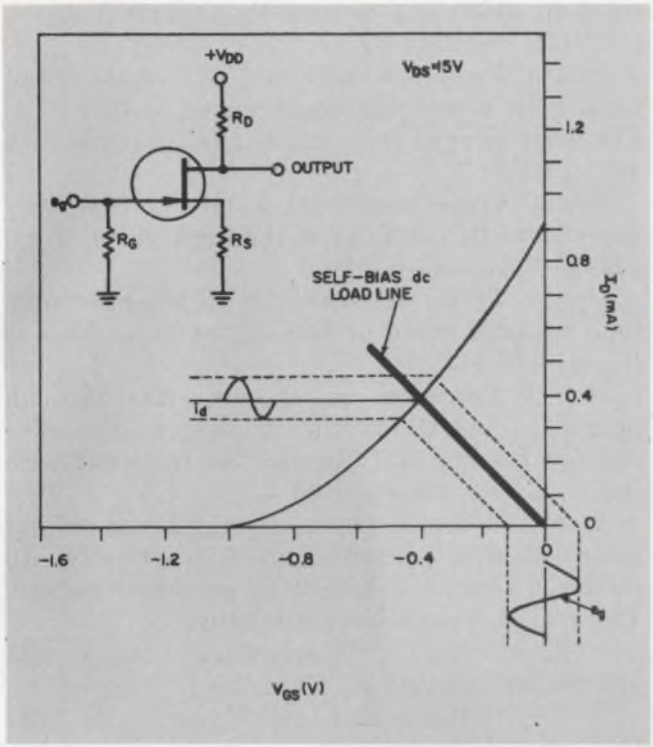
An apparently excellent method of biasing is the constant-current method of Fig. 3. Biasing in this manner fixes the operating drain current for all devices and sets V_{DSQ} to $V_{DD} - I_{DQ}R_L$ for any device in the production spread. V_{GS} automatically finds a value to set the appropriate I_{DQ} = constant for all devices. For the constant-current bias plot of Fig. 8, with $I_{DQ} = 0.39$ mA, V_{GS} would range from −0.11 V to −0.67 V.

Output characteristics are not needed as long as I_{DQ} is chosen to be below the minimum I_{DSS}. With $R_D = 39$ kΩ and $V_{DD} = 30$ V, V_{DSQ} is 14.8 V for all devices.

The disadvantages of the constant-current method are that it allows no signal to be developed unless the current source is bypassed and, as we shall see, it lacks the flexibility to provide constant gain despite variations in the forward transconductance, g_{fs}, of the devices.

The self-bias scheme is a reasonable choice for single-ended dc amplifiers and for ac amplifiers. In unbypassed or dc circuits, some compromise must be made between the gain loss due to current feedback degeneration and the advantage of current stabilization achieved with high R_S.

An appropriate choice of I_{DQ} limits can be made by using the pair of limiting transfer curves. For example, for $R_S = 1$ kΩ, the load line shown on the self-bias curve of Fig. 8 is established. The maximum I_D is 0.52 mA, and the minimum I_D is 0.24 mA. The operating range of V_{DSQ} may be calculated for any value of V_{DD} and R_D. Clearly, for $R_D = 39$ kΩ, the maximum-limit device (device B) would operate with $V_{DSQ} = 9.8$ V and the minimum-limit device (device A) would operate with $V_{DSQ} = 20.6$ V. This results in fairly satisfactory operation for all devices. However, such a variation in I_{DQ} imposes severe limitations on the circuit design.



5. **The self-bias load line passes through the origin** with a slope $-1/R_S$. Bypassing R_S will steepen the slope (color) and increase the gain of the circuit.

A better aprpoach is illustrated by the combination-bias curve of Fig. 8 with $V_{GG} = 1.2$ V. The range of I_{DQ} for this bias condition is 0.25 mA to 0.32 mA. A similar minimum difference in I_{DQ} could be achieved with $R_S = 6$ kΩ and $V_{GG} = 0$, (a self-bias condition) but the operating points would be pushed toward the toe of the transfer characteristics and allowable signal input would be reduced.

The upper load line allows $v_{gs} = \pm 1.8$ V (limited by I_{DSSA}), while the lower line allows a v_{gs} of only ± 0.7 V (limited by V_{PA}). (The subscript letters A and B refer to the minimum and maximum devices, respectively.) The combination circuit allows almost ideal operation over the full production spread of devices. Even with $R_D = 62$ kΩ, the V_{DSQ} would range only between 10 and 15 V.

For this circuit, R_D should be chosen to allow the largest output signal swing for I_{DQ} midway between the two extremes of 0.25 and 0.32 mA; namely 0.285 mA. Setting the voltage drop across R_D at one-half of $(V_{DD} - 2V_{P\,typ})$ or 14 V, yields $R_D = (14\text{ V}/0.285\text{ mA}) = 49$ kΩ.

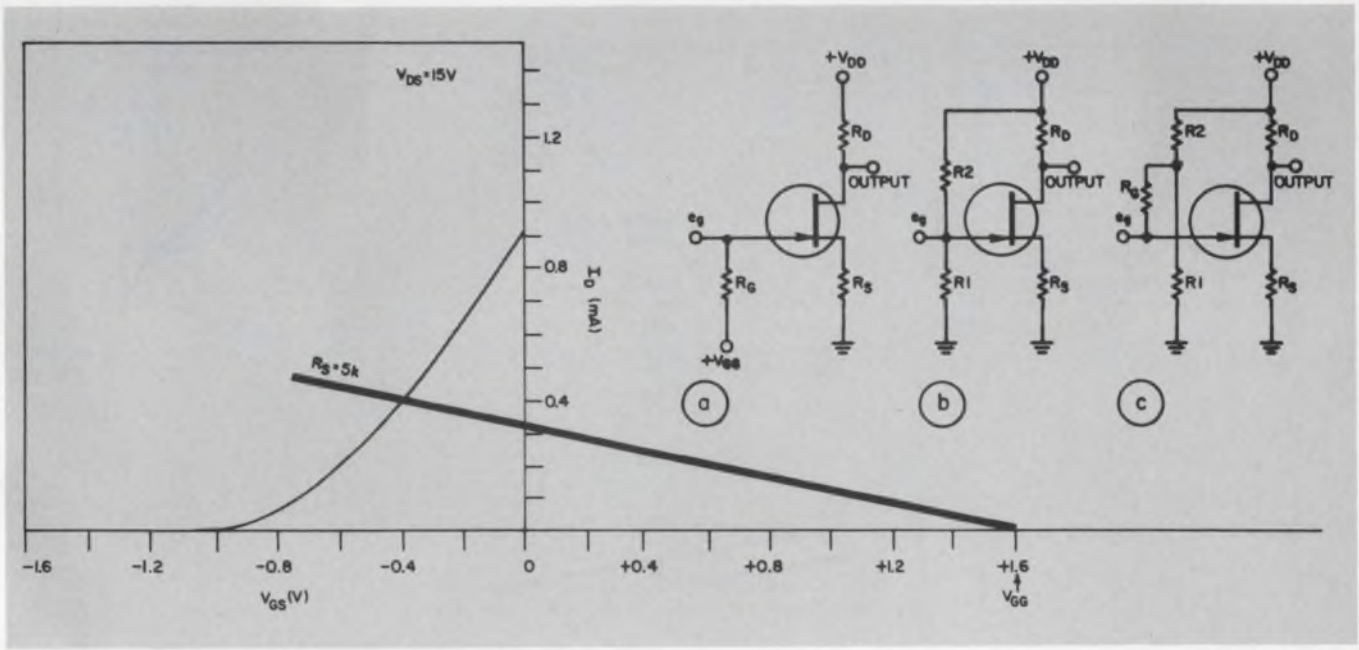
It is helpful, in any design, to know the effect of temperature variations on the transfer curves and transconductance characteristics. Ideally, minimum and maximum transfer characteristics would be plotted at three temperatures: above, below, and at room temperature. Then the design would take all types of variation into account.

Minimize the gain variations

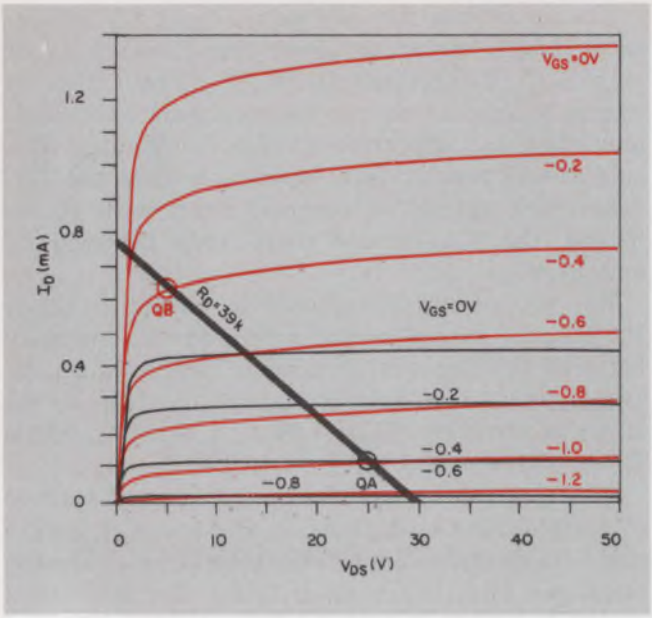
Leaving R_S unbypassed helps reduce gain variations from device to device by providing degenerative current feedback. However, this method for minimizing gain variations is only effective when a substantial amount of gain is sacrificed.

A better approach is to use the combination-bias technique with the bias point selected from the transfer and transconductance curves (Fig. 9).

As Fig. 9 shows, it is possible to find an R_S and a V_{GG} that will set I_{DQA} and I_{DQB} to values



6. **All three combination-bias circuits are equivalent.** They add constant-voltage biasing to the self-bias circuit to establish a reasonably flat load line without sacrificing dynamic range.



7. **The wide variations in device performance** shown by this pair of output characteristics make clear the disadvantages of constant-voltage biasing.

so that g_{fsQ} will be the same for both devices. The g_{fsQ} of all intermediate devices will be approximately equal to the limiting values. Thus, a constant, or nearly constant, stage gain is obtained even with a bypass capacitor.

The design procedure is as follows:

Step 1. Select a desired I_{DQA} below I_{DSSA}. A good value, allowing for temperature variations, is 60% of I_{DSSA}. This will allow for decreasing I_{DSS} due to temperature variation and for reasonable signal excursions in load current.

Step 2. Enter the transfer curves at $I_{DQA} \cong 0.6\ I_{DSSA}$ (0.3 mA) to find V_{GSQA}. This $V_{GSQA} \cong 0.2$ V for the 2N4339.

Step 3. Drop vertically at V_{GSQA} to the minimum limit transconductance curve to find g_{fsQA}. The value as read from the plot is approximately 1000 μmho.

Step 4. Travel across the g_{fs} plot to the maximum curve to find V_{GSQB} at the same value of g_{fs}. This is $V_{GSQB} \cong -0.7$ V.

Step 5. Travel vertically up to the maximum limit transfer curve to find I_{DQB} at V_{GSQB}. This is $I_{DQB} \cong 0.36$ mA.

Step 6. Construct an R_S bias line through points Q_A and Q_B on the transfer curves. The slope of the line is $1/R_S$, and the intercept with the V_{GS} axis is the required V_{GG}.

As Fig. 9 demonstrates, it may be somewhat inconvenient to perform Step 6 graphically. An algebraic solution can then be employed instead. The source resistance is given by

$$R_S = (V_{GSQA} - V_{GSQB})/(I_{DQB} - I_{DQA}) \quad (2)$$

and the bias voltage is

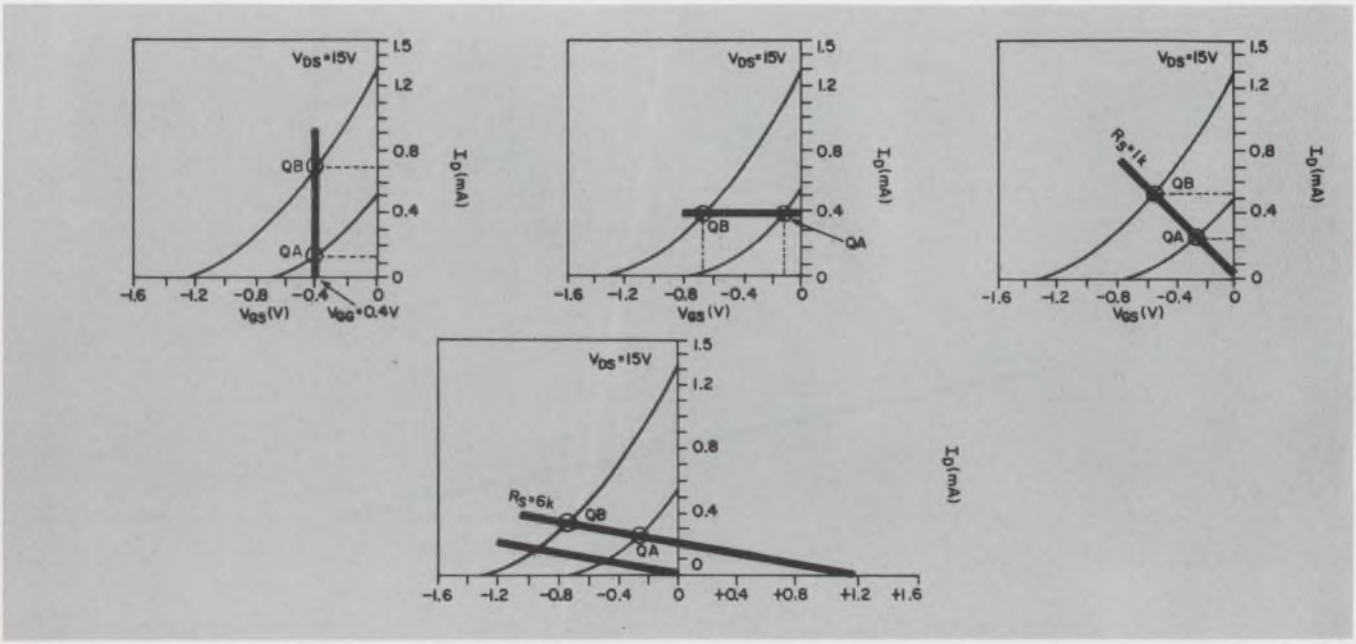
$$V_{GG} = R_S\ I_{DQB} + V_{GSQB} \quad (3)$$

Care should be taken to maintain the proper algebraic signs in Eqs. 2 and 3. (For n-channel FETs, V_{GS} is negative and I_D is positive. For p-channel units, the signs are reversed.)

If the transconductance curves of Fig. 9 are not available, g_{fs} can be determined by simply measuring the slope of the transfer curve at the desired operating point. Just place a straightedge tangent to the curve at the Q-point and note the points at which it intercepts the I_D and V_{GS} axes. The slope and g_{fs} are given by:

$$\text{slope} = g_{fs} = I_{D(\text{intercept})}/-V_{GS(\text{intercept})} \quad (4)$$

In designing a constant-gain circuit, simply



8. **The advantages of combination biasing,** when one is working with a spread of device characteristics, are made obvious by plotting the load lines for the various types of biasing on a pair of limiting transfer curves.

set the straightedge tangent to the transfer curve of device A at point Q_A and slide it, without changing its slope, until it is tangent to the curve of device B. The tangency point is Q_B.

Designing without output curves

Although the transfer characteristic has been seen to be extremely valuable in designing a bias circuit, it cannot be used to graphically establish V_{DSQ}. However, if a set of output curves is not available, V_{DSQ} can be determined or selected from the transfer curve by using the following procedure:

Step 1. Establish R_S and limiting values of I_{DQ}, V_{GSQ} and g_{fsQ} from the transfer curve.

Step 2. Establish V_{DD} as available, but in no case greater than BV_{GSS} nor less than several times V_P. There are special cases where V_{DD} will be below this limit, but in no case should instantaneous v_{dg} be allowed to fall below $2 \times V_P$ if minimum distortion is to be achieved.

Step 3. Set V_{DSQ} approximately midway between V_{DD} and $2 \times V_P$; lower if large output signals will not be handled.

Step 4. Select R_D to give the appropriate V_{DSQ}. The formula is:

$$R_D = [(V_{DD} - V_{DSQ})/0.5\, I_{DQA} + I_{DQB}] - R_S. \quad (5)$$

In the example of Fig. 8, this procedure would have yielded $V_{DSQ} = (30\text{-}3)/2 = 13.5$ V and $R_D = (30 - 13.5)/0.5\ (0.52 + 0.24)$ mA $- 1$ kΩ $= 42.5$ kΩ.

Step 5. Check to ensure that with this R_D, device B is not in a saturated condition—$V_{DQB} = V_{DD} - I_{DBQ} R_D > 2 V_P + R_S I_{DBQ}$. Decrease R_D if this condition is not met.

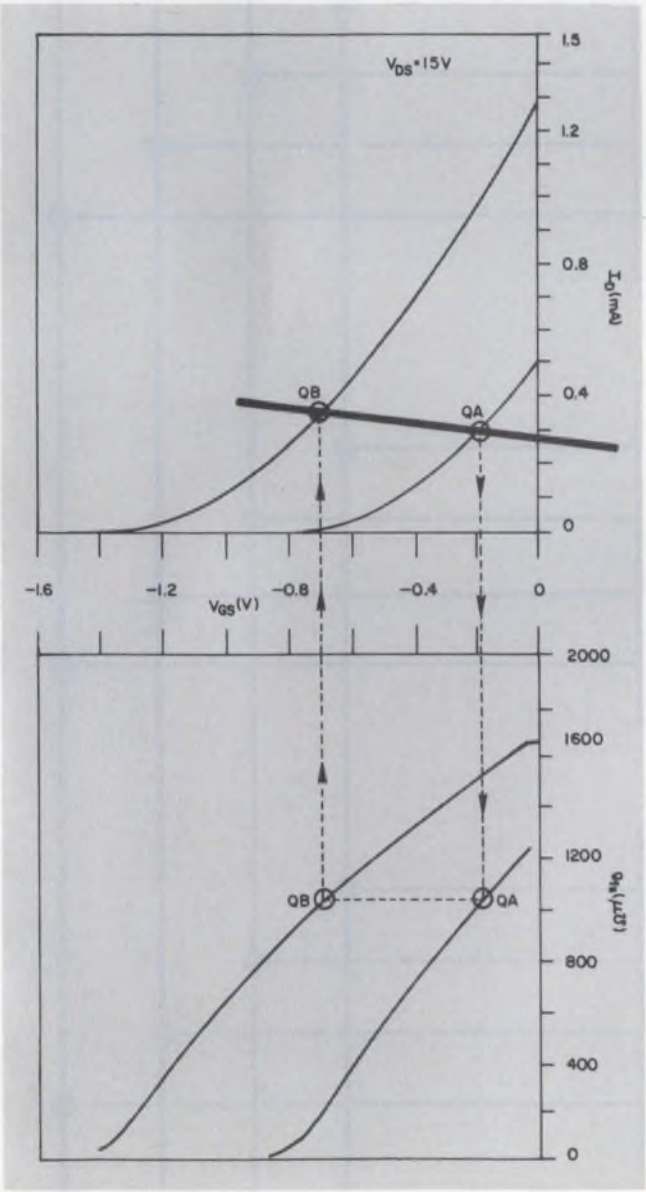
An alternate method, that selects R_D to provide a specified voltage gain, follows Steps 1 and 2 above and then proceeds as follows:

Step 3. Determine required stage gain, A_v, and set $R_D = A_v/g_{fsQ}$.

Step 4. Calculate V_{DSQ} to ensure that the criteria of Step 2 are not violated:

$$V_{DSQ} = V_{DD} - (R_D + R_S)\, I_{DQ}. \quad (6)$$

Step 5. If necessary, change I_{DQ}, V_{DD}, A_V and/or R_D to obtain an optimum compromise. ■■



9. **Gain variations are minimized** when the load line is designed to intersect the pair of limiting transfer curves (top) at points of equal g_{fs} (bottom).

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Test your retention

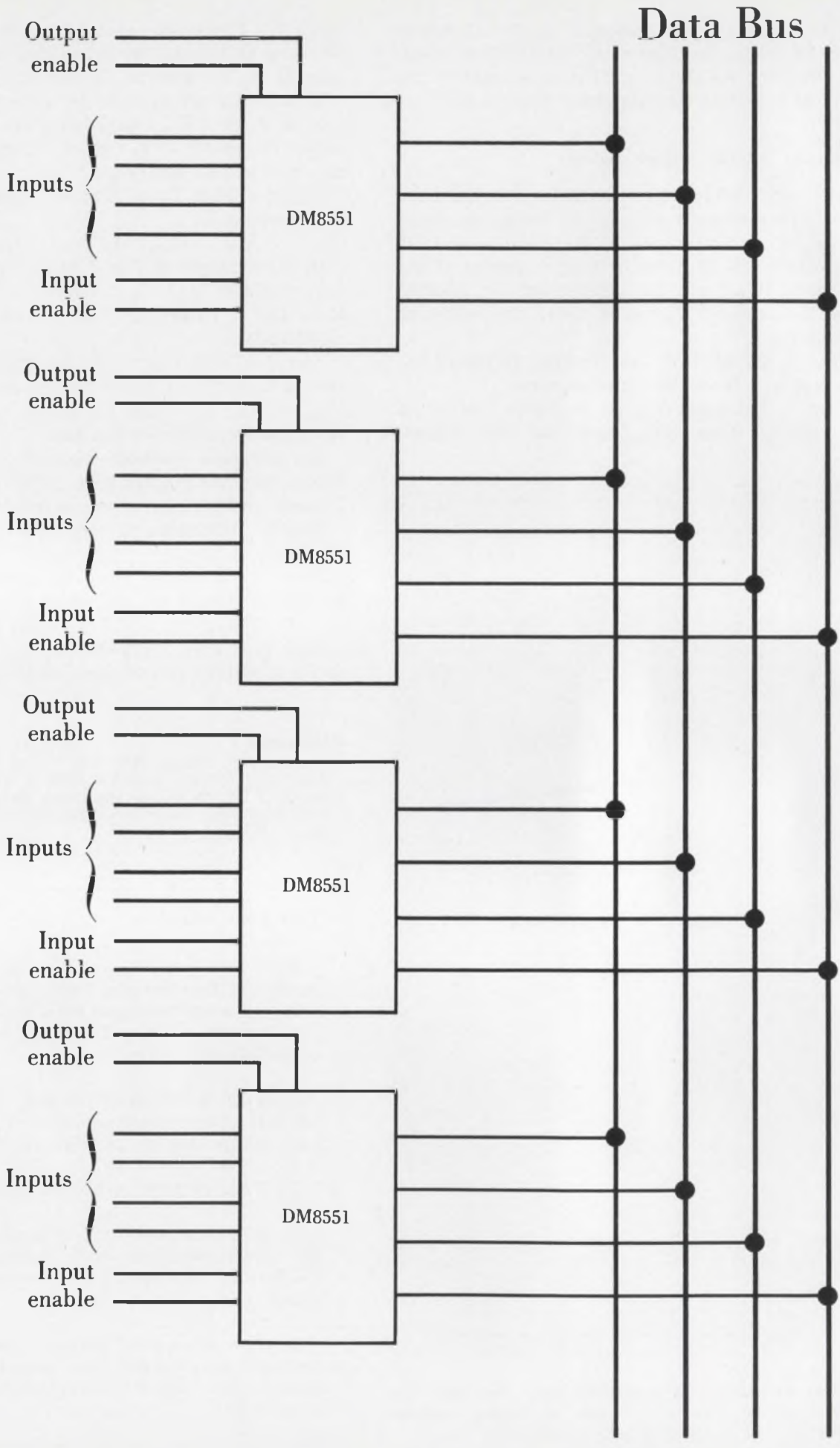
Here are questions based on the main points of this article. Their purpose is to help you make sure you have not overlooked any important ideas. You'll find the answers in the article.

1. Why is constant-current biasing unsuitable for common-source dc amplifiers and unbypassed ac amplifiers?

2. What is combination biasing?

3. How can combination biasing be used to reduce amplifier gain variations when FETs with different transconductances are used?

4. How can a FET transfer characteristic be used to establish the output operating point when output characteristics are not available?


Data Bus
Output enable
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DM8551
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Design filters in minutes.

Characterize performance by nondimensional ratios and calculate their values on a computer.

Filter design can be reduced to a simple routine by using a computer program to derive basic relationships, such as capacitance or resistence ratios. A plot of these results is then used to determine filter parameters. The entire process of filter synthesis can be completed in a matter of minutes.

As an example of this approach, two types of filters — an active low-pass and a passive bridged-T — are designed. Coefficients of the filter transfer functions are related to performance specifications, and suitable programs are written for them.

Use dimensionless ratios

The key to the method is to define a set of dimensionless ratios that makes it possible to design the filters without regard to passband gain, corner frequency, damping ratio or impedance levels. Thus all filters can be designed from one set of curves.

For the feedback amplifier of Fig. 1a, for example,

$$E_o/E_1 = (R_3/R_1)/(R_3R_1C_1C_2s^2 + (2/R_1 + 1/R_3)\,R_1R_3C_2s + 1).$$

This equation is of the form

$$E_o/E_1 = (R_3/R_1)/((s/\omega_o)^2 + (2\zeta s/\omega_o) + 1)$$

where:

$$\omega_o = 1/\sqrt{R_3R_1C_1C_2}$$

$$\text{or } C_2 = 1/(R_1\omega_o\sqrt{(R_3/R_1)\,(C_1/C_2)})$$

$$\text{and } \zeta = \sqrt{(R_1/R_3)\,(C_2/C_1)}\,(1 + 2R_3/R_1)/2$$

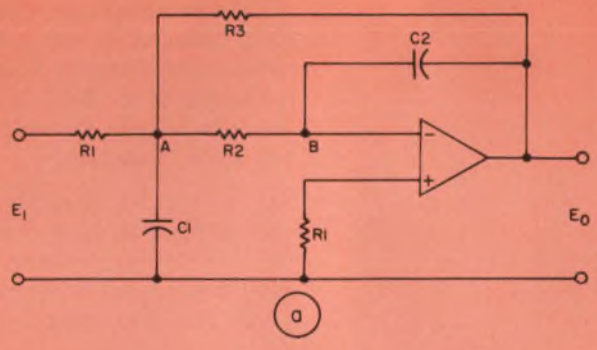
$$\text{or } C_1/C_1 = (1 + 2R_3/R_1)^2/4\,(R_3/R_1)\,\zeta^2. \qquad (1)$$

The network thus provides adjustable passband gain, R_3/R_1, damping factor, ζ, and corner frequency, ω_o.

Equation 1 is the relationship to be plotted. Instead of four independent variables, only two need be considered and, since all variables of Eq. 1 are dimensionless, a single plot provides a general solution to a set of specifications.

A BASIC program to compute values for Eq. 1 is given in Fig. 1b. Capacitance ratios to 100 and damping ratios from 0.1 to 1.0 offer realizable results for Butterworth, Chebyshev and other low-pass filters.

Minimum capacitance ratio exists for $R_3/R_1 = 0.5$ and $R_1 = R_2$. The results are plotted in Fig. 2. Only this graph is required for the desired synthesis. For example, a Butterworth 2-pole, low-pass




```
LOPASS

10 PRINT "R=", "Z=", "C="
20 FOR N=1 TO STEP 1
30 LET R = .0625*(2↑N)
40 FOR Z=.1 TO 1.1 STEP .2
50 LET C =((2*R+1)↑2)/(4*R*(Z↑2))
60 PRINT R,Z,C
70 NEXT Z
80 NEXT N
90 END

RUN
```

b

1. **The active low-pass filter is based on a feedback amplifier** (a). In the analysis given, $R_2 = R_1$. A BASIC program computes values for the filter repsonse (b).

Benton Bejach, Electronic Development Manager, Borg-Warner Controls, Santa Ana, Calif.

filter is required with a passband gain, R_3/R_1, of 32 and a corner frequency of 1 kHz. R_1 is chosen to be 10 kΩ and $\zeta = 0.707$. Referring to Fig. 2:

$C_1/C_2 = 66$ and $C_2 = 1/(10^4 \times 2\pi \times 10^3 \sqrt{32 \times 66})$.

Thus $C_2 = 347$ pF, $C_1 = 66 \times 347 = 22900$pF,

and $R_2 = 32 \times 10^4 = 320$ kΩ.

When components with 5% tolerance are used, about 1-dB deviation from the predicted frequency response is observed.

Bridged-T filter is another test

Another analysis treats the passive bridged-T filter (Fig. 3). Its transfer function is of the form:

$$E_o/E_i = [(s/\omega_o)^2 + 2\zeta_1 s/\omega_o + 1]/[(s/\omega_o)^2 + 2\zeta_2 s/\omega_o + 1].$$

If $s = j\omega_n$, the notch depth is $E_o/E_i = \zeta_1/\zeta_2$ and the following dimensionless relationships exist:

$$R_1/R_2 = 1/(4\zeta_1^2(-1 + \zeta_2/\zeta_1) - 1),$$

$$C_2/C_1 = (4\zeta_1^2(-1 + \zeta_2/\zeta_1)^2)/4\zeta_1^2(-1 + \zeta_2/\zeta_1) - 1,$$

$$\omega_o = 1/\sqrt{R_1C_1R_2C_2}. \quad (2)$$

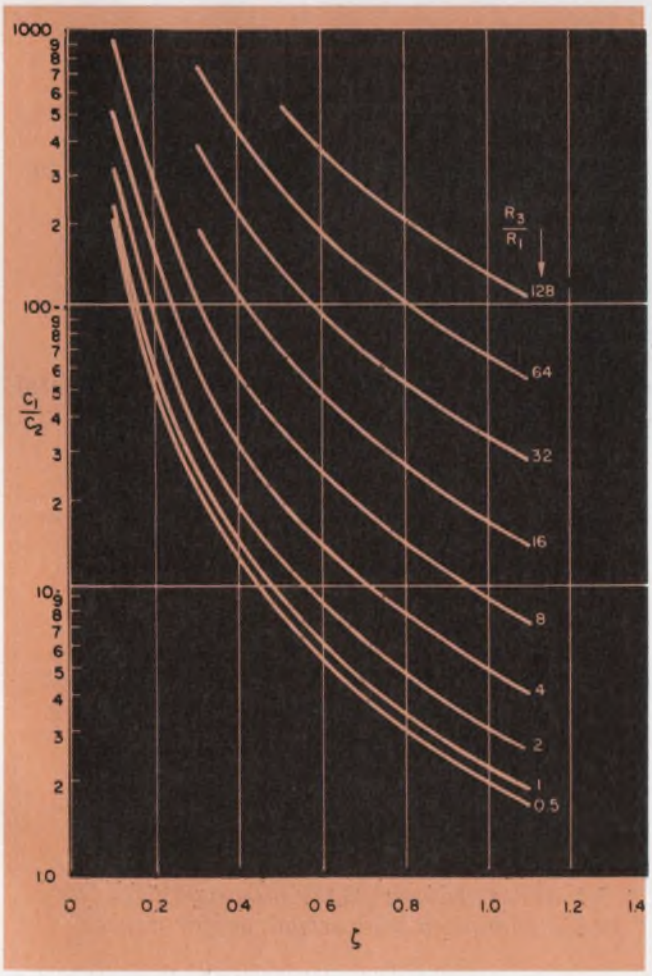
These relationships approach infinity for pairs of ζ_1 and ζ_2/ζ_1 obeying the relation:

$$\zeta_2/\zeta_1 = 1 + (1/4\zeta_1^2)$$

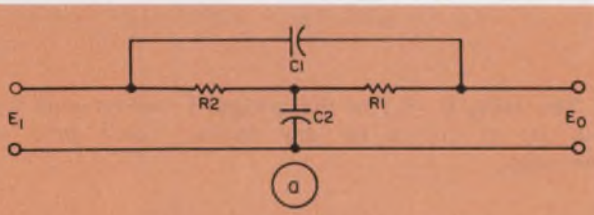
Some values of this set that establish the boundaries of physically realizable networks are as follows:

ζ_1	ζ_2/ζ_1
0.10	26.0
0.15	12.1
0.20	7.25
0.25	5.0
0.30	3.78
0.35	3.05
0.40	2.56
0.50	2.0

The BASIC programs given in Fig. 3b plot the R_1/R_2 and C_2/C_1 ratios. Dummy variables are used as follows: R for the resistance ratio, C for the



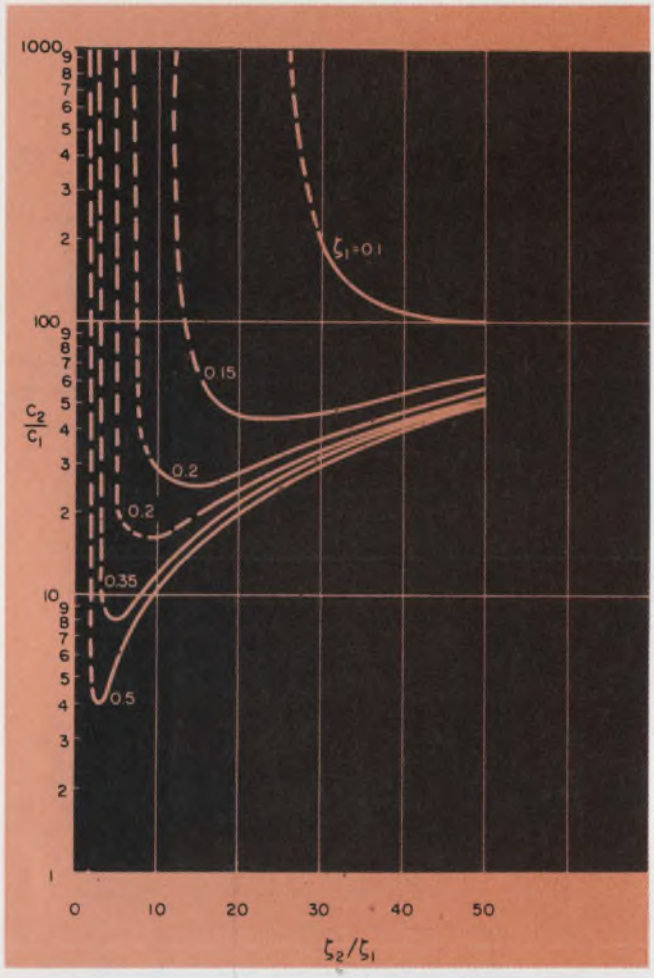
2. **A nondimensional plot of low-pass filter response** uses C_1/C_2 and the damping factor as variables and R_3/R_1 as a parameter.



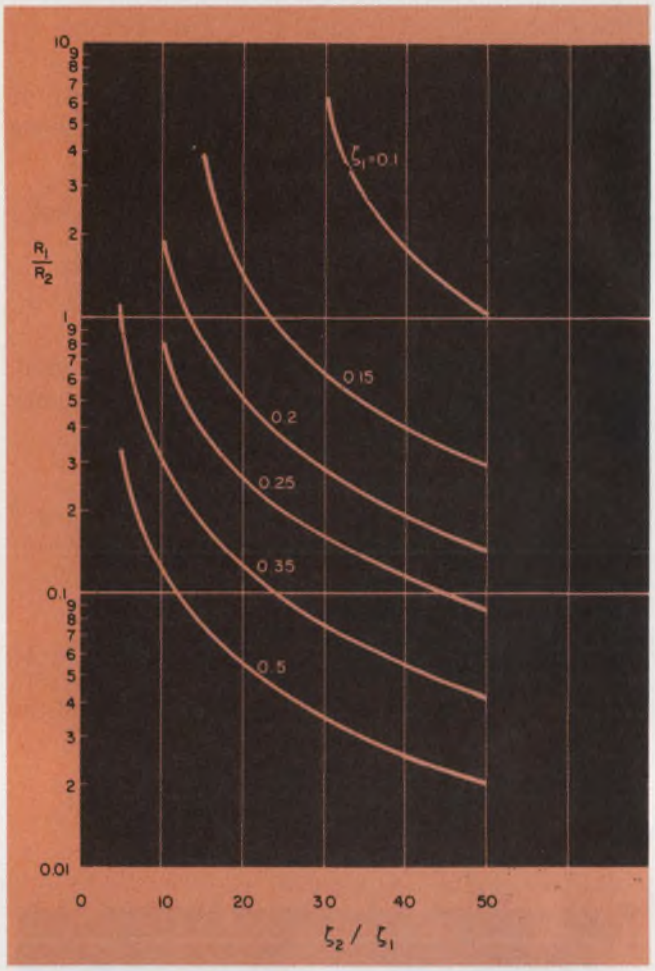

```
CAPACITANCE RATIO PROGRAM.
 5     FOR D = 5 TO 50 STEP 5
10     PRINT "D ="; D
15     FOR Z = .1 TO .5 STEP .05
20     LET C = (4*Z↑2*(D↑2-2*D+1))/
       (4*Z↑2*(D-1)-1)
25     PRINT "Z ="; Z , "C="; C
30     NEXT Z
35     NEXT D
40     END

RESISTANCE RATIO PROGRAM.
 5     FOR D = 5 TO 50 STEP 5
10     PRINT "D="; D
15     FOR Z = .1 TO .5 STEP .05
20     LET R = 1/(4*(Z↑2*(D-1))-1)
25     PRINT "Z ="; Z , "R="; R
30     NEXT Z
35     NEXT D
40     END
```

b

3. **The response of the passive bridged-T filter** (a) is computed by the BASIC program in (b). Both capacitance ratio and resistance ratio programs are shown.



4. **The ratio, C_2/C_1, of the bridged-T** can be read from this set of curves for any desired notch ratio and frequency.



5. **The bridged-T resistance ratio, R_1/R_2,** is determined from this family of curves. Both this set and that of Fig. 4 are plotted from the program values of Fig. 3 (b).

capacitance ratio, D for the notch ratio and Z for ζ_2/ζ_1. The results are plotted in Figs. 4 and 5.

For example, the open-loop transfer function of a proposed closed-loop system has complex roots at $f_o = 10$ Hz and $\zeta = 0.15$. The bridged-T filter is selected so that its complex zeros cancel the plant poles. Figures 4 and 5 indicate that pole cancellation can be achieved over a notch ratio range of at least 15 to 50. Thus the undesired complex poles are exchanged for a pair of easily calculated real-axis poles. Considerations of the closed-loop problem at hand will dictate the optimum notch depth.

Assume that $\zeta_2/\zeta_1 = 30$ is desired and that $R_2 = 100$ k.

From Figs. 4 and 5:

$R_1/R_2 = 0.62$ and $C_2/C_1 = 45.5$.

From Eq. 2:

$$C_1 = \frac{1}{\omega_o R_2 \sqrt{(R_1/R_2)\,(C_2/C_1)}}$$

Thus

$$C_1 = \frac{1}{2\pi \times 10 \times 10^5 \sqrt{0.62 \times 45.5}} = 0.03\mu f,$$

$$C_2 = 45.5 \times 0.03 = 1.37\ \mu f,$$

and $R_1 = 0.62 \times 10^5 = 62\ k\Omega$,

completing the synthesis. Again experimental results closely approach the theoretical. ■ ■

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 advantages of using non-dimensional ratios in filter design?

2. What causes most discrepancies between computed and actual performance?

3. What is the basic configuration of an active filter?

HERE'S HOW THE V-O-M SPECIALISTS GO DIGITAL

The principal problem with digital V-O-M's is that circuitry (rather than readability) limits their accuracy. Triplett has attacked that problem with characteristic thoroughness. The result . . . a totally new circuit (patent pending) in which there is virtually no internally-generated current from the V-O-M input circuit to affect measuring accuracy.

Triplett's Model 8000 digital V-O-M . . . the only V-O-M with this newly-developed circuit . . . offers a true DC accuracy of 0.1% of the reading ± 1 digit and an AC accuracy of 0.2% ± 1 digit. Triplett calls this "true accuracy" because it's the same accuracy you can achieve day-in and day-out, test-after-test, on *any* kind of circuit.

Quality-minded buyers will appreciate, too, the other job-matching features of Triplett's new digital V-O-M. Like . . . automatic zeroing; AC and DC voltage measurements from 0.1 mV to 1000 V in 5 ranges at 10 megohms input resistance; AC and DC currents from 0.01 uA to 1000 mA in 6 ranges; 0.1 ohm to 10 megohms in 6 ranges.

Sounds like it was worth waiting for, doesn't it? Available through your local Triplett distributor, the new Model 8000 is priced at only **$575** suggested USA user net. If you'd like the added convenience of an instant replay circuit that displays a previously-stored reading for on-demand comparison with an existing reading, ask for the Triplett Model 8000-A at **$630** suggested USA user net. For more information, or for a free, no-obligation demonstration, call your local Triplett distributor or sales representative. Triplett Corporation, Bluffton, Ohio 45817.

TRIPLETT

The World's most complete line of V-O-M's . . . choose the one that's just right for you

1. True 0.1% DC accuracy. Virtually no kickback current*. Allows voltage measurements in high resistance circuits at stated accuracy.
2. High AC accuracy with nearly perfect AC linearity and 10 megohm input resistance.
3. Low profile design in shielded case with modular construction for ease in use and maintenance.

*There is virtually no internally generated current from the V-O-M input circuit to affect measuring accuracy. (Patent pending on this feature).

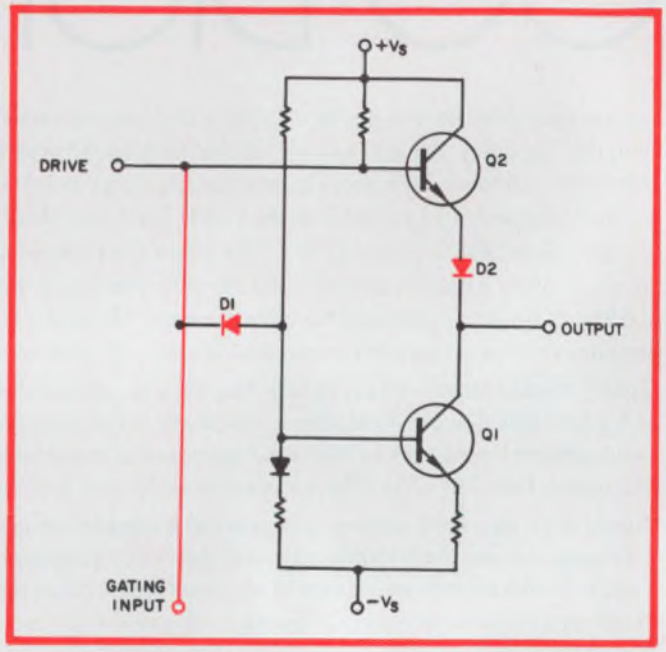
INFORMATION RETRIEVAL NUMBER 55

Gate your op amp—and get a powerful new device that simplifies test, control, switching and modulation circuitry.

Adding a gate to an operational amplifier produces a new device that acts as both a switch and an amplifier. It isolates inputs and outputs when a gating signal is applied, and it functions as a conventional op amp when the signal is not present.

The gated op amp can be used to provide variable gain, switch ac and dc signals, perform sample and hold operations and act as a wideband, phase-sensitive demodulator. And it usually does so with fewer components than conventional circuits require.

The supply voltage, ground or any other convenient source may be used to provide the gating signals. Depending upon the output stage configuration, converting an existing op amp for gated operation may be as simple as adding a single lead. But for most currently available IC op amps several external components will be required.



1. **Two diodes add gating capability** to this Class A output op amp. Similar techniques can be applied for op amps with Class B and emitter-follower output stages.

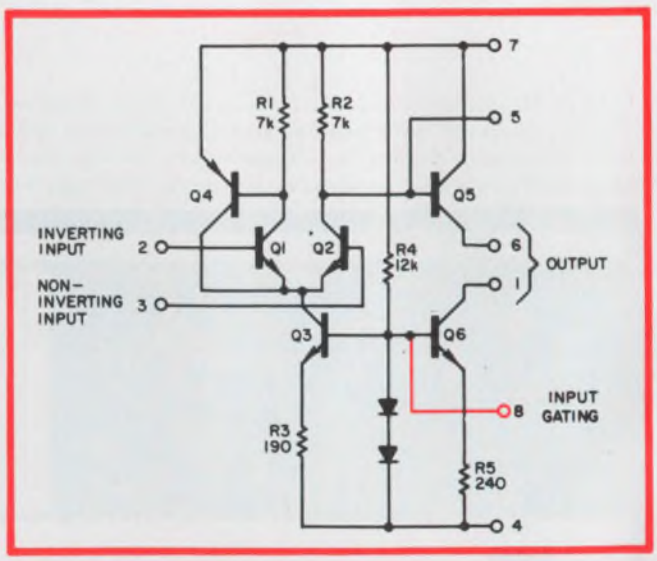
How to add the gate

A typical example of how to add gating control is shown in Fig. 1 for an amplifier with a Class A output stage using two npn transistors. In this case the addition of two diodes provides the required output isolation.

Assuming a high impedance drive from the preceding portion of the circuit, diode D_1 cuts off the constant current source, Q_1, when the gating terminal is connected to the negative supply, and diode D_2 protects the reverse base emitter junction of Q_2.

A similar example, involving only the addition of a lead for the gating signal is accomplished with the Ferranti ZLD2T op amp (Fig. 2).

In this case, with the gating input unconnected the amplifier performs as a normal ZLD2T, allowing the usual op-amp functions. When the gating input is connected to the negative supply line, both Q_3 and Q_6 are cut off. With no current supplied to Q_1 and Q_2, Q_5 does not conduct. The inverting and noninverting inputs are thus isolated from each other, and from the output.



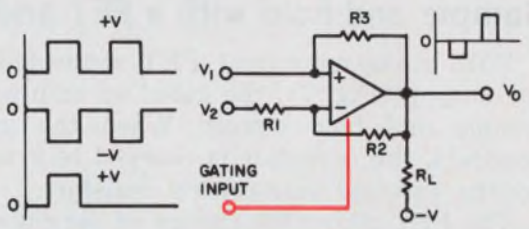
2. **One lead is all that is required** to convert the ZLDT operational amplifier for gated operation. External components are required to convert most other existing IC op amps.

John M. Morrison, Senior Research Engineer, Ferranti Limited, Edinburgh, Scotland

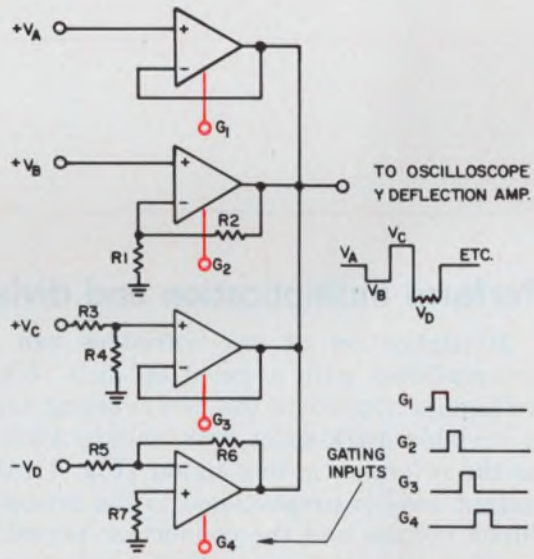
Build a pulse train encoder and visual fault indicators.

A simple pulse coding circuit is one application for gated op amps. As shown in Fig. 3, a gated op amp and four resistors will combine three pulse trains into a single signal. The eight possible input combinations produce eight distinct output voltage levels. This circuit is particularly useful in test data recording where the number of inputs exceeds the number of recording channels.

A useful display that provides visual fault indication is a second application for the gated op amp in test instrumentation. In a system where a single input generates multiple ac or dc outputs, all of varying amplitudes or polarities, a simple histogram plot on an oscilloscope screen (Fig. 4) is a time-saving check. For example, if we have a range of dc voltages to be monitored, which bear a specified relationship to each other, these voltages are normalized to some convenient value by a choice of suitable resistor ratios, and sequential selection is obtained by a ring counter synchronized with the time base sweep of the oscilloscope. Instant indication of any deviation is displayed.



3. **A handy coding circuit** produces eight distinct and unambiguous output voltage levels for three pulse train inputs. A much more complex circuit would be required if a gated op amp was not used.

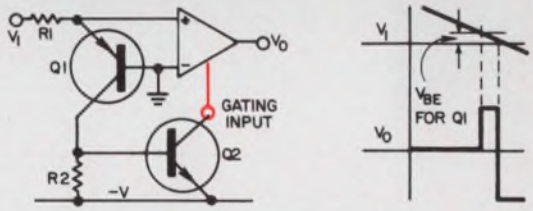


4. **A ring counter controls the switching** of the gated op amps in this histogram display. The oscilloscope alerts an operator to any malfunction. Any deviation from the reference voltage (V_A) is indicated as a change in voltage level on the scope.

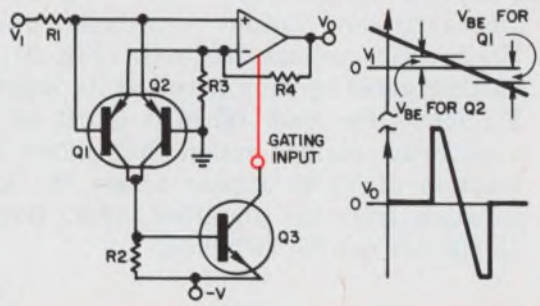
Get variable gain elements or three-state comparators.

Another application is the three-state comparator circuit of Fig. 5. An op amp in an open-loop configuration has two stable states. By adding two transistors to a gated op amp, a third state, with the output level zero, is present when the input voltage allows the extra transistors to conduct, thus cutting off the amplifier. This circuit is useful for limit monitoring.

A variation can be obtained by adding a third transistor (Fig. 6). Applications include a servo gain-change element, a portion of an afc feedback loop, frequency doubler and a special-purpose comparator.



5. **Get a three-state comparator** by using two transistors with a gated op amp. The circuit is useful for automatic testing and sorting.

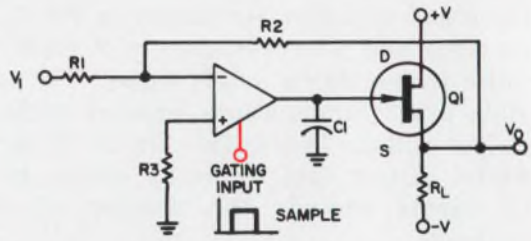


6. **Gain varies with input level** when a third transistor is added to the circuit of Fig. 5. The circuit is particularly useful in nonlinear control systems.

Sample and hold with a FET and a capacitor.

With a capacitor and FET connected across the output (Fig. 7), the gated op amp acts as a sample and hold circuit. When the amplifier conducts, the capacitor is charged to a value set by the external gain-control resistors.

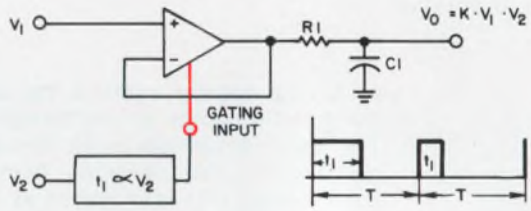
The FET allows the charge on the capacitor to be held for a period that is a function of the FET gate leakage and the cutoff leakage of the op-amp output stage transistors. Since the FET is inside the feedback loop, its gate source voltage is largely irrelevant.



7. **Make a sample and hold circuit** using a FET and a capacitor with a gated op amp. A feedback capacitor will convert this circuit to an integrating sample and hold circuit.

Perform multiplication and division of two variables.

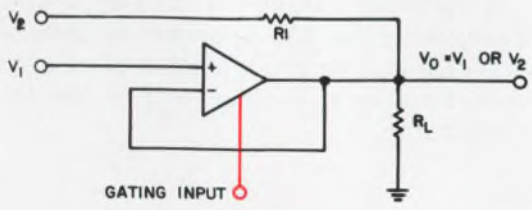
Multiplication of two variables can also be accomplished with a gated op amp. When a dc voltage is applied to the noninverting input, and a variable mark-space ratio square wave is used as the reference gating signal (Fig. 8), the mean output level is proportional to the product of the input voltage and the conduction period. (Many methods exist for generating a pulse period proportional to a dc voltage.) Division can be accomplished in a similar way.



8. **A voltage multiplier circuit** consists of a gated op amp and a pulse generator. Pulse repetition rate is constant while pulse width is proportional to V_2.

Use gated op amps to switch both ac and dc.

The gated op amp can also be used in many switching applications. With unity gain and an inherently low output impedance due to the 100% series voltage feedback (Fig. 9), the conducting gated op amp develops its input voltage, V_1, across the load. When it is cut off, there is a potential divider action that allows a defined fraction of V_2 to appear across the load, with isolation from the amplifier input. Both ac and dc signals can be switched.



9. **Switch both ac and dc signals** with the same gated op amp. When the op amp is conducting, output voltage is V_1.

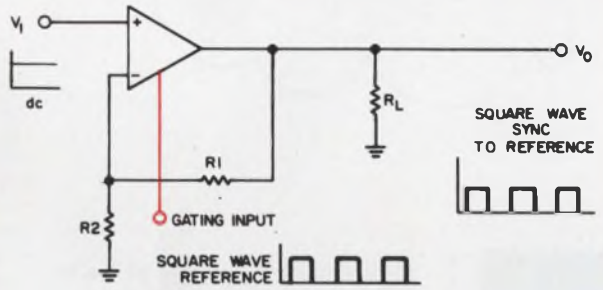
Modulators are possible, too.

Modulation is also an interesting field of application for the gated op amp. With a dc voltage applied to the input of the noninverting amplifier and a square-wave gating signal (Fig. 10), an output is generated that is synchronous with the gating reference.

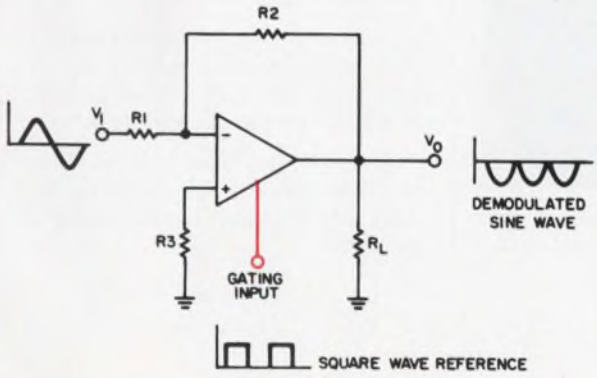
With a sinusoidal input and square-wave reference gating signal, a half-wave, phase-sensitive demodulation is produced. This circuit has a number of advantages over conventional demodulators. They include:

- High input impedance.
- A wide range of allowable load impedance.
- Wide range gain.
- No need for special reference transformers.

Full-wave demodulation is made possible by using an inverting amplifier configuration and an input in phase with the switching reference (Fig. 11). In this case one input half cycle is inverted when the amplifier conducts, and the other half cycle is reproduced across the load by the potential divider action of R_1 and R_2 when the amplifier is cut off. Unlike the half-wave demodulator, the output amplitude is load-dependent during one-half cycle. ■■



10. **Modulate an input voltage signal** using a square-wave reference to gate the op amp. Normal op-amp characteristics provide gain for low-level signals.



11. **Full-wave demodulation without special transformers** is accomplished in this gated op-amp circuit. The same circuit can be used for a wide frequency range of signals.

It's true.

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

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

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

New, modular line of Teletype® 4210 magnetic tape data terminals.

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

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

It contains 100 feet of ½″ precision magnetic tape.

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

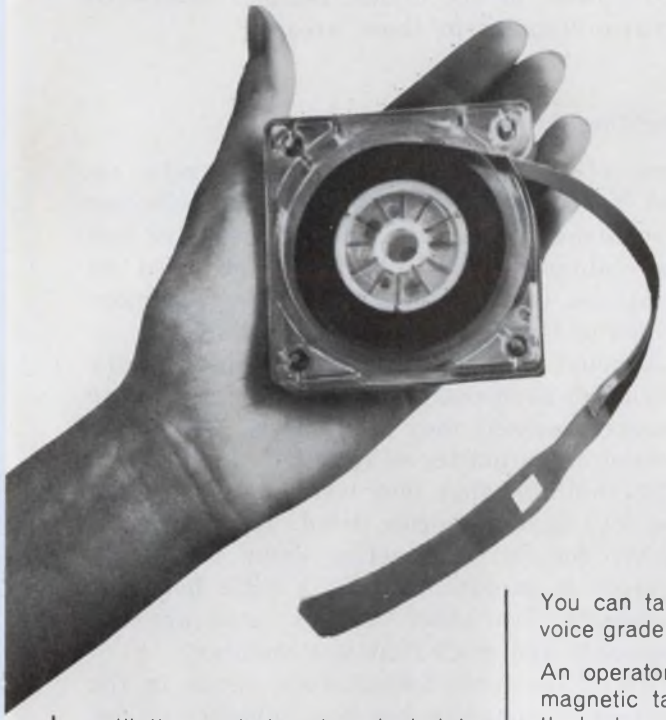
This means that your data is easier to store, easier to handle, easier to work with than ever before. And it's reusable.

Teletype is a trademark registered in the U.S. Pat. Office.

The units have a "fast access" switch which will move tape forward or reverse at a speed of 33 inches per second. A digit counter provides a reference point to help locate various areas of the tape.

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

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



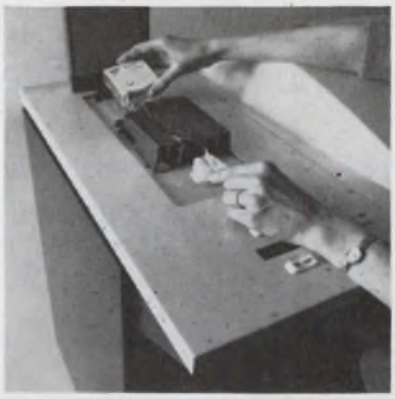
Also magnetic tape adds high speed on-line capability to low speed data terminals.

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

You can take better advantage of voice grade line speed capabilities.

An operator can prepare data for magnetic tape transmission using the keyboard terminal in local mode. Then send it on-line via the magnetic tape terminal up to 2400 words per minute.

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



Straight-through threading makes tape loading and unloading exceptionally easy.

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

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

Teletype 4210 magnetic tape data terminal with 37 keyboard send-receive set.

TELETYPE

machines that make data move

INFORMATION RETRIEVAL NUMBER 57

Engineers want more challenges, according to this attitude survey. Many respondents say they not only become bored but even change jobs because the work is too elementary.

Richard L. Turmail, Management Editor

Are you bored with engineering?

Are you in favor of an engineering union?

Would you change your job title to match the work you do?

How much more money do you think you should be earning?

How much responsibility do you think your employer should assume for your continued education in technology?

ELECTRONIC DESIGN has answers to these questions and many others as the result of a management survey conducted among a random sampling of 1000 of the magazine's subscribers. Of the nationwide sample canvassed, 55 per cent responded to our questionnaire.

A further breakdown of responses by titles reveals that 2 in 3 respondents are engineers; 1 in 4 is a manager; 1 in 19 is a president or vice president; and 1 in 24 is a chief engineer.

Over one-third of those who responded are in their 30s, while those in their 20s and 40s split half the total response.

Survey data

This report reveals the findings of a survey conducted in March, 1970, among subscribers to ELECTRONIC DESIGN. We mailed 1000 questionnaires to a random sample of our subscribers, and 550 replies were returned to us in time for tabulation and analysis. All information was treated anonymously.

The survey was designed to include responses from two engineers for each manager—a job title ratio that adequately reflects our subscription list.

The questionnaire contained 18 items. Engineers were told that the information they supplied on the form would be used in a management survey article designed to inform them how their attitude compares with that of their colleagues concerning their career needs, their complaints and their expectations in the engineering profession.

Nearly 1 in 2 respondents indicated that they lived on either coast, with those of the East Coast having a slight edge in numbers. The Midwest was represented by 1 in 6 engineers. Nearly 4 in 5 engineers like their employment location. Those who would rather live elsewhere would choose, in order of preference, the West Coast, the Southwest or the South, mainly because of the warm climates in those areas.

Spotlighting the survey highlights

Some of the attitudes that are generally assumed to be held by EEs—such as believing they're underpaid, and feeling that they've had a poor education—are generally confirmed by the response. Other responses, however, are more enlightening—and sometimes disturbing:

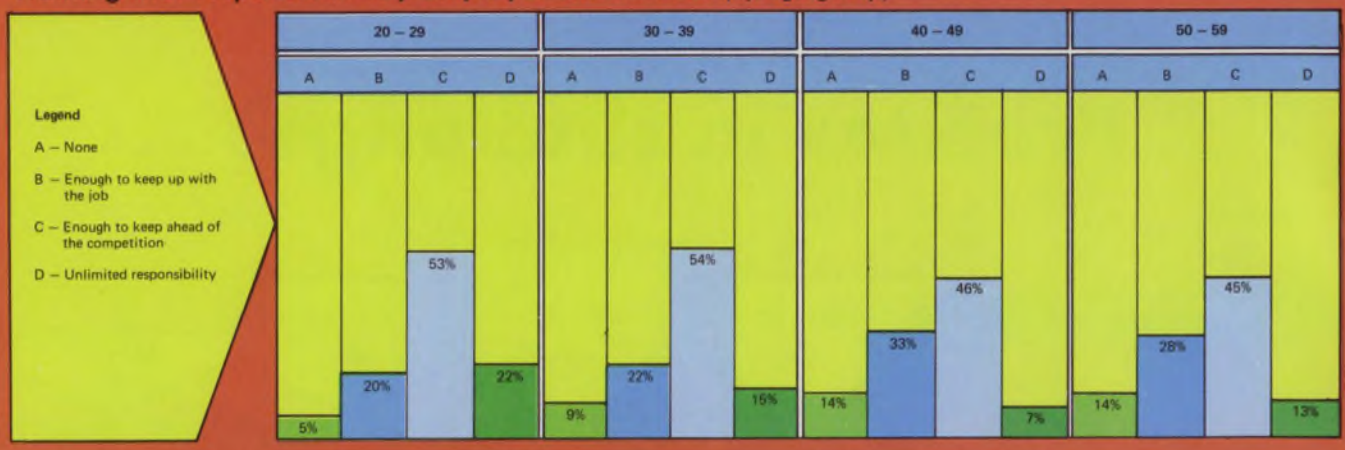
- Although you may find your present work satisfying or even challenging, 1 in 6 responding engineers admitted they were bored with their profession. As a matter of fact, EEs in their 20s and 30s indicated that they were the most bored of the four age categories listed. The main reason given for this engineering ennui is that an EE career is unrewarding, with little hope for advancement. Two other reasons listed are bad management and work that is elementary.
- One of the most tossed-about issues in the engineering community has been whether or not the engineer should unionize. In this survey, nearly 1 in 8 EEs said that their company is unionized. Asked "Do you favor an engineering union?" 1 out of 4 engineers who responded to the question said they thought a union would promote more benefits and job security for the EE, and more bargaining power with corporate management.

The remaining 3 of 4 responding EEs reported, in many cases angrily, that union affiliation would stifle incentive, degrade the engineering profession, create a barrier between the engineer and his manager, hinder the recruitment of new employees, and foster promotion on a seniority basis rather than on merit.

Engineers from New England and the South reported the greatest number of unionized com-

Profiles in challenges

Age group	20 - 29 27%	30 - 39 38%	40 - 49 26%	50 - 59 9%
Why did you choose an engineering career?				
Like to build things	54%	47%	49%	75%
Other	28%	33%	31%	20%
Best salary	10%	12%	10%	—
Teaches sequence	8%	9%	10%	5%
Did you change jobs in last 2 yrs?				
Yes	50%	28%	24%	14%
Why?				
Unchallenging work	34%	16%	18%	71%
Advancing career	20%	32%	40%	14%
Underpaid	16%	19%	18%	—
Bored with engineering – and Why?				
Yes	22%	22%	11%	4%
Unchallenging	97%	84%	87%	—
Too much time reading	3%	16%	13%	100%
Consideration for career advancement				
Interesting work	44%	29%	40%	39%
Money	29%	27%	23%	37%
Promotion	27%	23%	24%	8%
Socially-conscious work	—	21%	13%	16%



panies, while the least number are reportedly in the Southwest and West Coast.

East Coast engineers favor unionization most, while Southwestern EEs favor it least.

■ What's in a title? "Nothing," say some engineers, while others would upgrade their titles if given the option. Still others report they would have to downgrade their title if it was necessary to describe what it is they actually do.

Of the presidents and vice presidents represented in the survey, only 1 in 8 would change his corporate nomenclature. Of course, the vice presidents would most often change their title to "division president," while many presidents would change theirs to "retired." (So they said.)

Only 1 in 10 chief engineers reporting would change his label to read either "department head" or "engineering manager." Most chiefs are satisfied with their designation—probably because the title of chief is all inclusive.

Of the managers, only 1 in 10 would rather be called "consultant" or "vice president." Very few respondents downgrade their titles at this level.

Engineers, however, apparently feel that they are the most maligned of career men in the matter of titles. One in six of them would change their name plates to read either "clerk" or "assistant technician." Jobs at the engineering level tend to be general in nature, with the usual load of paper work and technician's duties.

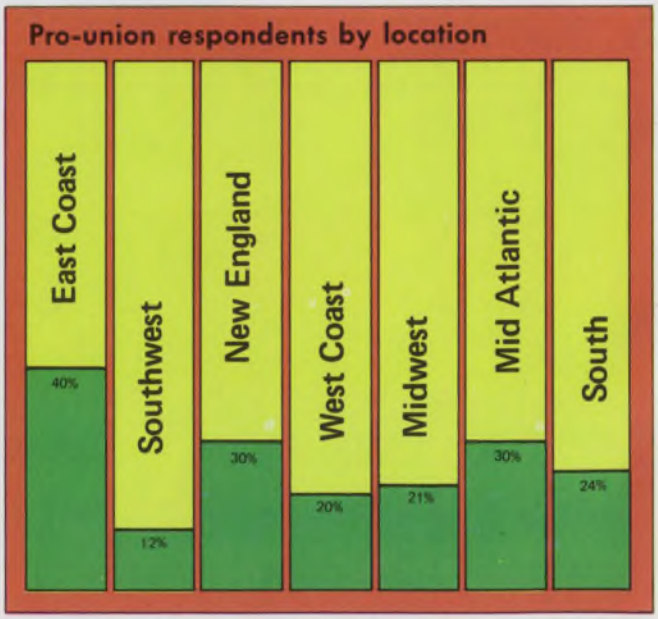
■ Regardless of title, however, most responding engineers agree on the amount of additional salary they think they should be earning. One-third, representing a plurality of the respondents in each title category (excepting that of president and vice president) believe that they should be taking home $2500 more annually than their present salary. Reasons given for the proposed increase are that experience, responsibility, and the high cost of living justify it.

Three of 10 of both managers and engineers feel that their present wages are satisfactory. Half of the presidents and vice presidents are satisfied with their stipend, because, in most cases, they either receive a liberal bonus or own the company.

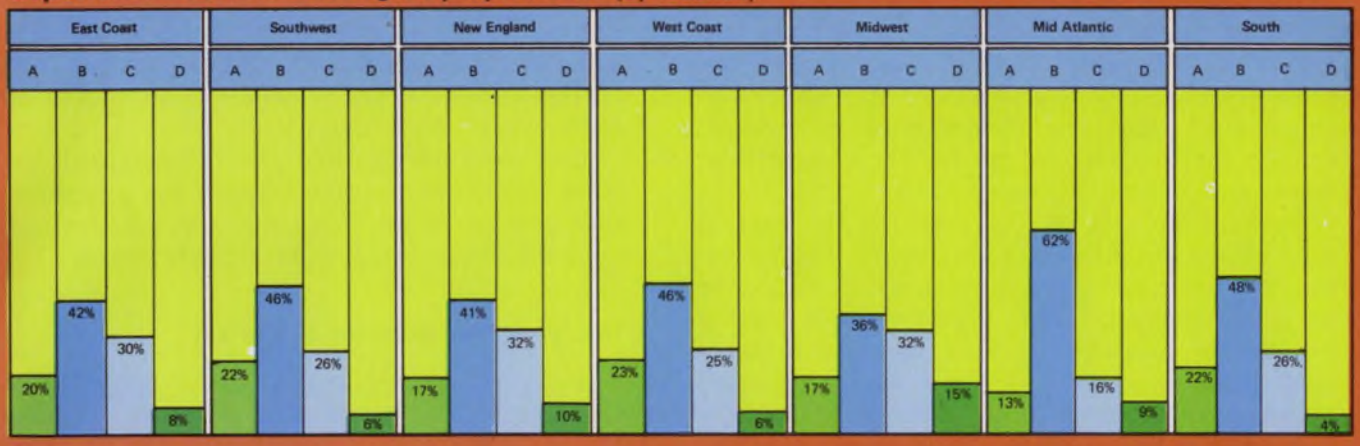
■ And if you owned a company, how much of your profits should you invest in the continued technical training of your employees? In our survey, 1 in 2 of all responding EEs feel that their employer should finance enough training to keep them ahead of the company's competition. One in four EEs feel that their company should at least be responsible for keeping them up with the latest developments in their work.

While over 2 in 5 of all companies reported by responding EEs offer enough education to keep their engineers up to date on the job, 1 in 5 companies reported offer no training at all.

There is an interesting parallel between those EEs who are for or against unionization and the amount of company-sponsored training of-



Reported amount of training employers offer (by location)



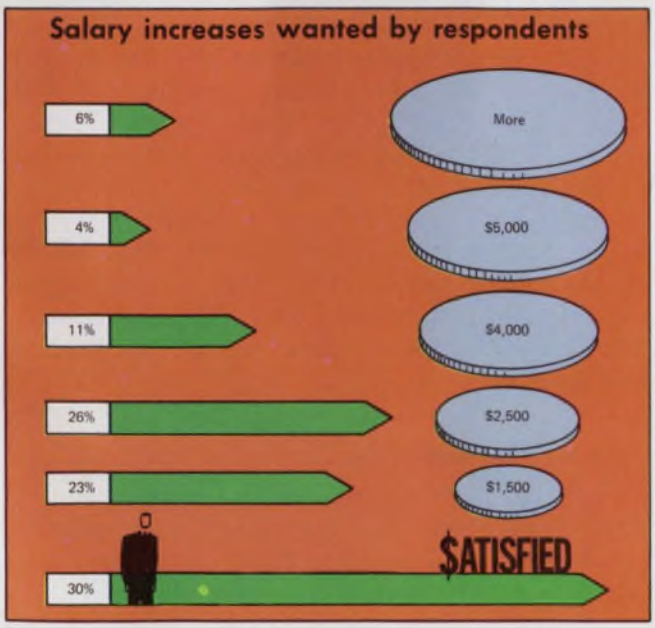
fered. Seven of ten of those who are pro-union, believe that their non-union companies should keep them ahead of the competition or should take on unlimited educational responsibility. Yet significantly, according to our survey, pro-union EEs work for companies that, in 7 out of 10 cases, offer either only enough training to keep the EE proficient at his job or no education.

Responding engineers who are anti-union tend to believe that their company should not necessarily be responsible for much more than enough training to keep them up with their work. Yet, according to the report, most anti-union engineers work for companies that offer more training than they expect to receive.

Job-hopping by age groups

As might be expected, the survey indicates that the younger the engineer the more likely he is to change jobs. In the past two years such was the case of half the respondents in the 20-to-29 age category. The reasons most often given for the change were either "unchallenged by the work" or "advancing the career."

According to our survey, the percentage of job-hopping EEs decreases, however, as they grow older. Three out of 10 EEs in their 30s have changed company allegiance in the last two years, stating as their reasons: "to advance their career" or "underpaid." One in five engineers in their 40s switch jobs, usually for purposes of advancement, and only 1 in 7 of those respondents in their 50s had a change of scene, with the excuse of "finding more rewarding work."



What EEs say about higher education

Nearly half of the respondents reported that their engineering training in college did not prepare them properly for contemporary technology, at the time of their graduation. The reason most often listed for this lack of preparation is "not enough practical application of engineering fundamentals in college." "Poor choice of curriculum" is another reason often given. Poor instruction is least noted as a cause.

Over half of those EEs who indicated that their training was satisfactory said that they chose engineering because they like to build things and because the profession teaches them logical sequence.

Two apparent contradictions developed in the areas of job-hopping and career choice when compared with education tabulations. For example: one of the main reasons given by "poorly educated" EEs for choosing an engineering career was that they thought they "could earn the best salary." The second contradiction is the report that while "well-educated" EEs change jobs to advance their careers, "poorly educated" ones say they usually change jobs because they're

unchallenged by the work.

Interesting also, is the finding that companies, regardless of location, place exactly the same emphasis on the amount of training they offer their employees. They are, in order of preference: enough for the job; enough for the competition; none; and unlimited responsibility.

Perhaps help is on the way for the current crop of student EEs in the matter of insufficient practical engineering application in college. In an article published this year by the American Society for Engineering Education, an industry spokesman suggested, at a conference attended by representatives of both industry and education, that industry update both curriculum and student by creating more part-time employment opportunities for engineering students and faculty members. In reciprocation, the spokesman suggested the schools could create a more practical, industry-related curriculum.

The extracurricular engineer

A few respondents facetiously—perhaps—considered "paying my family's bills" and "job hunting" to be worthwhile community activities, while others listed such disparate activities as the "third world liberation front," "underwater rescue team," and "converting text books to the Braille system" as being worthwhile projects.

One disturbing tabulation is that one engineer in five is not engaged in any community activity at all. Most of those in that category plead that their engineering studies don't give them time.

One engineer in five, however, has found time to serve his church, and 1 in 7 busies himself in civic affairs, including such diverse activities as the chamber of commerce, law enforcement, conservation, voluntary fire department, parks commission, Red Cross, and the development of human resources. Scouting engages 1 in 10 engineers, and the PTA and other school associations hold the attention of 1 in 20 EEs. Additional activities listed include charities, social work, little league, little theatre, politics, YMCA, and volunteer teaching.

What about that generation gap?

It appears that the so-called generation gap certainly exists, but not on the scale we've been told—at least not in the engineering profession.

Of those who considered themselves qualified to answer the question, 1 in 6 engineers under 30 years of age said that he had trouble understanding his boss. The most prevalent reason for the misunderstanding, according to the young EE, is that his supervisor is either "unwilling or unable to make clear-cut decisions."

Only 1 in 12 managers over 30 years of age reported having trouble understanding their under-30 subordinates. The reason most often given for this gap was "language" (a failure to express himself) or "attitude" (he thinks the world owes him a living).

Most respondents said they understood each other pretty well, either because the age difference between them was slight, or because most companies have a policy to air grievances.

That great advancement in the sky

Of all respondents, whether by age, title, or location, 2 out of 5 said that the most important consideration in the advancement of their engineering career in the next five years revolves around "more interesting work." One in four said that "more money" is the most important consideration, while another quarter of them said "promotions" were more important. The least listed consideration was "socially conscious work."

Sounding board vs the suggestion box

What then is the general mood and attitude of electronic design engineers, according to our survey results?

For one thing, even though some younger EEs are admittedly bored with their work, most respondents are EEs because they like to build things. And even though their working conditions are often undesirable, the vast majority of them still don't want anything to do with a union, mainly because it would stifle their incentive and degrade them as professionals. Those who are pro-union feel that their company should provide them with more training.

While most respondents feel they should be earning more salary, a surprisingly high percentage of them are satisfied with their pay.

Although the majority of responding engineers say they were "poorly trained," the reason they most often give for switching jobs is that they were unchallenged by the work.

It may be that the respondents to this survey took advantage of it to register all the opinions and gripes they couldn't air at work. If so, the survey is a sounding board that should be posted in electronics firms across the country where management, as well as other EEs, can read it. Who knows? It might even replace the suggestion box. ■■

Our thanks . . .

to those 550 engineers and engineering managers who took time out to complete our questionnaire. You have performed a nationwide service for EEs.

Guess the price of HP's new counter

Clues:

it averages time intervals to 10 picoseconds
it has a built-in 0.05% integrating DVM
it's dc to 50 MHz, CW or burst
its counter and DVM are easily programmable

Surprise: $1550. That modest amount buys a Hewlett-Packard timer/counter that does things universal counters never did before. For example, it averages time intervals as short as 0.15 nanoseconds. So you can resolve to 10 picoseconds on repetitive signals.

That modest sum also buys a counter with a built-in integrating digital voltmeter. So it's the only counter that can measure internal trigger level settings or other inputs with DVM precision. Now you can measure 10 to 90% rise times, half power points and other voltage-dependent time intervals. That means unprecedented simplicity, for example, in propagation delay measurements. The counter also features four integration times. As a DVM, it provides three voltage ranges, 60 dB noise rejection and 0.05% accuracy.

Even without these exclusive features, the 5326's are real bargains. They count to 50 MHz direct with seven-digit resolution (eight digits optional), measure period and multiple period average and scale input frequencies by any power of 10 up to 10^8. They measure ratio and they totalize.

With programming and BCD output options, the 5326's fit easily into systems applications. Counter and DVM are DTL programmable through a common connector.

You can get all of these benefits in the 5326B for $1550, or buy the same counter, less the DVM, in the 5326A for $1195. Any way you look at the 5326 A or B—either is a great counter value. Your local field engineer has all the facts about HP's new IC counter line. Give him a call or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

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INFORMATION RETRIEVAL NUMBER 59

Product Source Directory

Function Generators

Squarewave Generators

This Product Source Directory covers Squarewave and Function Generators.

For each table the instruments are listed in ascending order of one major parameter. The column containing this is color-coded white.

The following abbreviations apply to all instruments listed:

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

Unless otherwise specified, the power requirements for the instruments are 105-125 Vac.

Manufacturers are identified by abbreviation. The complete name of each manufacturer can be found in the Master Cross Index below.

Abbrev.	Company	Function	Square-wave
Argonaut	Argonaut Associates Inc. P.O. Box K Beaverton, Ore. 97005 (503) 292-3149	**451**	**452**
Datapulse	Datapulse Div. Systron-Donner Corp. 10150 W. Jefferson Blvd. Culver City, Calif. 90230 (213) 836-6100	**453**	
EICO	Electronics Instrument Co., Inc. 283 Malta St. Brooklyn, N.Y. 11207 (212) 949-1100		**454**
EMR	EMR-Hatboro East County Line Road Hatboro, Pa. 19040 (215) 672-1240	**455**	
Exact	Exact Electronics Inc. 455 Southeast 2nd Ave. Hillsboro, Ore. 97123 (503) 648-6661	**456**	**457**
GR	General Radio Co. 22 Baker Ave. W. Concord, Mass. 01781 (617) 369-4400		**458**
Heath	Heath Co. Benton Harbor, Mich. 49022 (616) 983-3961		**459**
H-P	Hewlett-Packard Co. 1501 Page Mill Road Palo Alto, Calif. 94304 (415) 326-7000	Contact local sales office	Contact local sales office
IEC	Interstate Electronics Corp. Data Products Div. 707 E. Vermont Ave. Anaheim, Calif. 92803 (714) 772-2811	**460**	
Krohn-Hite	Krohn-Hite Corp. 580 Massachusetts Ave. Cambridge, Mass. 02139 (617) 491-3211	**461**	**462**

Abbrev.	Company	Function	Square-wave
Marconi	Marconi Instruments 111 Cedar Lane Englewood, N.J. 07631 (201) 567-0607		**463**
Measure	Measurements, McGraw-Edison P.O. Box 180 Boonton, N.J. 07005 (201) 334-2131		**464**
Microdot	Microdot Instruments 220 Pasadena Ave. S. Pasadena, Calif. 91053 (213) 682-3351	**465**	
Philips	Philips Electronic Instruments 750 S. Fulton Ave. Mount Vernon, N.Y. 10550 (914) 664-4500	**466**	
Radiometer	Radiometer The London Co. 811 Sharon Drive Westlake, Ohio 44145 (216) 871-8900		**467**
RCA	RCA Electronic Components & Devices 415 S. Fifth St. Harrison, N.J. 07029 (201) 485-3900		**468**
Servo	Servo Corp. of America 111 New South Road Hicksville, N.Y. 11802 (516) 938-9700	**469**	
Tektronix	Tektronix Inc. P.O. Box 500 Beaverton, Ore. 97005 (503) 644-0161	**470**	**471**
Varitron	Varitron Corp. P.O. Box 2594 St. Louis, Mo. 63114 (314) 231-9240	**472**	
Wavetek	Wavetek 9045 Balboa Ave. San Diego, Calif. 92123 (714) 279-2200	**473**	**474**

Function Generators

Manufacturer	Model	FREQUENCY Min. Hz	Max. kHz	Rise µs	Fall µs	Function	OUTPUT Min. V	Max. V	Imp. Ω	Atten. dB	Misc. Features	Price $
Varitron	WBFG	0.02	0.2	0.3	0.3	a	1	3	600	n/a	a	126
EMR	1641	0.02	0.5	n/a	n/a	c	±10µV	±10	1	n/a	cd	6385
Servo	1999	0.001	1	2	2	b	20	40	500	111		3575
Philips	PM5168	0.005	5	3	ina	b	ina	20	600	ina		550
Argonaut	LRG 051	0.01	10	1	1	square	0	10	100	n/a		275
						ramp	0	100	1000			
						pulse	0	10	100			
						del. pulse	0	10	100			
Tektronix	162	0.1	10	1	ina	pulse	50	n/a	1000	ina		165
						gate	50	n/a	1000			
						sawtooth	25	145	1000			
H-P	203A	0.005	60	0.2	0.2	j	0.3	30	600	40	j	1250
Krohn-Hite	4025	0.001	100	ina	ina	z	ina	10 rms	200/600	ina	z	1950
Krohn-Hite	4024	0.001	100	ina	ina	z	ina	10 rms	200/600	ina	z	1200
H-P	3300A/3301A	0.01	100	0.25	0.25	y	-40 dB	35 p-p	600	40	y	730
H-P	3300A/3302A	0.01	100	0.25	0.25	x	-40 dB	35 p-p	600	40	x	945
H-P	3300A/3304A	0.01	100	0.25	0.25	w	-40 dB	35 p-p	600	40	w	945
Krohn-Hite	4100	0.1	100	ina	ina	l	ina	10 rms	50	ina	l	550
H-P	3300A/3305A	0.1	100	0.25	0.25	u	0.03	24 p-p	600	40	uv	1675
Varitron	WBFG	20	200	0.3	0.3	a	1	3	600	n/a	a	96
Exact	505B	0.0001	1000	0.05	0.05	g	0	28	600	40	gi	645
Exact	5000	0.0001	1000	0.05	0.05	g	0	28	600	40	gh	500-1200
Exact	502	0.0001	1000	0.05	0.05	e	0	10	600	40	e	385
Exact	503B	0.0001	1000	0.05	0.05	e	0	28	600	40	ei	545
Exact	504B	0.0001	1000	0.05	0.05	g	0	28	600	40	gi	565
Exact	500B	0.0001	1000	0.05	0.05	e	0	28	600	40		495
Wavetek	116	0.0015	1000	0.01	0.01	u	1	30	50	40	pu	845
Wavetek	115	0.0015	1000	0.01	0.01	u	1	30	50	40	mu	745
Wavetek	111	0.0015	1000	0.01	0.01	u	1	30	50	40	u	545
Wavetek	112	0.0015	1000	0.01	0.01	u	1	30	50	40	trigger	695
Wavetek	114	0.0015	1000	0.01	0.01	s	1	30	50	40	s	795
Wavetek	113	0.001	1000	0.01	0.01	u	0.01	30	50	50	pushbutton	595
Wavetek	110	0.005	1000	0.01	0.01	b	1	30	50	40	6 outputs	445
Microdot	F280A	0.01	1100	0.01	0.01	q	0.01	11 p-p	50	yes	qkr	1545
Microdot	F270A	0.01	1100	0.01	0.01	q	0.01	11 p-p	50	yes	qr	1445
Datapulse	410	0.0002	2000	50	50	a	0.004	40	50/600	40	a	995
Datapulse	401	0.02	2000	40	40	b	0.002	0.02	50/600	40	b	395
Wavetek	130	0.2	2000	0.1	0.1	b	0.01	20	50	40	b	295
Wavetek	131	0.2	2000	0.1	0.1	b	0.01	20	50	40	b	395
Wavetek	134	0.2	2000	0.1	0.1	u	0.01	20	50	40	u	495
Wavetek	135	0.2	2000	0.1	0.1	u	0.01	20	50	40	u	695
Wavetek	136	0.2	2000	0.1	0.1	b	0.0001	20	50	80	b	595
Microdot	F220A	0.005	3000	0.01	0.01	e	n/a	16.25	50/600	yes	ekp	1085
Microdot	F210B	0.005	3000	0.01	0.01	n	n/a	16.25	50/600	yes	nk	785
Microdot	F240A	0.005	3000	0.01	0.01	e	n/a	16.25	50/600	yes	ekm	1105
Microdot	F230B	0.005	3000	0.01	0.01	e	n/a	16.25	50/600	yes	ek	1095
Exact	120	0.1	3000	0.06	0.06	b	0.01	10	50	60	b	295
Exact	123	0.1	3000	0.06	0.06	b	0.01	10	50	60		345
Exact	126	0.1	3000	0.06	0.06	e	0.01	10	50	60	ef	495
H-P	3310A	0.0005	5000	0.03	0.03	s	0.03	24 p-p	50	60	st	595
Exact	100	0.001	5000	0.05	0.05	e	0.01	15	50	70	e	445
IEC	F55	0.0005	10000	0.03	0.03	a1	n/a	15	50	yes	a1, a5	1195
IEC	F54	0.0005	10000	0.03	0.03	a1	n/a	15	50	yes	a1, a4	1085
IEC	F53	0.0005	10000	0.03	0.03	a1	n/a	15	50	yes	a1, a3	895
IEC	F52	0.0005	10000	0.03	0.03	a1	n/a	15	50	yes	a1, a2	795
IEC	F51	0.0005	10000	0.03	0.03	a1	n/a	15	50	n/a	a1	595
Wavetek	144	0.001	10000	0.02	0.02	u	0.0001	30	50	80	pu	895
Wavetek	142	0.001	10000	0.02	0.02	u	0.0001	30	50	80	u	595
Tektronix	R116	99.9	10000	0.01-110	0.01-110	a	±0.02	±10	50	ina	a	1825
Tektronix	115	100	10000	0.01-100	0.01-100	a	0.02	±10	50	ina	a	865
Tektronix	284	100k	10000	70×10^{-6}	ina	pulse	0.01	1	50	ina		555
		100M	1 GHz			sine	0.1	0.1	50			
		100k	10000			square	0.01	1	50			

a. Functions, sine, square, triangle, pulse, sine squared, sawtooth.
b. Functions, sine, square, triangle.
c. True arbitrary.
d. Paper tape programming.
e. Functions, sine, square, triangle, ramp, pulse, burst.
f. Internal sweep, dc offset. Pulse variable in width and repetition rate. Gating and triggering.
g. Functions, sine, square, triangle, ramp, pulse, haversine, havertriangle, half sine.
h. Modular construction, price varies with requirement.
i. VCF 50:1. Gating & triggering. Dc offset. Three output amplifiers.
j. Functions, sine, square, phase shifted sine and square.
k. VCF 100:1. Gating & triggering, dc offset, phase shift.
l. Functions, sine, square pulse. Model 4130 at $1295, programmable.
m. Phase lock generator.
n. Functions. sine, square, triangle, ramp, pulse.
o. Programmable pulse-paired, burst, gated, delayed & undelayed generator.
p. Triggered tone burst generator.
q. Functions, sine, square, triangle, sine squared.
r. All functions programmable.
s. Functions, sine, squared, triangle, ± pulse, ± ramp.
t. Programmable frequency within one range. Sync output and dc offset included.
u. Functions, sine, square, triangle, ramp.
v. Type 3305A, sweeper plug-in at $975 included. 0-4 decades log sweep in any one range.
w. Functions, sine, square, triangle, sawtooth. Type 3304A, sweep/offset plug-in at $285 included. Programmable frequency within one range. Sync pulse output, dc offset included.
x. Type 3302A trigger/phase lock plug-in at $245 included. Programmable single period, multiple period, phase lock &

(continued on pg. 106)

Datapulse is making waves.

Big or little, one channel or two, FM or AM, square, triangular, sine or swept, the new family of Datapulse function generators makes better waves. What's more, we've put a couple of new ideas to work in the design so that you get more ⩘⎍⩘ for your $$$.

The little beauty on top, the Datapulse Model 401, sells for only $395 and gives you a dial accuracy of one percent (that's about twice as good as the competition). Frequency is 0.02 Hz to 2 MHz, and sine distortion is only 0.25 percent in the audio range. Square-wave rise time is a fast 40 nanoseconds. To handle low levels, we give you 80 db dynamic amplitude range.

You can field calibrate the 401 with a screwdriver, and we give you a calibrated 1V p-p square wave out for scope work. A switchable 40 db attenuator and your choice of 50 or 600 ohms output impedence further simplifies your life. You get 1000:1 voltage control, too.

The other unit, the one with all the buttons, bells and whistles, is the elegant and sophisticated Model 410. It takes up where the 401 leaves off.

Frequency is 0.0002 Hz to 2 MHz. Dial accuracy is 1%. Uniquely among function generators, the 410 allows you to both AM and FM outputs for an extra dimension in wave generation. A built-in triggerable sweep generator gives complete flexibility using either or both of the independently controllable 40V p-p output channels to generate sine, square, triangle, sawtooth, and swept waves. Price is a modest $995.

To arrange a demonstration or obtain more data, contact your local S-D man. Or address Datapulse Division, Systron-Donner Corporation, 10150 W. Jefferson Blvd., Culver City, California 90230. Phone (213) 836-6100.

DATAPULSE
DIVISION

SYSTRON DONNER

Squarewave Generators

Manufacturer	Model	FREQUENCY Min. Hz	Max. kHz	Rise µs	Fall µs	OUTPUT Min. V	Max. V	Imp. Ω	Atten. dB	Misc. Features	Price $
Argonaut	SRS020	0.1	10	0.5	0.5	0.01	150	a	n/a	a	225
EICO	377	60	30	ina	ina	10	10	1000	n/a		60
GR	1313-A	10	50	0.1	ina	n/a	5 p-p	60	0-20	c	350
Heath	IG-18	5	100	0.05	0.05	0	10	52	-62 to +22	g	99
Measure	71	6	100	0.2	0.1	0	75	var	s	s	290
GR	1309-A	10	100	0.1	ina	n/a	5 p-p	600	0-20	c	375
RCA	WA-504A	0.02	200	1	1	n/a	10	ina	n/a	b	95
RCA	WA-44C	0.02	200	ina	ina	n/a	8	100k	n/a		99
EICO	379	20	200	0.1	ina	0	10	ina	n/a	b	95
GR	1210-C	20	500	0.35	ina	0	30 p-p	2.5k	ina	c	255
Exact	500B	0.0001	1000	0.05	0.05	0	28	600	40	ef	495
Krohn-Hite	4100	0.01	1000	ina	ina	ina	10 rms	50	s	s	550
Marconi	2103	10	1000	30	30	0.25	2.5	600	ina	t	135
Tektronix	106	10	1000	0.012	ina	0.5	120	ina	ina	x	665
Radiometer	RC011	10	1000	0.05	0.05	0	1	50/600	u	bu	633
Heath	EUW-27	20	1000	0.15	ina	0.1	10	52	n/a	c	100
Tektronix	114	100	1000	0.01	0.01	1	10	50	ina	v	340
Wavetek	130	0.2	2000	0.1	0.1	0.1	20	50	40		295
H-P	209A	4	2000	0.05	0.05	-20 dB	20 p-p	600	26	ch	345
Exact	120	0.1	3000	0.06	0.06	0.01	10	50	60		295
Exact	123	0.1	3000	0.06	0.06	0.01	10	50	60	d	345
Measure	72	5	5000	0.05	0.05	0	12	75/500	s	s	360
Wavetek	142	0.0001	10000	0.02	0.02	0.0001	30	50	80		595
H-P	8005A	0.3	10000	10ns-2s	10ns-2s	0.02	5	50	p	pq	1100
H-P	8003A	0.3	10000	0.005	0.005	0.05	5	50	p	p	470
H-P	8002A	0.3	10000	10ns-2s	10ns-2s	0.05	5	50	p	p	700
H-P	8010A	1	10000	12ns-1s	12ns-1s	0.02	5	50	p	pr	1925
H-P	221A	1	10000	0.015	0.015	0	5	50	j	j	225
H-P	220A	1	10000	0.015	0.015	0	-5	50	j	j	225
H-P	211B	1	10000	0.005	0.005	0.02	5	50	i	i	450
Microdot	F324A	10	10000	0.01	0.01	100µV	6.32 p-p	50/600	yes	bz	660
Marconi	1370A	10	10000	0.4	0.4	0.001	73.2 p-p	75-100	-50	c	935
Microdot	F323A	10	10000	0.01	0.01	100µV	6.32 p-p	50/600	yes	by	795
H-P	222A	100	10000	0.004	0.004	0.05	10	50	k	k	690
H-P	1900A/1905A/1915A	25	25000	7ns-1ms	7ns-1ms	±1.25	±25	50	n	n	2570
Tektronix	2101	2.5	25000	0.005	0.005	0.5	10	50		w	req
H-P	1901A/1905A/1917A	25	25000	10ns-40ms	10ns-40ms	0.2	10	50	m	m	1195

a. 50mA maximum current.
b. Solid State.
c. Also Sine wave output.
d. Programmable dc.
e. Three outputs.
f. Dc offset.
g. Output impedance on 0.1V & 1V range, 220Ω on 10V range.
h. Programmable sync.
i. Also 600Ω unit, 1 Hz-1000 kHz, 70 ns rise & fall time, 0.3-30V output. Attenuator calibrated in volts, 7 steps in 1, 2.5, 5 sequence with vernier.
j. Remote frequency programming. Attenuation calibrated in volts.
k. Pulse generator that may be operated as squarewave generator. Attenuation calibrated in volts, 7 steps from 0.1-10V in 1, 2, 5 sequence.
m. Plug-in pulse generator operated as squarewave generator, programming is optional. Attenuation calibrated in volts, 5 steps. Price includes one blank plug-in.
n. Plug-in pulse generator operated as squarewave generator, programming is optional. Attenuation calibrated in volts, ±2.5 to ±50V high Z source and ±1.25 to ±50V, 50Ω source.
p. Pulse generator operated as squarewave generator. Attenuation calibrated in volts, 7 steps in 1, 2.5, 5 sequence with vernier.
q. Simultaneous + and - outputs.
r. Two independent channels. Outputs may be combined.
s. Attenuation calibrated in volts.
t. Battery or line operated.
u. Attenuation calibrated in volts, 4 steps, 1, 10, 100mV, 1V.
v. Continuously variable pulse width period & variable amplitude.
w. Continuously variable period, duration, delay, amplitude and baseline offset.
x. ± fast rise or high amplitude, sync input or trigger output.
y. Expanded scale. Conversion from rms to p-p available.
z. Expanded scale.

(continued from pg. 104)

reference frequency. Sync pulse output included. Functions, sine, square, triangle (2 outputs).
y. Functions, sine, square, triangle (2 outputs). Type 3301A plug-in at $30 included. Programmable frequency within one range. Sync output included.
z. Functions, sine, square, pulse. Model 4024 frequency accuracy 0.5%, model 4025, 0.1% accuracy.
a1. Functions, sine, square, ± ramp, triangle, ± pulse, variable width pulse.
a2. Gate & triggering included.
a3. Gate, triggering and phase lock included.
a4. Gate, triggering and sweep included.
a5. Gate, triggering, phase lock and sweep included.

Let's face it: We won't knock them out of the ring tomorrow. But Microdot is hereby announcing its entry into the general instrument market. With a full line of solid state waveform generators and test oscillators. So, while the guys at H-P are still yawning with surprise, here are some facts for your consideration.

There are five models in each series. The waveforms cover a frequency spectrum of .005 Hz to 3 MHz. They offer a wide variety of output signals: sine, square, triangle, ramp and sync pulse. Their versatility is evident in one model which offers you six instruments in one: function generator, VCO, sweep generator, sawtooth generator, pulse generator and tone burst generator. Other models provide full digital programming capability that is compatible with system interfaces using standard TTL and DTL positive logic.

The five test oscillators cover a frequency range from 10 Hz to 10 MHz. Each instrument includes an output signal level monitor, and amplitude is controlled by precision step attenuation.

When Microdot takes on a giant of the instrument business, we don't fool around. These instruments are now in the hands of good reps all across the country, and inventory is available for immediate delivery.

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We'll offer you complete literature, a demonstration if desired — and, of course, a pair of miniature boxing gloves inscribed with our motto (which might be yours someday): "Sock it to the fat cats." After all, if we're going to get into a fight against these kinds of odds, we need all the friends we can get.

MICRODOT INC. / INSTRUMENTATION DIVISION
220 Pasadena Ave., South Pasadena, Calif. 91030

Here we were, busily competing with Amphenol on connectors, Belden on cable products, SPS and Esna on fasteners and Philco-Ford on RF instrumentation–

and now some wise guy decides to take on Hewlett-Packard.

INFORMATION RETRIEVAL NUMBER 61

Integrated op-amp pulse circuit has 18-second time constant

New-generation low-input current-integrated operational amplifiers lend themselves readily to long-time constant pulse circuits. In the following example, a monostable multivibrator with an 18-second time constant is achieved with a minimum of components, cost and complexity.

To understand circuit operation (Fig. 1), assume the output to be in its quiescent state at the positive saturation level of the LM 107. In that case, the noninverting terminal is at approximately $(V_{sat})(R_3)(R_2+R_3)$. The inverting terminal is at $V_D (\approx 0.56$ V at room temperature).

If a negative spike greater than $[(R_3V_{sat})/(R_2+R_3)] + V_D$ is brought to the noninverting terminal, the amplifier output will reverse states at the slewing rate of the amplifier ($\approx 0.34 v/\mu s$). After this has occurred, the capacitor C_1 will charge through R_1 until the voltage across C_1 is greater than $(-V_{sat})(R_3)/(R_2+R_3)$. At this point the amplifier, acting as a comparator, will return itself to the quiescent state.

However, as shown in Fig. 2, the one problem with this basic circuit is that the reset time is as long as the output pulse. To remedy this, it is necessary only to add a diode and resistor in the feedback loop (D_2, R_4) in such a direction that the reset time constant is shortened as shown in Fig. 1 where

$$\text{pulse duration} = R_1C_1 \ln\left(\frac{R_2}{R_2+R_3} - \frac{V_D}{V_{sat}}\right),$$

assuming that $V_{sat} = -V_{sat}$.

Choose:

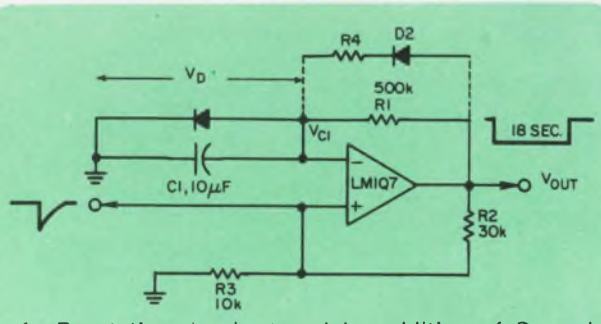
- $R_4 \ll R_1$.
- $(V_{sat}R_3)/(R_2+R_3) \gg V_D$ (to minimize effects of V_D changes with temperature).
- $(V_{sat}R_3)/(R_2+R_3) \ll V_{sat}$ (to minimize effects of V_{sat} changes with temperature).

$$\text{Reset time} = R_1C_1 \ln\left(\frac{R_2}{R_2+R_3} - \frac{V_D}{V_{sat}}\right)$$

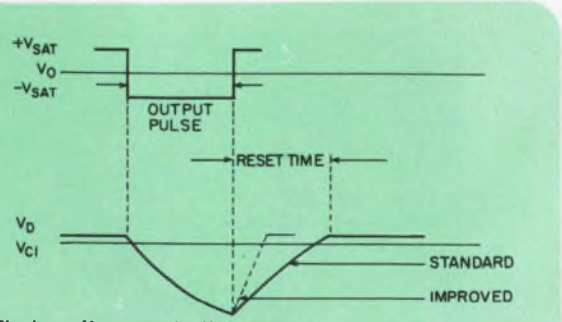
Note that ion-implantation diodes have a lower forward breakdown and a better temperature coefficient than standard silicon junction diodes, and that they result in an even more stable output over temperature.

Peter Berg, Group Supervisor, Dalmo Victor Co., Belmont, Calif.

VOTE FOR 311



1. **Reset time** is shortened by addition of D_2 and R_4 to the feedback loop.



2. **Timing diagram** indicates improvement obtained from circuit modification.

There isn't another like it. A ¼-inch, single-pole, six position, 28-vdc. Helipot switch for PC boards.

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Model 374H $3.00 (1-9 pieces)

Model 374 $2.75 (1-9 pieces)

INFORMATION RETRIEVAL NUMBER 62

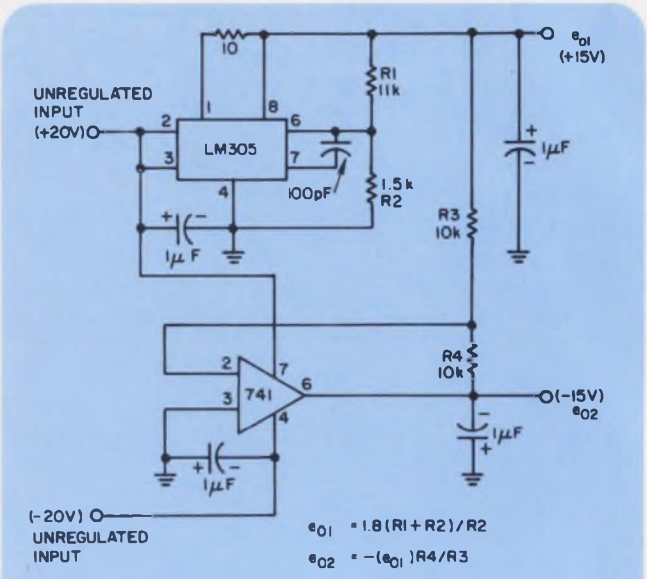
Monolithic circuits provide inexpensive dual regulation

For powering analog circuits, such as op amps, both positive and negative voltages are usually needed. A low-cost approach to the problem of providing dual, regulated voltages is shown in the circuit diagram.

The heart of this design is a low-priced monolithic operational amplifier connected in a unity gain, inverting configuration. The monolithic voltage regulator provides the reference voltage, and the op amp provides negative current.

Because of the circuit arrangement, both output voltages—e_{o1} and e_{o2}—can be controlled by the one regulator. The negative output stability will be dependent upon the positive output stability. This is acceptable because most operational amplifiers that could be powered from this circuit are insensitive to common-mode voltage changes.

The input-output voltage drop is 5 V and the maximum available current is about 25 mA. These two figures indicate a safe margin on power dissipation at maximum load current.



Dual regulated outputs, e_{o1} and e_{o2}, are controlled by a single voltage regulator. Maximum current is 25 mA.

Richard C. Gerdes, President, Optical Electronics, Inc., Tucson, Ariz.

VOTE FOR 312

Low-voltage shunt regulator can power tunnel diodes

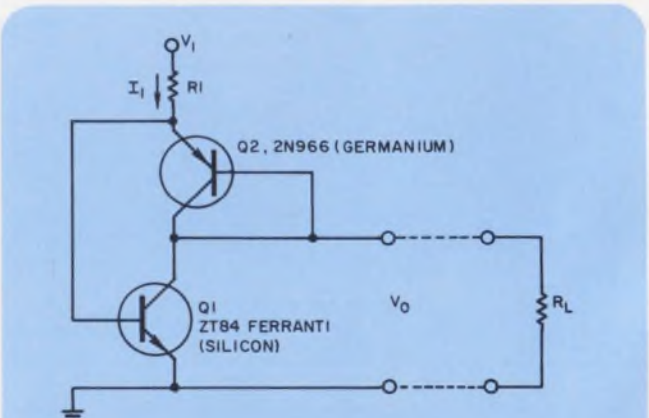
A simple circuit that has only three components can provide a low-voltage (0.3-V), low-impedance (0.3 Ω) power supply with a temperature coefficient on the order of 0.1%/°C.

A high-gain general-purpose silicon npn transistor is used in a basic shunt mode, with a forward-biased germanium diode in series with its collector. As shown in Fig. 1 the output voltage V_o is initially the difference between the conduction potentials of the silicon base-emitter voltage (0.6 V) and the germanium-diode drop (0.3 V). The collector-to-emitter saturation voltage of Q_1 must be less than the difference.

It is more convenient, in practice, for improved thermal tracking of the two junctions to employ a diode-connected pnp germanium transistor, Q_2, rather than a germanium diode. With both transistors in TO-18 cans, and collectors to case, a small heat sink maintains good thermal contact.

Base-emitter voltage of Q_1 decreases by about 2.3 mV/°C, tending to reduce V_o; but the base-emitter voltage of Q_2 decreases by approximately the same extent and opposes the change in V_o caused by Q_1. Since the temperature dependent term is a function of junction current, the temperature stability varies with load R_L.

The shunt configuration gives an inherently low output impedance, as shown in Fig. 2, with $R_L = \infty$, $R_L = 1$ kΩ and $R_L = 220$ Ω, over a range of input voltages. The slope change from negative to positive output impedance is due to the finite current gain of Q_1. With Q_1 and Q_2 in a



1. **Low-voltage shunt regulator** uses germanium transistor as diode to provide voltage difference.

RCA-TA7487 is new.
It offers 2 W with 10 dB gain (min.)
at 2 GHz for solid-state microwave designs.

RCA-TA7487 is a ceramic-metal coaxial unit.
It can do a big job for engineers
designing to achieve minimal space without
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performance at UHF/microwave frequencies.

By the nature of its package, TA7487 features
low parasitic capacitances and inductances.
This introduces stability into your designs
for point-to-point microwave relay links,
S-band telemetry, distance measuring equipment,
and collision avoidance systems.

Here's a suggestion:
Use TA7487 as a driver for RCA-TA7205—
another RCA "overlay" transistor
in the industry's champion RF power line.

Ask your local RCA Representative
about TA7487 and other "overlay" units.
For technical data, write:
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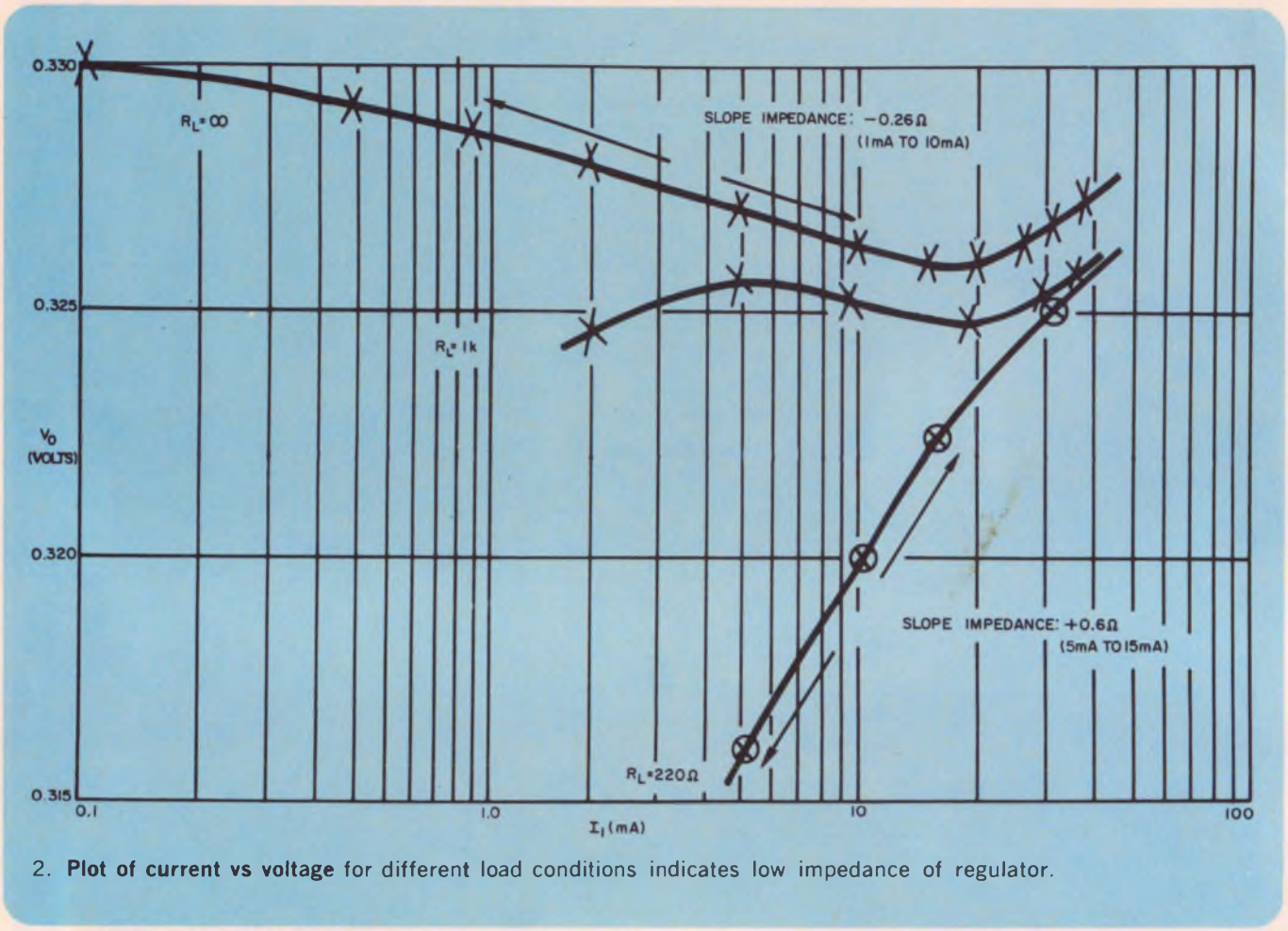
Commercial Engineering,* Harrison, N. J. 07029.
In Europe: RCA International Marketing S.A.,
2-4 rue du Lièvre, 1227 Geneva, Switzerland.

RCA

The Collision-Avoidance Transistor

*Section PG5-2/UF7

INFORMATION RETRIEVAL NUMBER 63



2. **Plot of current vs voltage** for different load conditions indicates low impedance of regulator.

common heat sink and no load, $V_o = 0.326$ V at 25°C and 0.310 V at 75°C, corresponding to 0.32 mV/°C change. For $R_L = 220\ \Omega$, $V_o = 0.313$ at 25°C and 0.290 V at 75°C, equivalent to 0.42 mV/°C.

The supply was designed for powering a gallium-arsenide tunnel-diode oscillator where 0.3 V crosses the negative resistance region. With suitable choice of Q_1 and Q_2 it is also useful as a low-voltage stable reference derived from a widely varying input voltage.

John M. Morrison, Design Engineer, Ferranti, Ltd, Edinburgh, Scotland.

VOTE FOR 313

High-frequency VCO uses TTL gates

One of the problems encountered when constructing high-frequency astable multivibrators from cross-coupled transistors is the shunt capacitance, C_{be}, of each transistor. This capacitance sets an upper frequency limit on the multivibrator. The input circuit of a TTL gate presents only a small shunt capacitance to the circuit.

The circuit shown utilizes two TTL NAND gates, two capacitors and six resistors to form a voltage-controlled oscillator (VCO). With the indicated component values and V_{in} at 0 V, the frequency of oscillation is approximately 7 MHz.

The gates are biased at their turnover points (typically 1.4 – 2 V) by the voltage divider networks R_1, R_2 and R_3, R_4. These networks, together with C_1 and C_2 define the basic operating frequency. The gates are protected from negative-going input pulses by diodes D_1 and D_2.

R_5 and R_6 provide the input connections for the oscillator control voltage V_{in}. The frequency may be adjusted ±10% by varying V_{in} between

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$12 Unit Quantities

At just $12. in unit quantities, the **Model 40** becomes the FET input op amp recommended in nearly all general purpose applications where high input impedance and low bias current are required. Two versions are offered which differ only in initial offset voltage, input bias and difference current, and price. The encapsulated module measures 1" x 1" x 0.5".

CHOPPERLESS DIFFERENTIAL

0.25μV/°C

Newest in a series of low drift chopperless differential op amps, the **Model 184** gives chopper-stabilized-like performance with the application flexibility of differential inputs, coupled with low cost. The 184 is recommended for an extremely wide variety of high performance applications and promises to become the industry standard for low drift requirements. Three versions are available, differing principally in drift characteristics and cost. Package size is 1.5" x 1.5" x 0.4".

FAST SETTLING FET

0.6μs to 0.01%

Settling time of just 0.6μsec to 0.01% accuracy makes the new **Model 45** applicable to many high speed/fast settling requirements such as A/D and D/A converters, pulse height amplifiers, etc. Input parameters are characteristic of FET differential input amplifiers. Two versions are available with differing offset and drift specifications. Package size is 1.12" x 1.12" x 0.4".

SPECIFICATIONS	MODEL 40 J | K	MODEL 184 J | K | L	MODEL 45 J | K
OPEN LOOP GAIN	5×10^4	3×10^5	10^5
RATED OUTPUT, min	±10V @ 5mA	±10V @ 5mA	±10V @ 20mA
FREQUENCY RESPONSE			
Unity gain, small signal	4MHz	500kHz	10MHz
Full power response, min	100kHz	5kHz	1MHz
Slew rate, min	6V/μsec	0.3V/μsec	75V/μsec
INPUT OFFSET VOLTAGE @ 25°C, max, μV	Adj to 0	±250 | ±100 | ±100	Adj to 0
Average vs. temp 10 to 60°C, max, μV/°C	±50 | ±20	±1.5 | ±0.5 | ±0.25	±50 | ±15
INPUT BIAS CURRENT @ 25°C, max	−50pA | −20pA	(0,+) 25nA	−50pA | −25pA
Average vs. temp 10 to 60°C, max, nA/°C	doubles every 10°C	−0.25	doubles every 10°C
INPUT DIFFERENCE CURRENT @ 25°C	±25pA | ±10pA	±2nA	±25pA | ±10pA
Average vs. temp 10 to 60°C, nA/°C	doubles every 10°C	±.02	doubles every 10°C
INPUT IMPEDANCE			
Differential	$10^{11}\ \Omega \| 3.5$pF	4MΩ	$10^{11}\ \Omega \| 3.5$pF
Common mode	$10^{11}\ \Omega \| 3.5$pF	1000MΩ	$10^{11}\ \Omega \| 3.5$pF
PRICE			
1 - 9	$12. | $19.50	$45. | $60. | $75.	$38. | $48.
10 - 24	$11.80 | $18.70	$43. | $57. | $71.	$36 | $46.

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Data on these three amplifiers is contained in a new brochure featuring pre-selected Analog Devices' op amps. The amplifiers outlined in this short form catalog are those recommended for about 85% of the requirements evaluated by Analog Devices' applications engineering department. Available without charge on request.

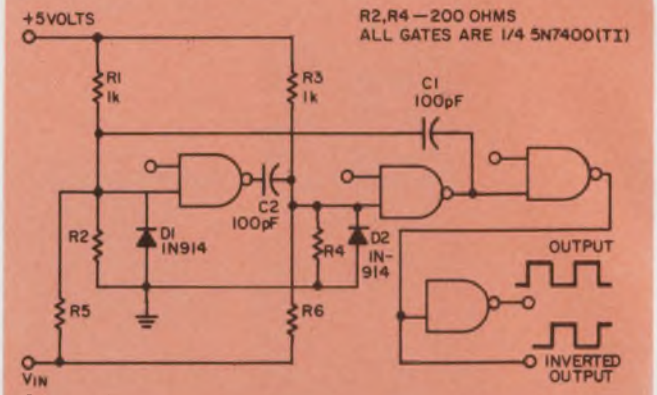
+5 V and −5 V.

The basic operating frequency may be increased by using smaller values of C_1 and C_2. By reducing the value of R_5 and R_6, the frequency control range may be extended.

The inverting gates are optional, but they provide improved wave shape, and buffer the output from external clock loads.

A. C. Burley, A. V. Aellen, Senior Engineers, Hawker Siddeley Dynamics Ltd., Hertfordshire, England.

VOTE FOR 314



Small shunt capacitance of TTL input gates allows this VCO to operate at 7 MHz.

Noise generator simulates radar return-signal 'grass'

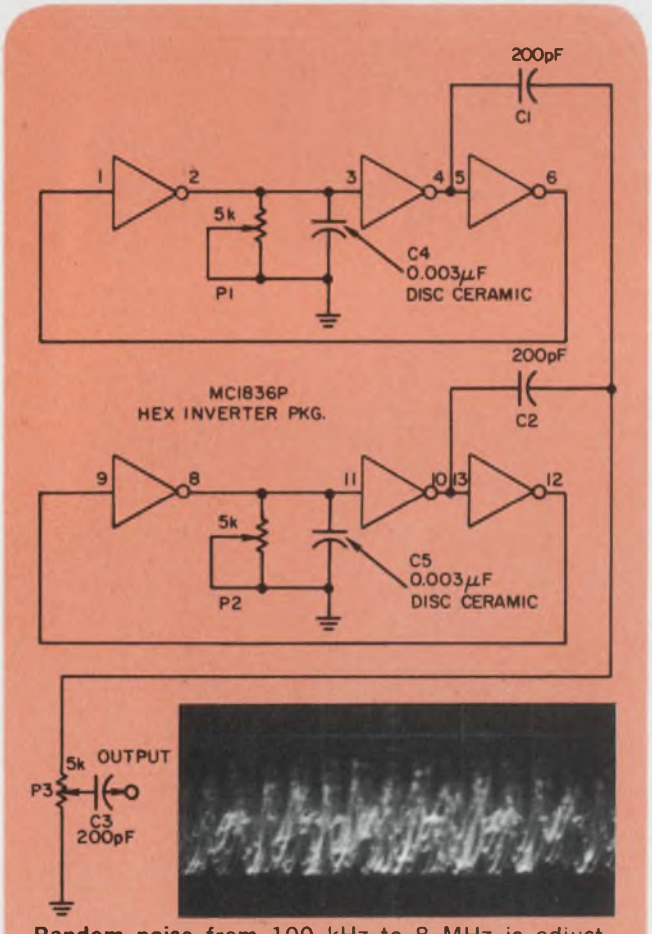
Radar return-signal "grass" can be simulated in test setups by the following random-noise generator that operates in the range of 100 kHz to 8 MHz.

The circuit and its output signal are shown in the figure. The design uses one Motorola MC-1836P hex inverter package that contains three circuits in each of two networks. A variable resistor and fixed capacitor in parallel connection control the network frequency. Each network is adjusted to a different frequency, and the coupling capacitors, C_1 and C_2, provide interaction between the two circuits. The result is a random noise output signal.

Potentiometers P_1 and P_2 are used to produce various "colors" of noise. P_3 varies the output from 0 to 3.0 V peak to peak. Potentiometers are Spectro model 153-1. The capacitor C_3 is used to couple the noise into a video output amplifier. Fixed resistors could replace the variable potentiometers if only one output level is desired.

Donald D. Lacy, Member of Technical Staff, Logicon, Inc., San Diego, Calif.

VOTE FOR 315



Random noise from 100 kHz to 8 MHz is adjustable in content (P_1, P_2) and level (P_3). Scope photo sensitivity is 2 μs × 1 V.

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

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IFD Winner for February 1, 1970

George S. Oshiro, Design Engineer, Teledyne Systems, Los Angeles, Calif. His Idea "EXCLUSIVE-OR Gates Replace Choppers in Phase-Lock Loop" has been voted the Most Valuable of Issue award.

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G.A. GmbH
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Frauenlobstr 9
06121-83073

INFORMATION RETRIEVAL NUMBER 65

Content addressable memories match input to stored data

Signetics Inc., 811 E. Arques Ave., Sunnyvale, Calif. Phone: (408) 739-7700. P&A: 40¢ to 70¢ per bit, 80¢ to $1.40 per bit; stock.

Two new monolithic arrays form a unique family of memory products known as content addressable memories (CAMs). They are the high-speed model 8220 and the low-power model 8222 elements.

Content addressable memories are memories in which data can be associated. That is any data placed at the input of the memory is matched against the memory's stored data. The memory responds with a match or mismatch answer.

With these two new CAMs, data can be written into them just like any other read/write memory and they then provide the association of input to stored data. They also give the address location of what word in the memory matches the data presented at its input.

Until now, to use data in a read/write memory, the stored data had to be processed after the input data was read in. The use of computer software was a common technique.

The model 8220 high-speed element can perform an associate function in 25 ns, while the model 8222 low-power element dissipates only 300 mW maximum and 200 mW typical.

Both elements incorporate the necessary addressing logic and contain eight identical memory cells, which are organized as four words, each being two bits long.

With reference to input and stored data, both can be conditioned to perform the following functions: associate, write-in only and read-out only.

Write-in can be done simultaneously to all bits, or to one bit at a time. The readout function of the stored information is performed on one word at a time.

Cell selection for read and write functions is obtained by the proper addressing of input and output lines.

The cell's output structure for each element is of the "bare collector" variety which allows cells to be mutually connected.

This feature permits the memories to be expanded in two directions—in word length and in the number of words when multiple packages are employed.

Each array contains 100 discrete gates and each has a circuit structure of the familiar TTL type (DCL family) and is fully compatible with TTL and DTL input and output structures. Both memory elements can be used in a computer data processing associative process and in stored comparator applications.

Each element can also be configured as a self-learning memory. In this mode, the memory does not issue a write command for the output if a matching input word is contained in its storage.

If however the input word is not contained in the storage, the memory will "learn" to put the input word into storage for subsequent associative functions.

In the self-learning configuration, the element is always in the associate mode when no word has to be written into storage.

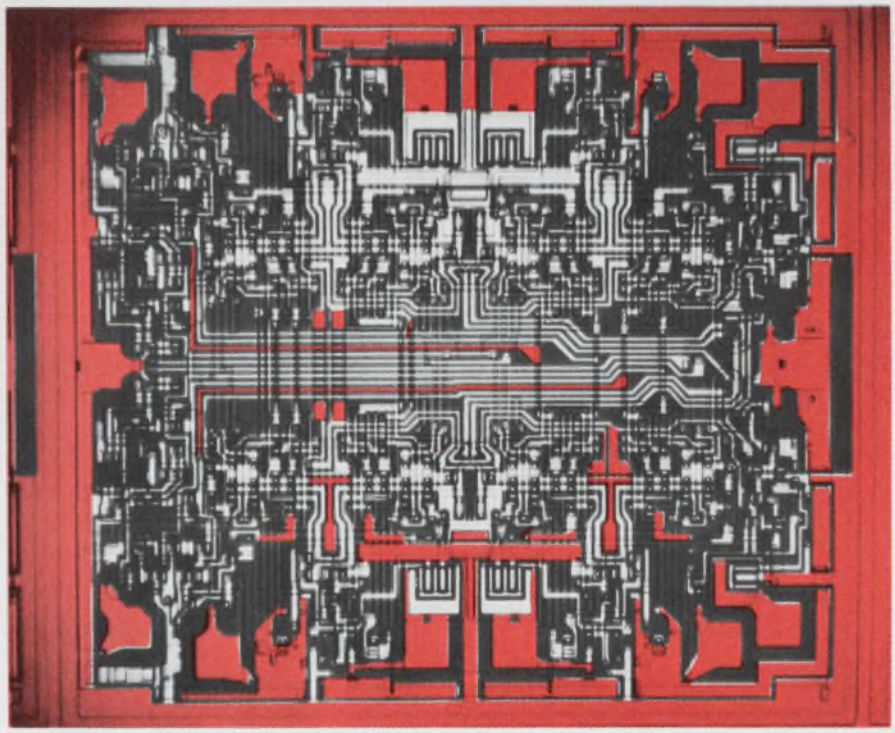
Monitoring the output lines provides a convenient way of decoding an available address.

A clear command totally erases the memory contents. The process of selectively erasing individual words is also a simple one.

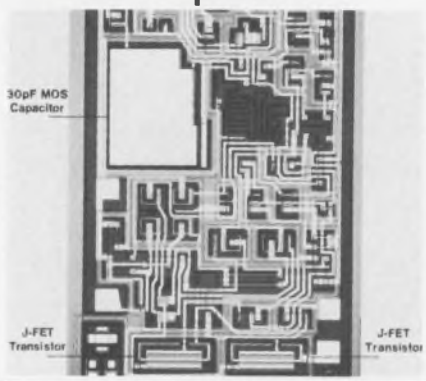
The model 8820 is available in 16-pin flatpacks in either temperature range of −55 to +125°C or 0 to +75°C. It is also available in a 16-pin dual-in-line case for the temperature range of 0 to +75°C.

The model 8222 is available in the following versions: 8222B (0 to +75°C) and 8222R (−55 to +125°C and 0 to +75°C).

CIRCLE NO. 250



Monolithic op amp has FET inputs

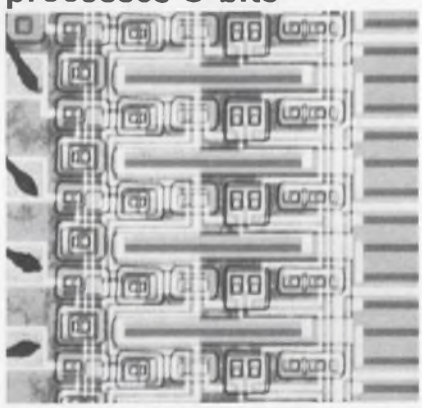


Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. Phone: (415) 962-3563. Price: $37.50 or $73.50.

Hailed as an industry first, the μA740 is a monolithic FET-input operational amplifier that operates with 200-pA maximum current into either input. In addition, the device features equivalent betas of more than 15,000 and an input impedance of 10^{12} Ω. Unity-gain slew rate is 6 V/μs; voltage gain is 120 dB.

CIRCLE NO. 251

D/a converter chip processes 8 bits

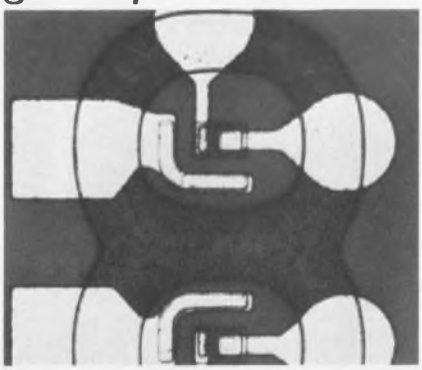


Radiation Inc., Microelectronics Div., sub. of Harris-Intertype Corp., Melbourne, Fla. Phone: (305) 727-5412. Price: $82.50.

Incorporating an on-chip resistor ladder network, the RI-1080 monolithic digital-to-analog current-mode converter can handle up to eight bits of data at the same time. Depending on the external voltage reference, this new MSI device can operate in three modes: bipolar, unipolar positive or unipolar negative. Operating temperature range is -55 to $+125$°C.

CIRCLE NO. 252

Dual transistor gains up to 1500



Intersil Inc., 10900 N. Tantau Ave., Cupertino, Calif. Phone: (408) 257-5450. P&A: $6; stock.

Suited for both radiation-hardened and industrial applications because of its dielectrically isolated construction, a dual monolithic super-beta transistor guarantees a beta of greater than 1500 at a 1-μA base current. Model IT124 also features a capacitance of 0.8 pF and a unity-gain crossover frequency of 100 MHz. Current offset is 0.5 nA.

CIRCLE NO. 253

Monolithic breadboard allows customized ICs

Silicon General Inc., 7382 Bolsa Ave., Westminster, Calif. Phone: (714) 839-6200. P&A: $5.30; stock.

Permitting fast low-cost fabrication of custom ICs, a new monolithic IC breadboard, the SG3801 QuikChip, contains over 50 separate components of various types and values. These components can be interconnected with a wire bonding machine, allowing the circuit designer to construct prototypes without the customary reliance on the semiconductor manufacturer.

CIRCLE NO. 254

Dual transistors boast 1.5-mV match

Qualidyne Corp., 3699 Tahoe Way, Santa Clara, Calif. Phone: (408) 738-0120. Availablity: stock.

A complete line of high-gain npn and pnp dual transistors features a matching specification (base-emitter voltage) as tight as 1.5 mV. These devices cover almost all of the popular dual 2N numbers now in use—over 150 transistors in all. Gains are greater than 200 with a 10-μA base current, and output capacitance is as low as 1 pF. Unity-gain crossover frequency is greater than 200 MHz.

CIRCLE NO. 255

Transistor for 84¢ accommodates 30 W

Power Physics Corp., P.O. Box 626, Eatontown, N.J. Phone: (201) 542-1393. P&A: 84¢; stock.

Selling for 84¢ each in lots of 100 to 999, a new silicon npn power transistor can typically handle collector-emitter voltages of 140 V. Type 2N3054 offers a power capability of 30 W. Peak collector currents range from 3 to 7 A. The unit, which is packaged in a TO-66 metal can, is expected to be used in power supplies, oscillators, voltage regulators and amlifiers.

CIRCLE NO. 256

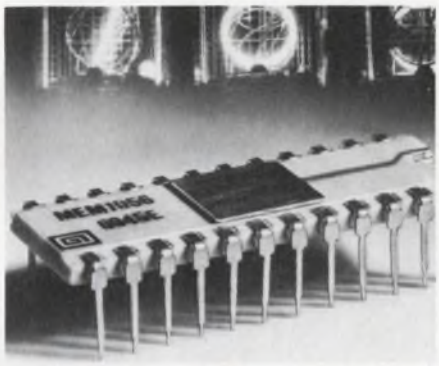
Digital ICs clamp inputs

Sylvania Electric Products Inc., sub. of General Telephone & Electronics, 1100 Main St., Buffalo, N.Y. Availability: stock.

Now available are 14 new series 7400N TTL integrated circuits offering the advantage of clamping diodes on all inputs for reliable short-circuit protection. Fully interchangeable with competing lines, the new devices come in a standard all-ceramic package with tapered lead ends to facilitate socket insertion. Circuit functions include NAND gates, AND-OR-INVERT gates, and dual D and J-K flip-flops.

CIRCLE NO. 257

Counter/driver IC runs readout tubes



General Instrument Corp., 600 W. John St., Hicksville, N.Y. Phone: (516) 733-3333. Price: $20.

Said to do the job of three conventional IC packages, a BCD-counter/display-driver can power a single seven-segment numeric indicator by itself. Model 1056 is an MOS IC that contains a single-decade up-down BCD counter, a storage register, a BCD-to-seven-segment decoding matrix, and display drivers. It is supplied in a 24-lead dual-in-line package.

CIRCLE NO. 258

Plastic complements dissipate 15 watts

General Electric Co., Semiconductor Products Dept., 1 River Rd., Schenectady, N.Y. Phone: (315) 456-2396. P&A: 45¢ to 65¢ in quantity; stock.

Offering collector saturation voltages of 0.5 V at 3 A, two new 15-W complementary Power Pac transistors, the D44C and D45C, are rated at 30, 45 and 60 V. These plastic units have typical switching times of less than 600 ns. The D44C is an npn device, while the D45C is a pnp device.

CIRCLE NO. 259

Arithmetic logic unit adds 16 bits in 42 ns

Fairchild Semiconductor, 313 Fairchild Drive, Mountain View, Calif. Phone: (415) 962-5011. Price: $14 to $30.80.

Model 9340 four-bit arithmetic logic unit is a new MSI circuit that can add two 16-bit numbers within 42 ns when connected in multiple. The unit can also perform several other functions like OR, AND, subtraction, and equivalence. Because the device includes carry-look-ahead circuitry, the user can add up to 16 bits with only four 9340s and no other package. It comes in military or commercial versions, either flatpacks or DIPs.

CIRCLE NO. 260

Zener diodes accept 50 W

Electronic Transistors Corp., 153-13 Northern Blvd., Flushing, N.Y. Phone: (212) 539-6700.

Offering tolerances of ±20, ±10 and ±5%, a new line of general-purpose zener diodes can dissipate power levels as high as 50 W. This new family of rectifiers comes in JEDEC TO-3 packages or in stud-mounted DO-5 packages. Their operating temperature range is −65 to +175°C; voltage ratings range from 4.7 to 200 V.

CIRCLE NO. 261

Dual sense amplifiers strobe independently

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. Phone: (408) 732-5000. P&A: $7 or $9.10; stock.

Intended for use with small core memories having as many as 4000 words, two new monolithic dual sense amplifiers feature independent strobing. The LM354A and LM354 are fuctionally identical, but the LM354A has a tighter guaranteed input threshold voltage uncertainty. Typical outputs for the circuits are 3.9 V for a logical 1 and 0.25 V (0.4 V maximum) for a logical 0.

CIRCLE NO. 262

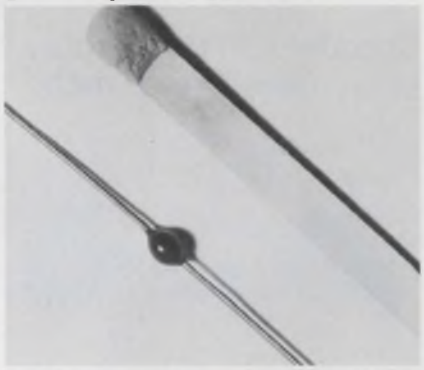
Photosensor chip can drive directly

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

Dielectrically isolated for good high-frequency response and radiation resistance, a new line of npn silicon matched-pair transistor chips provide a close parameter match, from 10 μA to 1 mA. Types 3423 and 3424 have their collectors isolated from each other and from the bottom of the chip. The chips are gold-backed, permitting conventional eutectic die-bonding.

CIRCLE NO. 264

Tiny thermistors give up to 10kΩ



Texas Instruments Inc., Components Group, P.O. Box 5012, Dallas, Tex. Phone: (214) 238-2011. P&A: $2.68 or $3.70; stock.

With a power output that is spectrally compatible with silicon sensors, two new pn gallium-arsenide light sources provide a minimum power output of 1 mW (the TIL24) or 0.4 mW (the TIL23). The units cover both the military and industrial temperature ranges. Both light sources have a narrow light beam emission at an angle of 35 degrees.

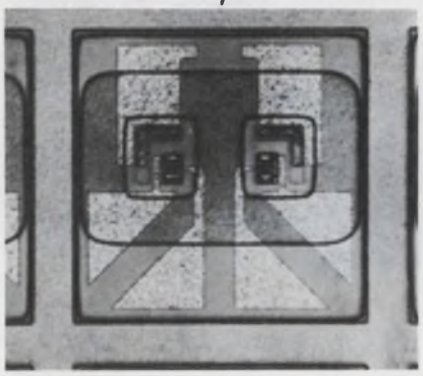
CIRCLE NO. 266

RCA/Electronic Components, 415 South Fifth St., Harrison, N.J. Phone: (201) 485-3900. P&A: $2.95; stock.

Combining a photosensitive section, an amplifier and two 100-mA driver transistors on a single chip, the CA3062 monolithic light sensor can drive a lamp, relay or triac without additional amplification. The unit operates either as a normally OFF or normally ON photoswitch. It comes in a hermetic 12-lead TO-5-style package.

CIRCLE NO. 263

Transistor chips match to 10 μA



Sensitron Inc., 225 Paularino Ave., Costa Mesa, Calif. Phone: (714) 540-4160.

Called micro-silicon devices, a new line of thermistors, the size of a 0.1-in. sphere, are available with resistances from 10 to 10,000 Ω. Series 125 units are available with radial leads or radial-opposed leads. Maximum operating temperature is 150°C, and nominal temperature coefficient is 0.7%/°C. The devices are designed for semiconductor circuit compensation.

CIRCLE NO. 265

Light sources put out 1 mW

INFORMATION RETRIEVAL NUMBER 70 ►

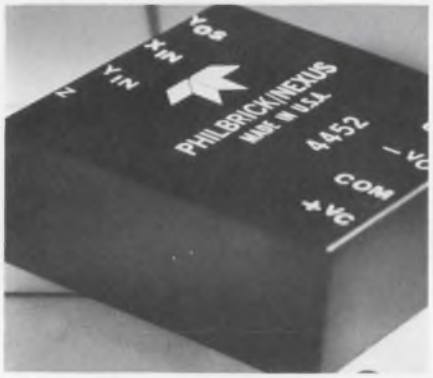
Fast d/a converters settle down in 25 ns

Datel Systems Corp., 943 Turnpike St., Canton, Mass. Phone: (617) 828-1890. P&A: from $195; 2 wks.

Containing buffer logic, switches, a ladder and voltage reference in a single package, the DAC-H series of d/a converters feature an output settling time of 25 ns to ±0.1% of final value. This allows for an update word rate of 40 MHz. Output is ±2.5 mA full scale with a voltage compliance of ±1.2 V, and output linearity is ±2.5 μA with a 5-μA resolution.

CIRCLE NO. 267

Low-cost multiplier downs price to $29.50

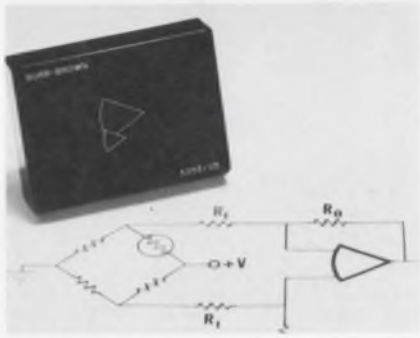


Teledyne Philbrick/Nexus Research, Allied Dr. at Route 128, Dedham, Mass. Phone: (617) 329-1600. P&A: $29.50; stock.

Providing an output of ±10 V at frequencies to 40 kHz, the model 4452 low-cost four-quadrant multiplier/divider retails for only $29.50. Its voltage range for either X or Y input is ±10 V and each input's impedance is 30 kΩ. Operation to 400 kHz is possible with derating of parameters. The unit measures 1.5 by 1.5 by 0.6 in.

CIRCLE NO. 271

Chopper-stable op amps are differential units



Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. Phone: (602) 294-1431. P&A: $110, $90, $70; stock to 4 wks.

A line of three new chopper-stabilized low-drift operational amplifiers include differential inputs. Models 3354/25, 3355/25 and 3356/25 drift 0.2, 0.5 and 1 μV/°C, respectively. Input bias currents are 20, 50 and 50 pA, respectively. Open-loop gain is 140 dB at dc.

CIRCLE NO. 268

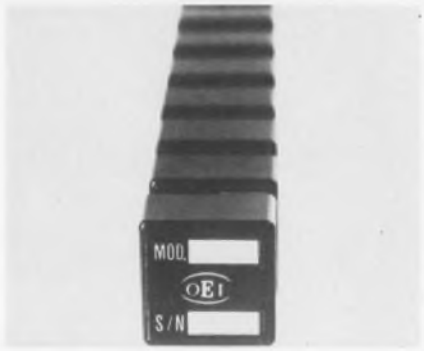
Low-cost FET op amp chops price to $17

GPS Corp., 14 Burr St., Framingham, Mass. Phone: (617) 875-0607. P&A: $17; stock.

Including an adjustable input offset voltage of 2 mV and an input bias current of 50 pA, the low-cost model 801 differential FET-input operational amplifier retails at $17. Other characteristics are an open-loop gain of 100,000, full output frequency of 50 kHz, a slewing rate of 5 V/μs and an input drift of 100 μV/V. The output is ±10 V at ±20 mA.

CIRCLE NO. 269

Wideband multiplier spans dc to 30 MHz

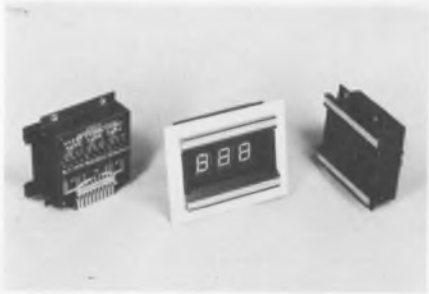


Optical Electronics, Inc., P.O. Box 11140, Tucson, Ariz. Phone: (602) 624-8358. P&A: $87; stock.

The model 5882 multiplier is a low-cost four-quadrant analog unit with a wide bandwidth of dc to 30 MHz. Its features include a maximum untrimmed offset voltage for both X and Y inputs of ±2 V. Also featured is a null rejection characteristic of 73 dB at 5 MHz. Both inputs have an impedance of 4 kΩ and a dynamic output range of −10 to +10 V.

CIRCLE NO. 270

Decoder/driver display slims depth to 1 inch



Integrated Circuit Electronics, Inc., 237 Riverview Ave., Newton, Mass. Phone: (617) 891-4311. Price: $49.50 (3 decades).

The D-4000 series decoder/driver display features behind-the-panel depth of only 1 in. It contains a bezel with filter lens, decoder, driver circuitry and replaceable low-voltage low-power readout tubes. It is IC-compatible and interfaces to four-line BCD levels. The use of a single-connector termination eliminates wiring.

CIRCLE NO. 272

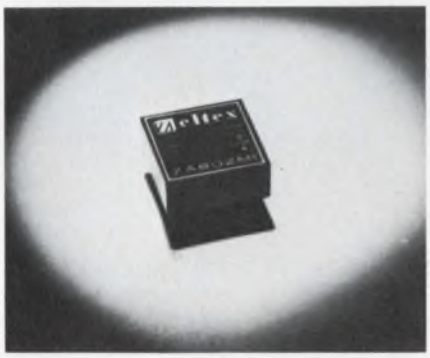
High-voltage supply drives price under $30

Venus Scientific Inc., 399 Smith St., Farmingdale, N.Y. Phone: (516) 293-4100. Price: under $30.

Supplying an output of 15 kV at 150 μA, the new all-silicon L-15 low-cost high-voltage power supply for computer and CRT displays boasts a price of less than $30. It is a dc-to-dc converter operating from 15 V dc and is short-circuit and arc-over protected. The input is protected against reverse polarity and the output has less than 1% of pk-pk ripple.

CIRCLE NO. 273

Tiny low-cost op amp is priced at $26

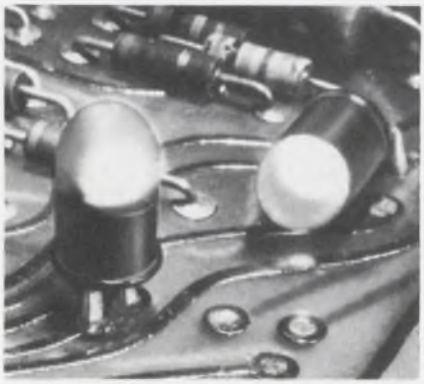


Zeltex, Inc., 100 Chalomer Rd., Concord, Calif. Phone: (415) 686-6660. P&A: $26; stock.

Featuring 15 pA of input current, a 100,000:1 common-mode rejection ratio and frequency response of 4 MHz at unity gain is the tiny low-cost FET-input ZA-802M1 operational amplifier that measures 1 by 1 by 0.4 in. and costs $26. Maximum input voltage drift is 50 μV/°C for the temperature range of −25 to +85°C.

CIRCLE NO. 274

Low-cost LED lamp sells for only 50¢



Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 326-7000. P&A: 50¢; 30 days.

Designed to replace miniature incandescent lamps, the 5082-4403 red light-emitting diode features a price of only 50¢ in large quantities. It requires only 1.8 V at 20 mA to operate and provides high visibility over a broad angle. This GaAsP lamp self-mounts in panels or on printed circuit boards and is compatible with most integrated circuits.

CIRCLE NO. 275

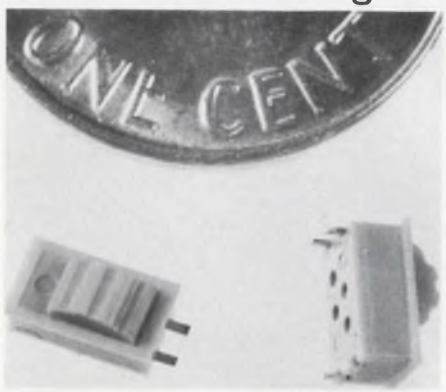
Indicator light for ICs works from logic levels

Dialight Corp., 60 Stewart Ave., Brooklyn, N.Y. Phone: (212)) 497-7600.

Designed for integrated circuits, a new transistorized indicator light operates directly from TTL, DTL and RTL modules thereby eliminating the need for a special power supply and interface circuitry. It includes all driving circiutry within its housing and accepts wide voltage swings without increases in signal current. Lamps used are T-1-3/4 incandescent types.

CIRCLE NO. 276

Spdt thumbwheel switch is but 0.225-in. long

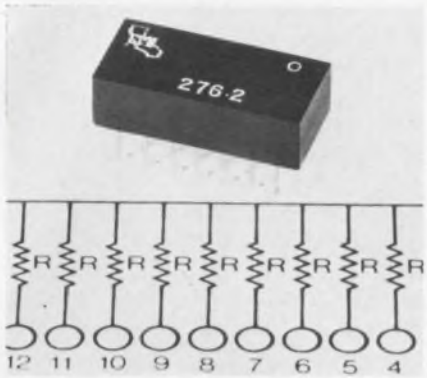


Wilbrecht Electronics, 240 Plato Blvd., St. Paul, Minn.

Only 0.225 inches long, the model 2000 spdt switch sets new standards for ultra electromechanical miniaturization. Its uniquely designed detent produces large-size switch feel. The use of precious metal contacts and wiping action results in low contact resistance. It is enclosed to ensure long life of over 50,000 cycles. For added flexibility it is available in a variety of colors.

CIRCLE NO. 277

Resistor/capacitors are dual-in-line arrays

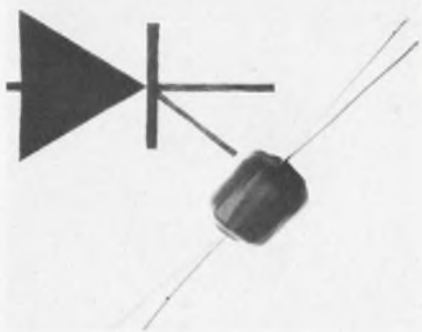


California Microcircuits, Inc. subsidiary of Teller Industries, Inc. Phone: (213) 772-2161.

New arrays containing networks of up to thirteen resistors or capacitors in a single 14-pin dual-in-line package are available. Resistors can have any value ranging from 20 Ω to 1 MΩ with a tolerance down to ±0.1%. Capacitors can have values ranging up to 0.1 μF. A 15-resistor array is also available in a 16-pin DIP housing.

CIRCLE NO. 278

Pulse transformers handle 500 Vμs

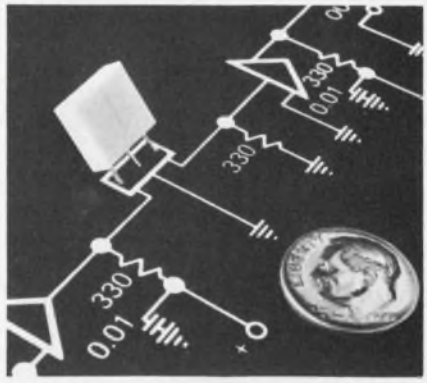


Aries Technology, 1247 El Camino Real, Mountain View, Calif. Phone: (415) 964-1606. Price: $3.85 to $4.10.

Two series of pulse transformers feature a product of pulse height times pulse width of 300 Vμs (type BM) and up to 500 Vμs (type BN). They were designed for SCR trigger circuits and general instrumentation where relatively long pulses are required. All units are available in a variety of turns ratios and use self-supporting #24 AWG leads.

CIRCLE NO. 279

Tiny ceramic FM filter measures but 0.016-in.³

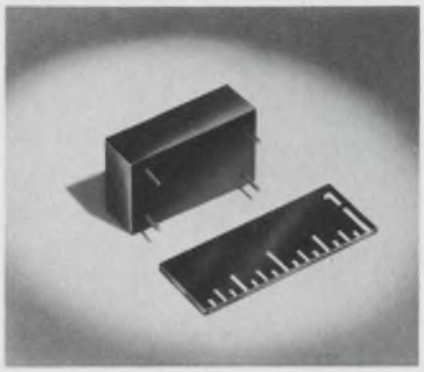


Gould Inc. Piezoelectric Div., 232 Forbes Rd., Bedford, Ohio. Phone: (216) 232-8600. P&A: 50¢ per 100,000; 2 wks.

Combining small size and high selectivity is the new FM-4 10.7-MHz ceramic bandpass FM filter. It is a high-Q piezoelectric ceramic molded in epoxy measuring only 0.415 by 0.38 by 0.1 in. It is distortion-free to a stop-band above 45 dB, with a 3-dB bandwidth of 235 kHz and a 40-dB bandwidth of 825 kHz.

CIRCLE NO. 280

Passive LC filters are dual-in-lines



ESC Electronics, 534 Bergen Blvd., Palisades Park, N.J. Phone: (201) 947-0400.

Housed in cases measuring 0.76 by 0.46 by 0.25 in. are several series of passive low-pass LC filters in dual-in-line packages. DIF-L20 units attenuate 20 dB minimum in the stopband beyond cutoff. DIF-L39 units attenuate 39 dB minimum in the stopband beyond cutoff. Insertion loss is 0.5 dB and passband ripple is ±1 dB. Other filter geometries are available.

CIRCLE NO. 281

Low-noise active filters reach down to 0.001 Hz

Analog Devices, Inc., 221 5th St., Cambridge, Mass. Phone: (617) 492-6000. P&A: $34 to $99; 2 wks.

The series 700 low-cost low-pass active filters use ICs and computer-aided design to span the frequency range of a low 0.001 Hz to 20 kHz at cutoff with only 50 μV of noise. Cutoff-frequency tolerance is 2% and signal amplitude range for a minimum discernible signal to ±10 V full scale is 10^4:1. The filters incorporate a two-pole Butterworth design.

CIRCLE NO. 282

Malfunction indicator shows faults in color

A. W. Haydon Co., 232 N. Elm St., Waterbury, Conn. Phone: (203) 756-4481.

A low-cost tiny fault indicator provides an instant visual display of a transient or continuous circuit malfunction by a color transfer of its display mode. This 0.32-in. dia device latches into place magnetically until it is reset. Resetting is done by energizing a reset coil. It was designed for pulse operation and does not need continuous power.

CIRCLE NO. 283

Miniature rotary switch has 9/16-in. diameter

Daven Div. of Thomas A. Edison Industries, Grenier Field, Manchester, N.H. Phone: (603) 669-0940.

With a diameter of only 9/16 in., the new series S compact rotary selector switches offer as many as 10 decks with spacings of 18, 22-1/2, 36 and 45 degrees. One-pole versions are available for 2 to 20 positions and 4-pole versions for 2 to 5 positions. Shorting and non-shorting types are included.

CIRCLE NO. 284

Shielded blower units suppress emi to 24 GHz

McLean Engineering Laboratories, P.O. Box 127, Princeton Junction, N.J. Phone: (609) 799-0100.

Generating no measurable emi noise, the R2EB300 series of blowers are designed with a theoretical attenuation capability for electric fields and plane waves of 109 dB to a frequency of 24 GHz. Tested against MIL STD 280, a shielded blower-enclosure combination provided attenuation of 71 dB to 10 GHz. Airflows range from 150 to 1000 cubic feet per minute.

CIRCLE NO. 285

In-circuit IC checker tests all pins at once

Caltron Industries, 2015 Second St., Berkeley, Calif. Phone: (415) 548-1966. P&A: $229; 4 wks.

Circuit-Vu 100 portable integrated circuit analyzer speeds the trouble-shooting of digital systems by allowing in-circuit checking of all inputs and outputs of an IC simultaneously. The status of each input and output is displayed through an overlay containing the schematic of the logic element under test. The overlay eliminates checking IC manuals for pin layouts.

CIRCLE NO. 286

Oscilloscope for $300 reaches out to 8 MHz

RCA/Electronic Components, 415 South Fifth St., Harrison, N.J. Phone: (201) 485-3900. Price: $298.50.

Besides a flat (within ±1 dB) vertical-amplifier frequency response from dc to 5 MHz, the WO-505A solid-state $298.50 oscilloscope is usable out to 8 MHz. This high-performance instrument also offers a gain of 15 mV pk-pk per inch on the high-sensitivity range of the vertical amplifier. Another feature is return-trace blanking circuits.

CIRCLE NO. 288

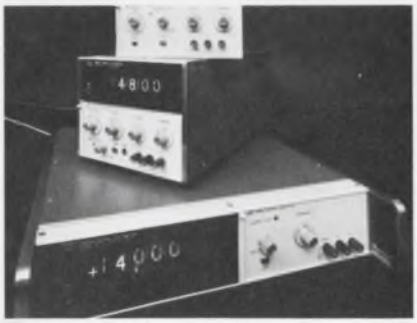
Compact IC tester sells for just $295

Spectrum Dynamics, P.O. Box 23699, Fort Lauderdale, Fla. Phone: (305) 566-4467. P&A: $295; stock to 2 wks.

Carrying a price tag of only $295, a new integrated circuit tester is a compact manually programmed instrument designed for dc and functional testing of most digital ICs. Model 101 has a 4 by 16 program matrix that permits selection of supply voltage, logic level 1, ground, or no connection at each pin. It has a pushbutton pulser.

CIRCLE NO. 287

True rms voltmeter reads 1000 times/s



Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 326-7000. P&A: from $800 or $900; stock.

Model 3480A/B general-purpose digital voltmeter is a four-digit instrument that can make up to 1000 readings per second for dc voltage or resistance. The unit also offers a true rms ac converter plug-in measuring down to 100 mV full-scale with response from 1 Hz to 1 MHz. The 3480A is a half-rack DVM, while the 3480B is a full-rack one.

CIRCLE NO. 289

Digital panel meter measures 17 ranges

Dixson Instruments, P.O. Box 1449, Grand Junction, Colo. Phone: (303) 242-8863. P&A: $199; stock.

A new 3-1/2-digit panel meter can measure 17 ranges of dc and ac voltage, and dc and ac current by simply switching its interchangeable plug-in cards. Model VT300 features a built-in power supply, automatic zero, overrange indicator, internal calibration reference voltage, BCD output, and an external trigger input. Accuracy is ±0.1% of reading, ±0.1% of full scale.

CIRCLE NO. 290

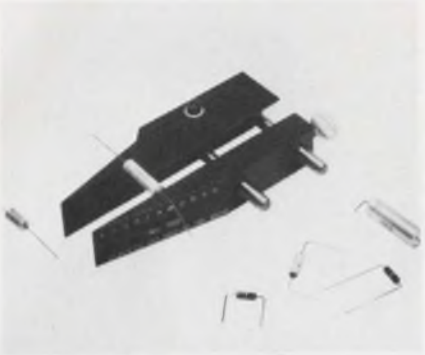
Pulser for $390 reps out to 10 MHz

Data Dynamics Div., 240 Humphrey St., Englewood, N.J. Phone: (201) 567-5300. P&A: $390; stock.

Costing only $390, a new pulse generator, model 5109, can deliver repetition rates from 10 Hz to 10 MHz. It has three separate outputs, which are always active and are simultaneously available. The three outputs are: positive pulse, negative pulse, and an IC-compatible output specifically designed for TTL, RTL and DTL circuits. Pulse width is adjustable.

CIRCLE NO. 291

Low-cost lead bender retails for $14.95

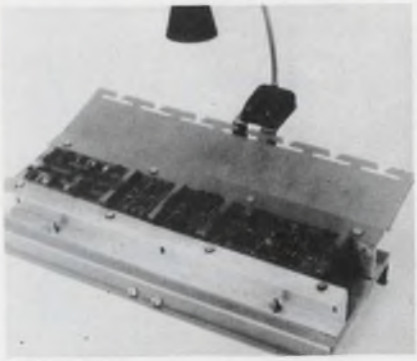


By-Buk Co., 4326 W. Pico Blvd., Los Angeles, Calif. Phone: (213) 937-3511. Price: $14.95.

A new lightweight component-lead bending block with gauge plate for use in prototyping, testing and product assembly costs only $14.95. Model 700 is a precision-made banding block which gives neat rounded bends to leads on resistors, diodes, capacitors, transistors and inductors, doing away with nicks, rings and plier damage normally encountered.

CIRCLE NO. 292

Universal work station adjusts several ways



Siks Manufacturing, Inc., 143 E. 233 St., Bronx, N.Y. Phone: (212) 892-8566.

Adjustable to accept a wide variety of printed circuit boards, terminal boards, connectors and assemblies is the Uni-Stat work station which can be positioned to allow different types of electronic and mechanical assembly operations. It is adjustable to combinations of height and width within its holding dimensions of 0 to 5-in. wide and 0 to 2-in. high.

CIRCLE NO. 294

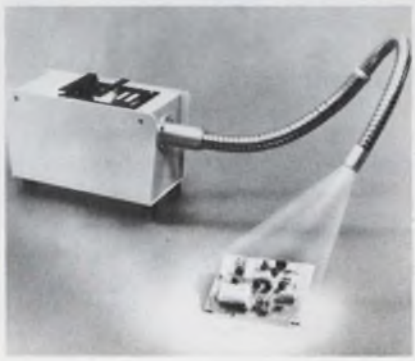
Technical pen set streamlines design

J. S. Staedtler, Inc., Box 68, Montville, N.J. Phone: (201) 335-1800.

The Mars-700 S9 is a new technical pen set whose compact design makes it ideal for both desk and board use. The set's case functions as a work stand and is designed to close in such a way that it is easy to store and convenient to carry. Keyholes are provided to hold the cap of each pen in a vertical position so the user can change line width easily.

CIRCLE NO. 293

Fiber-optic source beams 800 foot-candles



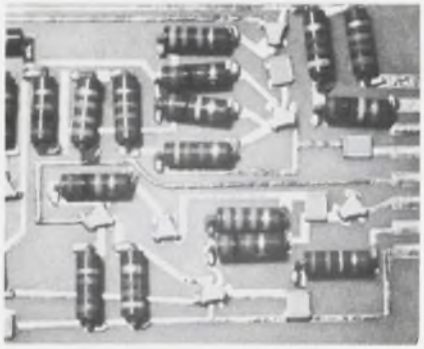
Bausch & Lomb, 635 St. Paul St., Rochester, N.Y. Phone: (716) 232-6000. P&A: $300; stock.

A new fiber-optics illuminator provides a cool 800-foot-candles spot of light within a 7-in. dia circle up to 6 in. from the end of its probe. The probe is a 1/2-in.-dia fiber-optics bundle and is available in two or three-foot lengths. It is flexible to allow its bending and will retain almost any shape to direct the illumination.

CIRCLE NO. 295

INFORMATION RETRIEVAL NUMBER 82 ►

High-density PC board reduces circuit size

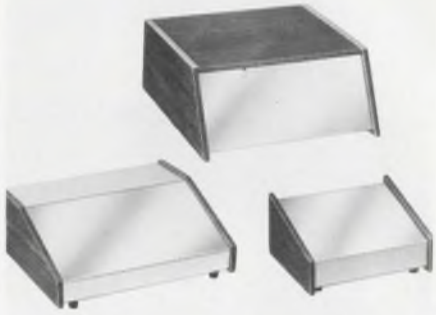


Circa-Tran, Inc., P.O. Box 832, Wheaton, Ill. Phone: (312) 858-3727.

A new PC board that reduces circuit size features copper conductors that are electroplated rather than etched to the phenolic substrate in thicknesses from 0.1 to 1 mil. Circa-Board's design allows mechanized assembly of all components to the same side as the copper conductors. Mechanized assembly via programmed feeders is made possible by distinctively shaped components.

CIRCLE NO. 296

Wood-metal cabinets enhance enclosures

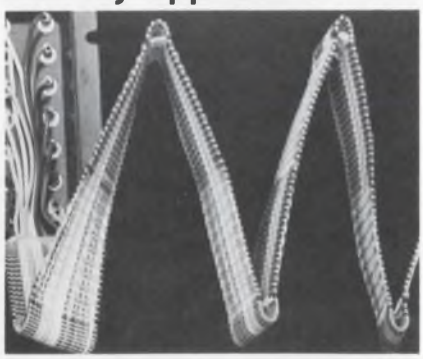


Javelin Precision, Inc., 116 Toledo St., Farmingdale, N.Y. Phone: (516) 293-6443. Availability: stock.

Slope-front desk panel cabinets, known as the Executive series, provide a unique combination of wood and aluminum. The enclosure's wood panels are constructed of hand-worked solid walnut, deep grained with an attractive luster finish. Metal panels are fabricated of 16-gauge anodized aluminum with a clean natural finish. All cabinets are equipped with rubber feet.

CIRCLE NO. 298

Custom-woven cable fits any application



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

In instances when only a certain type of connector will do for a given application, but the cable or harness presents a problem, FRC Fab-Ri-Cable may be the ultimate solution. A low profile allows it to fit into extremely limited spaces, and to fold once or several times. It will bend, spiral, or accordion fold without affecting the performance of the conductors.

CIRCLE NO. 297

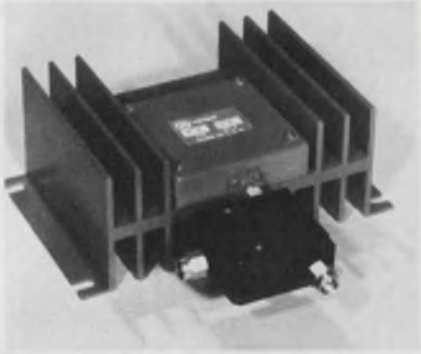
One-system liquid bonds in 60 seconds

Tescom Corp., Instrument Div., 2633 S. E. Fourth St., Minneapolis, Minn.

Called Zipbond, a new one-system bonding liquid joins most materials to themselves and to each other in just 60 seconds. Because no heat or pressure treatment is needed, it is ideally suited for jobs requiring fast curing time. Its tensile shear strength is 2770 psi. All types of materials can be bonded including rubber, metals, plastics, wood and glass.

CIRCLE NO. 299

Amplifiers for C band lower cost to $850

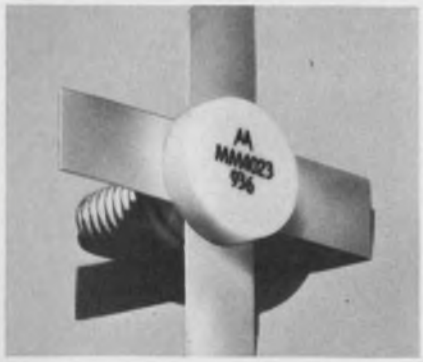


Varian Solid State Div., Beverly, Mass. Phone: (617) 922-6000. P&A: $850; 60 days.

Covering the frequency band of 3.95 to 8.2 GHz, the model VSC-9650K (3.95 to 5.85 GHz) and VSJ-9650K (5.85 to 8.2 GHz) impatt amplifiers deliver outputs of 100 mW at $850 per unit including the circulator. Both have two versions: one with a 50-MHz bandwidth and 13-dB gain and one with a 500-MHz bandwidth and 13-dB gain.

CIRCLE NO. 335

Pnp power transistors take 40 W at 175 MHz

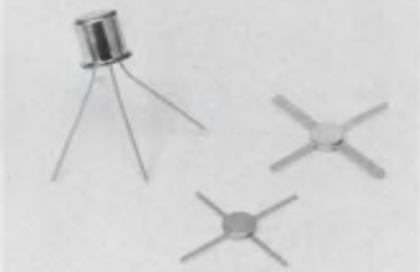


Motorola Semiconductor Products Inc., Box 20924, Phoenix, Ariz. Phone: (602) 273-3466. P&A: $6.20, $15, $23, $38; stock.

Four new additions to a line of pnp rf silicon power transistors are types MM4020, MM4021, MM-4022 and MM4023. They feature output powers and gains at 175 MHz of 3.5 W at 11.5 dB, 15 W at 7 dB, 25 W at 5.5 dB and 40 W at 4.5 dB, respectively. Each transistor features balanced-emitter construction.

CIRCLE NO. 337

Low-noise transistors operate to 2000 MHz

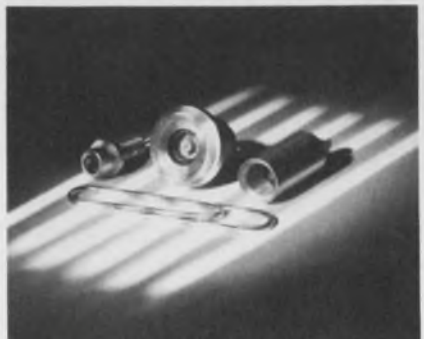


Avantek, Inc., 2981 Cooper Rd., Santa Clara, Calif. Phone: (408) 739-6170. P&A: $13, $25; stock.

Two families of silicon npn transistors are the AT-25, 25A and 25B, in TO-72 packages, and the AT-50, 50A, 51, 52 and 55, in stripline packages. The AT-25 series works to 1000 MHz, with a noise figure of 1.5 dB and 14-dB unneutralized gain at 500 MHz (AT-25B). The AT-50 series works to 2000 MHz with a noise figure of 2.5 dB and 14-dB unneutralized gain at 1 GHz (AT-50A).

CIRCLE NO. 336

GaAs laser diode line spans 8 to 200-W range



Sperry Gyroscope Electro-Optics Group, Great Neck, N.Y. Phone: (516) 574-2715.

Featuring low threshold currents and low costs at peak power densities is a line of new GaAs laser diodes ranging from 8-W units to 200-W arrays. Single diodes in the 8 to 23-W range are stud mounted. Higher-power units include a 40-W dual diode and 100 to 200-W radial arrays. Units in 500 and 1000-W densities will be available in the future.

CIRCLE NO. 338

Low-cost calculator uses mosaic lamps

Dictaphone Corp., Business Machines Div., 120 Old Post Rd., Rye, N.Y. Price: $695.

A 14-digit calculator, which sells for $695, uses a mosaic-lamp display to eliminate depth perception problems and glimmering effects, and to minimize operator eye fatigue and transposition errors. A principal feature of model 1401 is its zero suppression system, which displays only the actual numbers put into the calculator and the results.

CIRCLE NO. 339

Low-cost minicomputer simplifies programming

Atron Corp., Trapp Rd., St. Paul, Minn. Phone: (612) 454-6150. Price: from $6000.

The Datamanager 501 is a new low-cost minicomputer that is said to significantly reduce programming time. Its processor is specifically designed to handle data in strings as well as single characters. The basic machine, which costs $6000 in quantity, includes four high-speed buffered I/O channels with full buffer address control and two direct memory access ports.

CIRCLE NO. 343

Spiras Systems, Inc., 332 Second Ave., Waltham, Mass. Price: $7000 to $8000.

Introduced as a specialized version of the Irascope CRT data base display terminal, the model DBEC 1000 U/L system features 72 IBM-font upper and lower-case characters. This new terminal provides local and/or remote editing capabilities. It also claims flicker-free characters in a 2000-character field and a bonded safety faceplate etched for minimum glare.

CIRCLE NO. 340

CRT terminal stylizes font

Applied Digital Data Systems, Inc., 89 Marcus Blvd., Hauppauge, N.Y. Phone: (516) 273-7799. P&A: $2995 to $3995; 90 to 120 days.

Unlike most computer terminals, the Consul series of CRT displays show black characters on a white display page centered on the screen to ease eyestrain. The page format provides margins that enable the user to anticipate the end of a line or the last of a sequence of text. The units are compatible with teletypewriters.

CIRCLE NO. 341

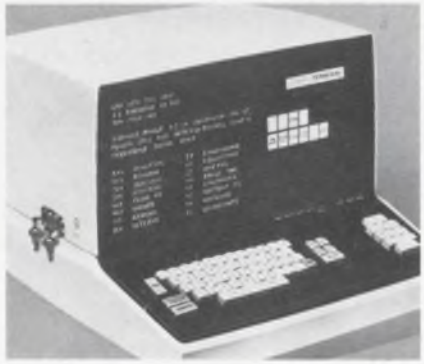
CRT computer displays show black-on-white

Wyle Laboratories, Computer Products Div., 128 Maryland St., El Segundo, Calif. Phone: (213) 322-1763.

Labeled as Computerminal, a new data display terminal offers a display capacity of up to 1024 characters. Model 800 can handle transmission speeds as fast as 2400 bits per second. It provides control disciplines that are equivalent to IBM models 2260 and 2265. Special keyboard configurations permit its use in a variety of applications.

CIRCLE NO. 342

Data display terminal shows 1024 characters



Solid-state keyboards cost just $100 each

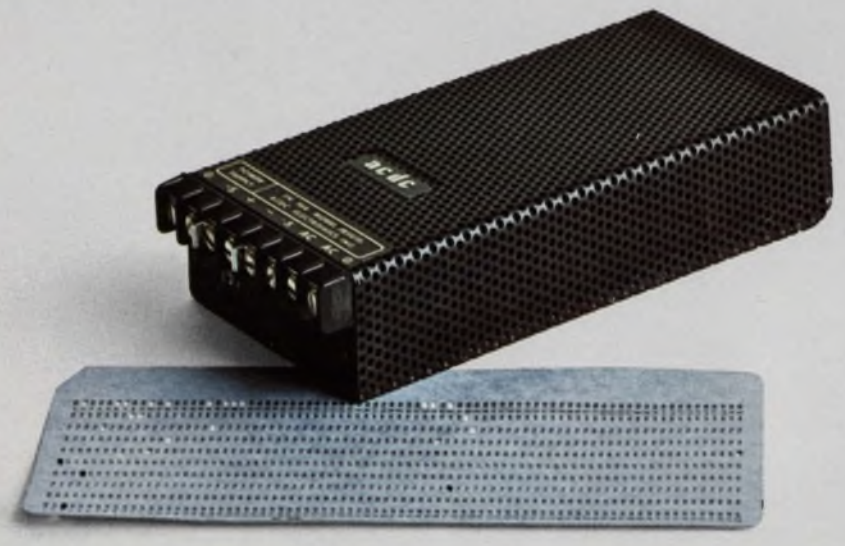
Control Devices, Inc., 204 New Boston St., Woburn, Mass. Phone: (617) 935-1105. P&A: $100; 30 days.

Low-profile solid-state keyboards are said to use a unique switching technique that allows these fully encoded units to sell for less than $100 in production quantities (1000 units or more). Series CDK keyboards offer two basic formats: one for typical typewriter applications and one for keypunch-type applications. The basic configuration has up to seven rows of keys.

CIRCLE NO. 344

The best power supply to tuck into impossible spaces is the one specifically designed to tuck into impossible spaces. We make it. We call it our Impossible Space Power Supply.

(also known as the JR series)



Weighing in at a mere 1.5 pounds and measuring only 1⅜" x 3⅛" x 6.5", ACDC's new JR offers more watts per unit volume than any other miniature power supply on the market. It's so small that you can put five of them in the same space normally occupied by one of "theirs" . . . so efficient (80%) that it requires no internal heat sinks . . . and so noise-free that you can use it anywhere.

Three JR models are available in continuously adjustable output voltage ranges from 3.0 to 30 volts (0.1% regulation) and in current ratings from 2.0 to 10 amps. And most important, it operates from conventional 60 or 400 cycle input.

Of course, the JR costs a little more than conventional power supplies ($285 in small quantity), but if space and efficiency is your problem, the JR is your only answer.

Get one tomorrow . . . or five . . . or ten . . . or a hundred. They're on the shelf.

acdc electronics inc.

Oceanside Industrial Center, Oceanside, California 92054, (714) 757-1880

JR Miniaturized Power Supply Module / Specifications

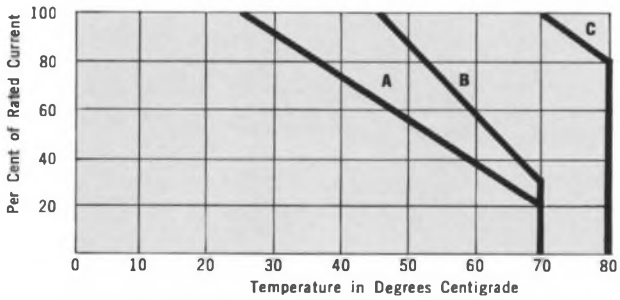
Nominal Output Voltage (VDC)	Output Voltage Range* (VDC)	Maximum Current Rating (Amps)	Maximum Dimensions (inches) H	W	L	Weight approx. (lbs.)	Case Size	Model (Add −1 for Overvoltage Protection)	Quantity	Price (add $30 for OVP)
5	3.0 5.0 5.5 6.0	10 10 9 8	1.375	3.125	6.5	1.5	K1	JR5K10	1-9 10-24 25-49 50-99	$298 291 285 280
15	12 15 18	4.0 4.0 3.0	1.375	3.125	6.5	1.5	K1	JR15K4.0	1-9 10-24 25-49 50-99	$298 291 285 280
25	22 25 30	2.5 2.0 2.0	1.375	3.125	6.5	1.5	K1	JR25K2.0	1-9 10-24 25-49 50-99	$298 291 285 280

*Continuously adjustable

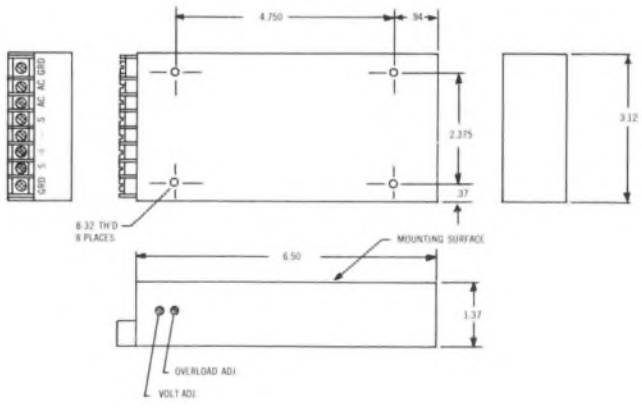
Input	105-125VAC, 47-420Hz, single phase.
Output	Voltage range shown in table is continuously variable between limits by externally accessible screwdriver adjustment of multiturn pot. Output is floating — either positive or negative terminal may be grounded. Current: zero to full load as shown in tables.
Regulation	0.1% + 5mV NL-FL ±0.1% ±5mV for ±10% input variation.
Ripple	3mV RMS max (120Hz). 25mV P-P (spikes at 50KHz rep. rate).
Stability	Typical 10mV for eight hour period after initial warmup.
Transient Response	Typically less than 1 msec in response to an NL-FL step.
Remote Sensing	Terminals are provided to maintain regulation at the load, compensating for the DC voltage drop in the load cable.
Remote Voltage Adjustment	Terminals are provided to adjust the output voltage by means of a remote variable resistor.
Ambient Temperature	Unit must be mounted to allow conductive heat-sinking to hold the case temperature below 80°C.
Weight	Approx. 1½ lbs.
Mounting	Mounting surface 3⅛ x 6½ has threaded mtg. holes.
Dimensions	1⅜ x 3⅛ x 6½.

Overload Protection	Models are inherently protected against overload and short circuits of any duration. Automatic recovery is electronically accomplished.
Overvoltage Protection (Optional)	A complete independent overvoltage protection module is available and straddles the output terminals. This protection does not depend on the regulating circuitry of the supply. Trip voltage adjustable from 5-30 volts.
Connector	Barrier strip termination.
Construction	Black anodized aluminum case. Unit may be removed from case for complete serviceability.
Temperature Coefficient	0.02%/°C max.

TEMPERATURE GRAPH FOR JR SERIES POWER SUPPLIES.



A. Ambient temperature. Unit unmounted. Base plate vertical.
B. Ambient temperature. Unit attached to HS-1 Heatsink. Fins vertical.
C. Base plate temperature of supply.



acdc electronics, inc. Oceanside Industrial Center, Oceanside, California 92054, (714) 757-1880

Full-feature display has $2995 price tag

Hazeltine Corp., Industrial Products Div., Little Neck, N.Y. Phone: (212) 321-2300. P&A: $2995 or $88/month; stock.

The model 1760 terminal is a compact stand-alone desktop display that includes a keyboard input and a CRT monitor for only $2995, not $500 as previously reported (ED 9, April 26, 1970, page C41, circle no. 265). This new display terminal can present 1760 characters on 32 lines of 55 characters each, or 1998 characters on 27 lines of 74 characters each. In addition, the 1760 offers split-screen capabilities and full editing features.

Characters have a 5 by 7 dot matrix structure, and character generation is by means of ON/OFF control of a standard 525-line TV raster. Nominal transmission rate for the new terminal is 110 baud, adjustable to 2400 baud or to below 110 baud. The unit comes with 9 or 12-in. monitors.

CIRCLE NO. 345

Electronic calculators trim operator time

IME Sales Corp., One IME Plaza, North Bergen, N.J.

Designed for general business use, series 120 electronic calculators feature a simplified keyboard to reduce the number of key depressions, thereby increasing operator efficiency by as much as one-third. Visual recall of both the factors and the total of the previous calculation, automatic rounding, and self-clearing are other advantages. The units are supplied with four, five or six memories.

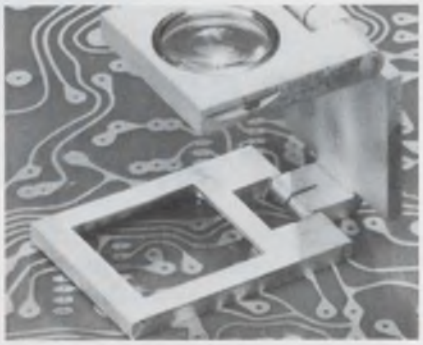
CIRCLE NO. 346

Evaluation Samples

Dry transfer lettering

Free samples of an extensive line of dry transfer letters and symbols are available. The line consists of four type styles (#1200, #9700, #1400, and #5700) in a variety of sizes. Styles include Jason, Computype, Parady and Futura Light in lower-case and capital letters and numerals. Tactype Inc.

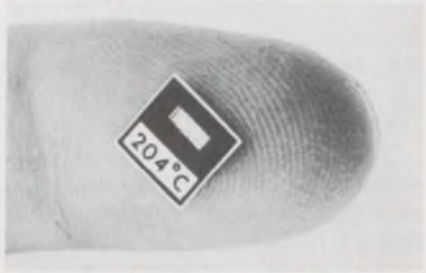
CIRCLE NO. 347



PC board etchant

Phodar is a new photopolymer dry-applied resist that reduces PC board etching to a simplified five-minute process. Preparation time is cut because no special cleaning solutions are required and meticulous care to assure perfect adhesion between film and plate is unnecessary. There is no waiting time between lamination and exposure and Phodar completely eliminates the post-baking cycle after development. Full details and a free test pack are available to qualified readers. Photopolymer Research Corp.

CIRCLE NO. 348



Temperature monitor

A free evaluation sample is available of a self-adhesive miniature 5/16-in. square temperature recorder. The model 200 is a pastel temperature monitor that indicates the temperature attained over the range of 100 to 1100°F by turning black permanently when its rated temperature is reached. Models are available with one to eight different calibrated temperature ratings. The rated temperature is printed below each indicator window. William Wahl Corp.

CIRCLE NO. 349

Drawing board cover

Vyco is a new cover that rejuvenates drawing board surfaces for better protection and longer life. It's vinyl three-ply laminated construction assures crack-free surfaces and consistent line drawing reproductions at high quality. It has two useable surfaces: green and ivory. Compass point holes and hard pencil impressions will not mar its two surfaces. Sample pieces are available for examination. Alvin & Co., Inc.

CIRCLE NO. 350

Design Aids

Resistor curves

A series of three curves and a table of comparison are available to assist engineers in calculating resistor power ratings. The curves are used to approximate how much heat a given resistor will generate under a given condition. One is a derating curve for resistor ambient temperature, another curve shows the resistor's temperature rise vs its power dissipation and the third curve gives the percentage of the resistor's power rating vs its temperature rise. The table gives the amount of heat the resistor will generate under a given circuit and ambient conditions. Ward Leonard Electric Co.

CIRCLE NO. 351

Color selector

A new contemporary color selector for a standard line of metal enclosures for electronic instruments and systems is available. It shows color swatches that are selected to afford the enclosure designer a wide opportunity to create attractive color schemes by coordinating, contrasting or harmonizing the standard colors shown. Premier Metal Products Co.

CIRCLE NO. 352

Frequency chart

A frequency-conversion chart that covers the frequency range of 1 Hz to 10 GHz and directly indicates frequency stabilities of oscillators is available. It gives frequency stabilities in parts-per-million and in per-cent figures. It is designed as a time saver for those engineering groups and manufacturers who are continually working with frequency-control devices. Accutronics/Div. of Gibbs Manufacturing and Research Corp.

CIRCLE NO. 353

Application Notes

Logic handbook

The sixth edition of the 1970 Logic Handbook contains 448 pages covering solid-state logic, application notes and descriptions and prices of more than 200 standard logic and accessory items. It describes M-series TTL interface and design circuits, K-series industrial control logic, analog/digital converters, power supplies, mounting hardware, cabinetry, and wire-wrapping services. It also describes earlier R, B and W-series logic modules. Digital Equipment Corp.

CIRCLE NO. 354

Wave analyzer

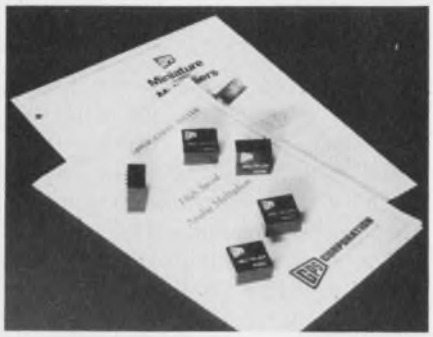
A number of typical wave analyzer applications are illustrated in a new 20-page booklet. It shows instrument connections on a page that is opposite an X-Y graphical recording of the result. Applications include measuring harmonic amplitudes, determining distortion, comparing filter characteristics and audio frequency-response recording. Hewlett Packard Co.

CIRCLE NO. 355

Ultrasonic delay lines

An illustrated two-color brochure describing new digital delay lines and their applications is available. It covers the basic definitions and measurements of delay, attenuation and spurious signal levels. Characteristic operating curves and tabulated performance data for representative designs are included. Microsonics Division of Sangamo Electric Co.

CIRCLE NO. 356



Analog multipliers

Application notes on high-speed analog multipliers are available in a new booklet. It presents a series of block diagrams with simplified technical descriptions of many useful multiplier applications as a systems component. Included are applications in the field of computation, signal conditioning, high-speed switching and modulation/demodulation. Useful background information on types of multipliers and typical sources of error is also presented. GPS Corp.

CIRCLE NO. 357

Data retrieval

"Modulated Time Codes Find Data in Analog Recording Systems" is an illustrated handbook on the theory of time code indexing and automatic data retrieval. It discusses the theory of operation, bandwidth recording on magnetic tape, time error accumulation and synchronization accuracy, weighted digit code recognition and reader-automatic search. CGS Scientific Corp., Datametrics Div.

CIRCLE NO. 358

Signal processing

A new method of signal processing called differential pulse width modulation is discussed in a six-page brochure. The method permits transducers to produce a high-level output signal to overcome the problems of noise and ground loops or power-frequency pickup. The brochure includes basic principles of operation with illustrations. Setra Systems, Inc.

CIRCLE NO. 359

Impatt diodes

A new method for measuring the thermal impedance of impatt diodes is discussed in a new application engineering bulletin. The new method achieves measurement results by the use of the reverse-bias characteristics of the diode's current-voltage curve. Thermal impedance values obtained by this method have been found to be more reliable and more meaningful than values obtained from forward-bias characteristics. Varian, Solid State Div.

CIRCLE NO. 360

Ladder networks

A new 14-page application engineering bulletin surveys the d/a and a/d requirements for networks and describes design principles for ladders. Schematic diagrams show basic converter circuits as well as formulas for calculating transfer functions and binary relationships. Circuit diagrams are also used to describe weighted, current-fed, and voltage switching ladders. Advantages and limitations of various networks for use in a/d and d/a converters are also presented. Vishay Resistor Products, Division of Vishay Intertechnology, Inc.

CIRCLE NO. 361

Neon glow lamp design

An illustrated technical discussion on the design of neon glow lamps, their operational characteristics and applications is available in a 12-page brochure. It starts with a discussion of what a neon lamp is, how it works and why, and what the operational characteristics of the device are. Included are two and three-element lamps showing how light is generated and what the spectral distribution of the light is. Ignition characteristics and methods are discussed with many curves and charts showing how the lamps act under different conditions. Signalite Inc.

CIRCLE NO. 362

New Literature

Switches

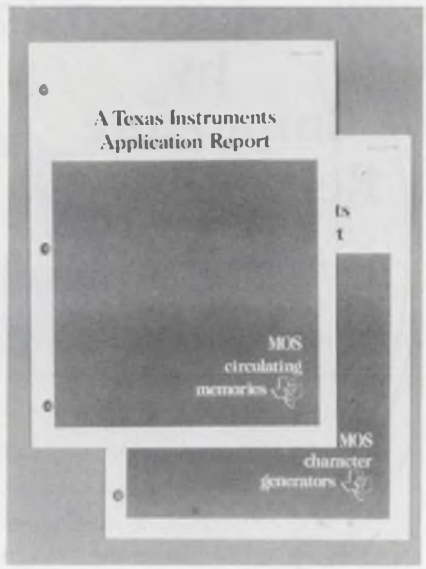
Miniature electronic switches, terminations, indicator lights, and a multitude of termination hardware are listed in a new comprehensive 88-page catalog. Switches contained include pushbutton, rotary, lighted and printed circuit types. Termination hardware includes binding posts, test jacks and clips, insulators, coil forms, washers, and transistor, lamp and tube sockets. Specifications, outlined dimensions and illustrations are shown. Grayhill Inc.

CIRCLE NO. 363

Indicator lights

Catalog MIL-70 is a quick and handy cross-reference to military numbers of indicator lights, base and cap assemblies. It also covers military products that are qualified and tested to meet requirements of MIL-L-3661B. The twofold, three-ring-punched catalog details indicator-light specifications and illustrates many military styles. Marco-Oak, a division of Electro/Netics Corp.

CIRCLE NO. 364



MOS ICs

Two new application reports discuss the use of MOS integrated circuits. One 16-page booklet discusses how MOS shift registers can be combined with TTL ICs to form economical data memories. The three main parts of a circulating memory are discussed in detail. Block diagrams are included to illustrate each of the circulating memory parts. The other report describes MOS read-only memory character generators and how they can be used advantageously in display systems. Covered are fundamentals of character generators and detailed applications. Texas Instruments Inc.

CIRCLE NO. 365

Modules and matrices

Programming modules and matrix boards and accessories are detailed in a four-page two-color condensed catalog. It describes the role of the matrix board as a fundamental programming method for thousands of different instruments and systems. Matrix boards listed are shown with hole patterns and spacing dimensions. Various ways are shown in which appropriate nomenclature, symbols and programming stripes can be added. Interswitch.

CIRCLE NO. 366

Metric tools

A broad line of foreign metric and domestic industrial tools are described in a new illustrated catalog. Tools shown include taps, dies, reamers, wrenches, precision and special instruments and other accessories in metric and non-metric sizes. The catalog is carefully compiled and designed for convenience, ready reference and reading ease. It includes tables of conversions and charts that are useful for practical shop work. Veteran Tool & Supply Co.

CIRCLE NO. 367

Shelf power supplies

A complete line of shelf power supply packages is described and shown in a new 12-page two-color catalog. Supplies shown include six different-sized packages with seven voltage levels ranging from 3.6 to 28 V dc at current ratings from 0.35 to 85 A. General specifications, dimensional data, options, accessories and prices are given. North Electric Co., Electronics Div.

CIRCLE NO. 368

Connectors

A full line of solderless terminations and unique attaching tools are described in a four-color 28-page catalog. Illustrated are insulated and non-insulated terminals to meet every requirement. Also included are special-type terminals for high-temperature applications up to 650°F. Vaco Products Co.

CIRCLE NO. 369

Instruments

Various laboratory and measurement instruments are described in a new 32-page illustrated catalog. It contains information on voltage, current and power measuring equipment. It also includes laboratory standards, ratio transformers, high-voltage dividers and several instrument accessories. Singer Instrumentation Div.

CIRCLE NO. 370

Filter program

A filter program that allows the filter designer or systems analyst to select a given filter transfer function from a program list is described in a new booklet. Selectable transfer functions include Bessel, elliptic, Butterworth-Thompson and ultrashperical, plus others. Selection can be made for the filter's geometry, and frequency and impedance transformations. Systems Associates, Inc.

CIRCLE NO. 371

Instrumentation

The 1970 edition of the Honeywell 276-page hard-cover instrumentation catalog is available to qualified readers. It covers in separate sections technical information on instruments and systems, applications notes on how and why particular instruments are used and descriptions of supporting services. Products shown include recorders, voltmeters, amplifiers, monitor scopes and data-acquisition and bio-medical systems. Other products include medical instruments, transducers, rfi/emi instrumentation, and signal-conditioning equipment. Honeywell Test Instruments Div.

CIRCLE NO. 372

Components

The new 120-page Component Selector contains listings and extensive engineering information on new lines of standard products that are said to cover 98% of industry requirements. These products include SCRs, capacitors, low-pass, L-section and rfi/emi filters, enclosed general-purpose relays, dual temperature-rated tantalum foil capacitors and many other components. Cornell-Dubilier Electronics.

CIRCLE NO. 373

Industrial controls

Application notes describing a line of monitors and time-delay relays are included in a revised 12-page catalog. Monitors included are voltage, current, phase-sequence and phase-loss types. These are for single-phase or three-phase delta or wye monitoring. Solid-state time-delay relays include delay-on-operate, interval-on-operate, delay-on-release and single-shot models. Diversified Electronics Inc.

CIRCLE NO. 374

Connectors

A large number of styles and sizes of high-density rack-and-panel connectors are described in a 12-page catalog. Described are military and commercial types with 9 to 51 contacts in plastic and metal shells. Included are detailed engineering drawings, photographs, and exploded parts views that present all physical parameters and contact locations. Microdot Inc., Connector Div.

CIRCLE NO. 375

Lamps and magnifiers

A full line of industrial lamps, magnifiers, and magnifier-lamp combinations are described in a comprehensive eight-page catalog. Lamps covered include high-intensity, balanced-arm engineering, magnetic-base, spotlight and utility lamps. Accessories and prices are also shown. Roxter Corp.

CIRCLE NO. 376

Microwave products

A line of broadband components for rf, i-f and microwave signal-processing systems is available in a 12-page catalog. It gives descriptive specifications on over 150 devices offered in standard connector and subminiature PC plug-in types. Hybrids, power dividers, combiners, directional couplers, and balanced mixers described cover the frequency range of 0 to 3 GHz in multi-octave bands to permit broadband signal processing. Anzac Electronics division of Adams-Russell Co., Inc.

CIRCLE NO. 377

Dc power supplies

A complete line of regulated and parametric dc power supplies are covered in a new eight-page document. It lists six basic lines and numerous models of dc power supplies for both laboratory and systems requirements. Included is such data as regulation, ripple, noise, attenuation, response time, operating temperature, circuitry, dimensions and delivery information. Wanlass Instruments.

CIRCLE NO. 378

Resistors and rheostats

Various types of wire-wound resistors, rheostats and accessories are featured in an 18-page catalog. Included are fixed, adjustable, noninductive, axial-lead and lug-ended type resistors with power ratings from 1 to 225 W. Power rheostats with ratings to 300 W are also shown. A discussion on resistor selection and ratings is contained along with resistor temperature-rise curves. Ward Leonard Electric Co.

CIRCLE NO. 379

Power semiconductors

Specifications for a complete line of power transistors, power rectifiers, rectifier assemblies, zener and reference diodes, triacs and SCRs are offered in an 80-page catalog. Individual booklets of different colors separate the catalog into various product families. A listing of JAN and JAN TX military part numbers is also included. Sensitron Semiconductor.

CIRCLE NO. 380

Thermistor probes

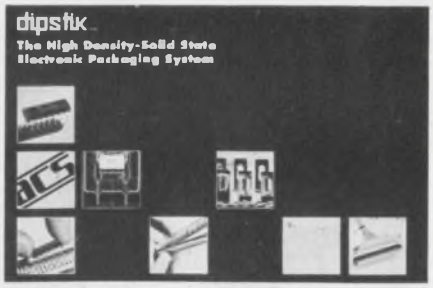
Thermistor probes for precise temperature measurement and control in medical, scientific, and industrial applications are illustrated and described in a new eight-page catalog. It contains complete specifications, prices, and ordering data. Included is information on an improved line of probes offering close tolerances. Also included are extremely small, high-temperature, and linear-output probes. Yellow Springs Instrument Co., Inc.

CIRCLE NO. 381

Terminals

Open-barrel terminals for automatic-machine applications are covered in a 32-page catalog. It describes over 825 types that are intended for high-speed automatic installation. The associated automatic machinery is also described. Part numbers, dimensions and material contents are detailed in tabular form. A handy numerical index for locating any part number in the catalog is also included. AMP Incorporated.

CIRCLE NO. 382



Dual-in-line packaging

How to mount 5 dual-in-lines in a package 1/4 the size of a PC board in 30 seconds without a drop of solder is only one of the features covered in a 16-page catalog. It details how a new high-density IC packaging device eliminates most of the problems associated with PC boards and socket mounting systems while providing high-capacitance and low-impedance ground and power planes. Other areas covered in detail are the device's capability to accommodate dual-in-lines with varying tolerances. ACS Industries.

CIRCLE NO. 383

IC sense amplifiers

A series of high-speed sense amplifiers is fully described in an eight-page booklet. Electrical characteristics, recovery and recycle times and logic diagrams are included. Switching characteristics and schematics are also included. Three output configurations that are widely used in this series are shown. Component values are included on schematics. Silicon General Inc.

CIRCLE NO. 384

SCRs and triacs

Specifications, characteristics, parameters and ratings for the selection and application of SCRs and power logic triacs are contained in a new 112-page catalog. It includes outline drawings, an abundance of characteristic curves, dimensional data and pertinent considerations regarding device use. A separate section contains information on power control assemblies and a discussion on heat exchangers. International Rectifier.

CIRCLE NO. 385

Electronics in Canada

Over 200 Canadian electronics companies are listed in a comprehensive booklet, published by the Canadian Government, to serve as a ready reference for anyone who is interested in Canadian electronic products and services. Listings of electronic equipment and systems, components, consumer products and consultant companies include addresses, products and services. A product index shows you exactly where to look for particular requirements. The booklet also outlines the story of the growth and success of the electronics industry in Canada. Canadian Department of Industry, Trade and Commerce.

CIRCLE NO. 386

Rf coaxial connectors

Miniature SMA 3-mm rf coaxial connectors designed to meet requirements of MIL-C-39012 are described in a 32-page catalog. It also contains a complete line of SMB and SMC subminiature connectors which meet requirements of MIL-C-22557 and MIL-C-39012. The comprehensive catalog contains specifications and mating characteristics typical to each line, plus detailed mechanical drawings of each connector style. Wherever necessary, recommended cable impedances and type numbers are called out. Sealectro Corp.

CIRCLE NO. 387

Lafayette catalog

The new 116-page 1970 Lafayette Radio Electronics catalog 704 is available. It features high-fidelity systems and components, citizen's band equipment, radios, televisions, tape recorders and small home appliances. It also features automobile tape players, musical instruments and amplifiers, camera equipment and special closeout prices on speakers. Lafayette Radio Electronics Corp.

CIRCLE NO. 388

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Advertising Sales Staff
Keith Aldrich
Sales Manager

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Robert W. Gascoigne
Thomas P. Barth
Samuel M. Deitch
850 Third Avenue
(212) Plaza 1-5530
TWX: 867-7866

Philadelphia 19066
William C. Repetto
P. O. Box 206
Merion Station, Pa.
(215) MA-3-5888

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Hingham, Mass.
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Chicago 60611
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Cleveland
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(312) 337-0588
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London W. 1
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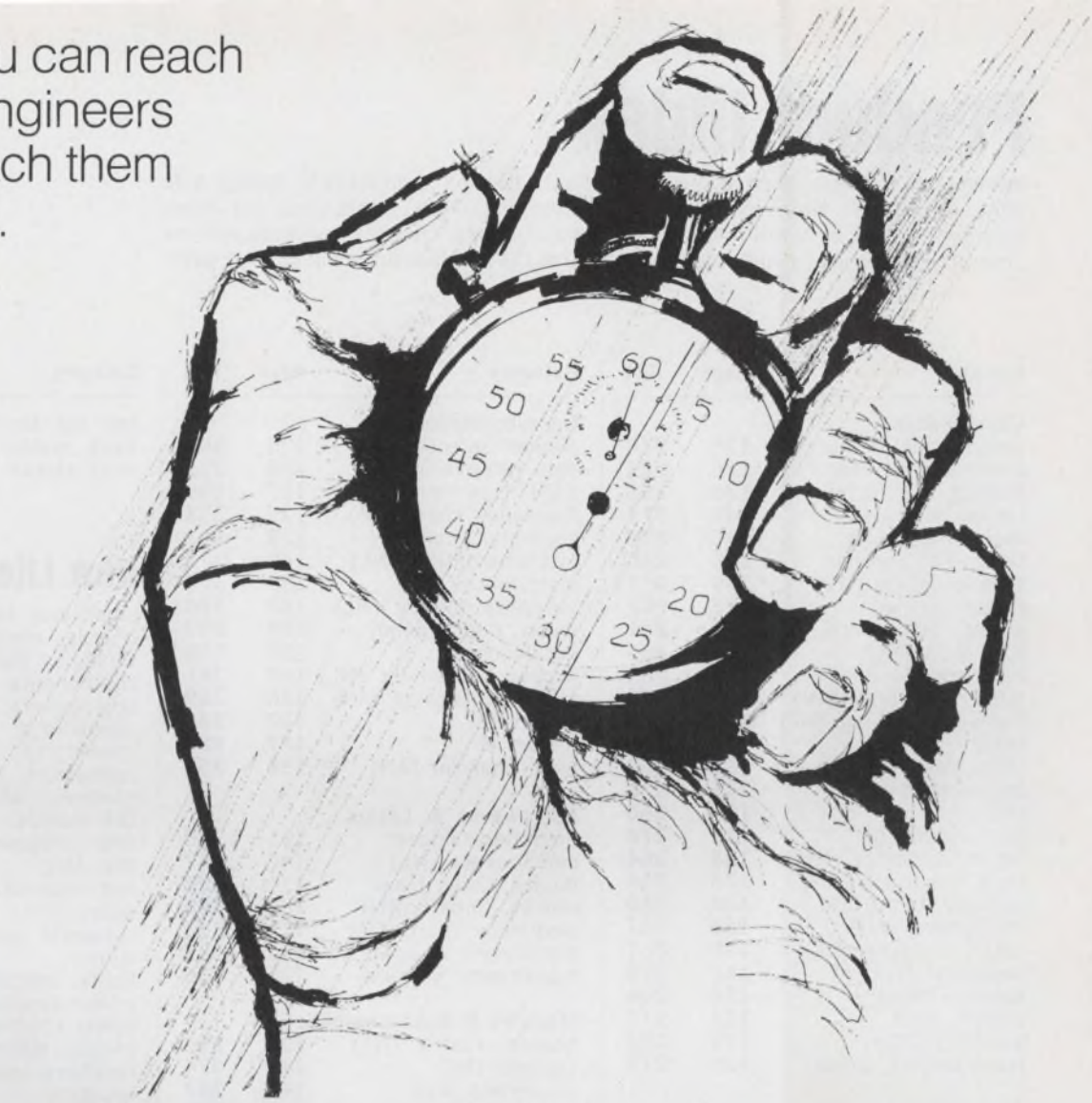

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		ORDER IN N.Y. OFFICE	FILM POS. AT PRINTER
June 7	May 4	**May 22**	**May 25**
June 21	May 18	**June 5**	**June 8**
July 5	June 1	**June 19**	**June 22**
July 19	June 15	**July 3**	**July 6**
Aug. 2	June 29	**July 17**	**July 20**
Aug. 16	July 13	**July 31**	**Aug. 3**
Sept. 1	July 27	**Aug. 14**	**Aug. 17**
Sept. 13	Aug. 10	**Aug. 28**	**Aug. 31**

ISSUE DATE	REGULAR CLOSING	FAST CLOSE	
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Oct. 11	Sept. 8	**Sept. 25**	**Sept. 28**
Oct. 25	Sept. 21	**Oct. 9**	**Oct. 12**
Nov. 8	Oct. 5	**Oct. 23**	**Oct. 26**
Nov. 22	Oct. 19	**Nov. 6**	**Nov. 9**
Dec. 6	Nov. 2	**Nov. 20**	**Nov. 23**
Dec. 20	Nov. 16	**Dec. 4**	**Dec. 7**

Product Index

Information Retrieval Service. New Products, Evaluation Samples (ES), Design Aids (DA), Application Notes (AN), and New Literature (NL) in this issue are listed here with page and Information Retrieval numbers. Reader requests will be promptly processed by computer and mailed to the manufacturer within three days.

New Literature

Application Notes

Design Aids

Evaluation Samples

This new "4th generation" I-C plug-in counter/timer Outperforms all others...

And will for years to come!

Why compromise for less? The Model 1500A has a main frame counting range from dc to 125 MHz (to 3 GHz with a single plug-in). This instrument is fully programmable, has provision for external time base up to 10 MHz, and many other significant features, including the well recognized advantages of Monsanto's "4th generation" 90% integrated circuit design.

Shown above is the Model 1104B 3 GHz frequency converter plug-in. Also available: Model 1100A uncommitted plug-in; Model 1101A 500 MHz prescale plug-in; Model 1102A 6-digit preset plug-in; Model 1103A 500 MHz frequency converter plug-in; Model 1107A time interval plug-in; Model 1201A DVM plug-in.

Unparalleled performance plus award-winning design make the Model 1500A the ultimate counter for the no-compromise engineer. The price for the main frame is $2400.00, FOB West Caldwell, N. J. Other models of the 1500 Series offering a wide selection of features and capabilities begin at $1800.00.

Most engineers take Monsanto's reliability for granted because of our 2-year warranty. But, just in case, we maintain 37 Service Centers located strategically throughout the United states and overseas.

For a demonstration, or for full technical details, call your local Monsanto Field Engineer now or contact us directly at: Monsanto Company, Electronic Instruments, West Caldwell, New Jersey 07006, (201) 228-3800.

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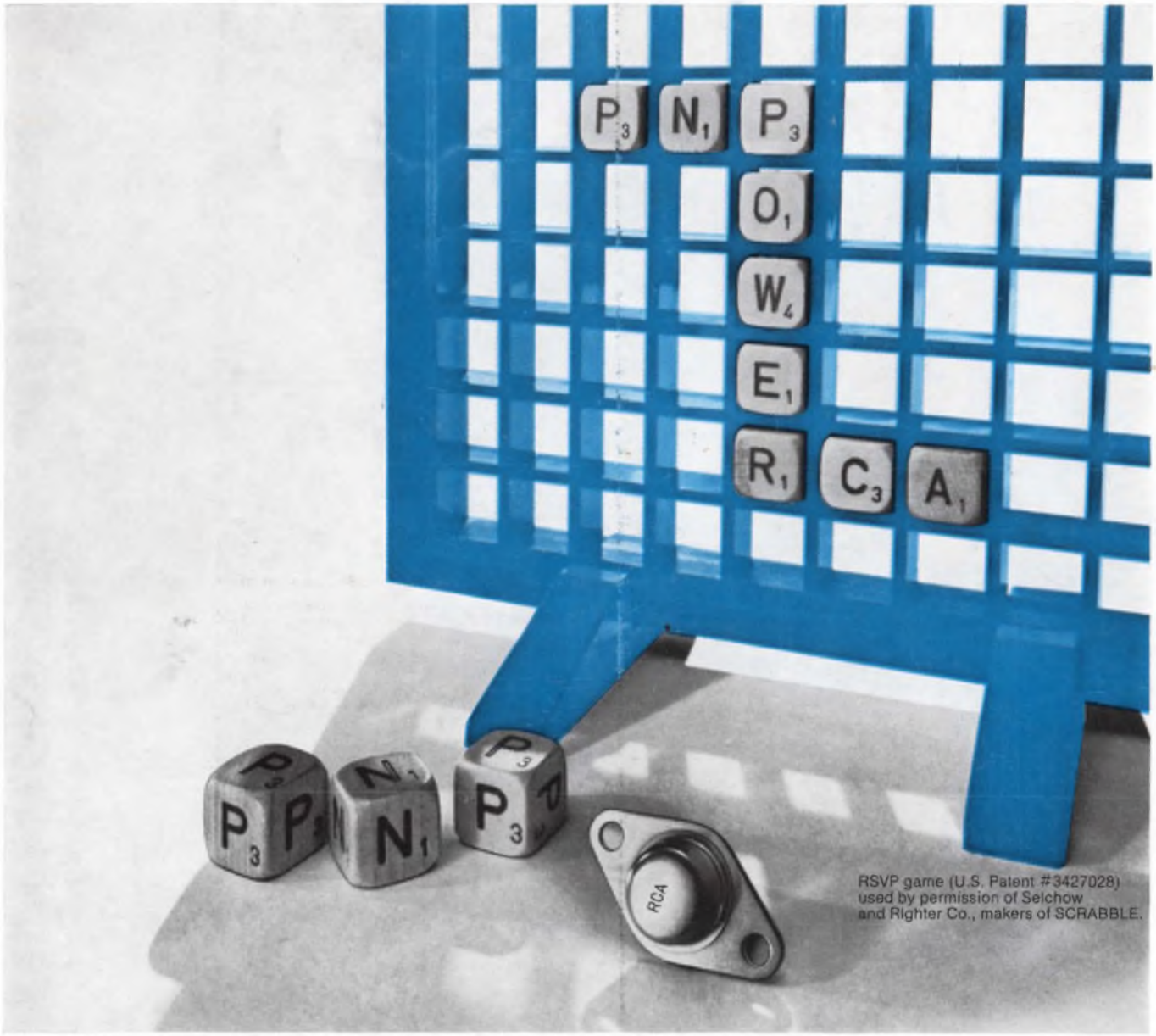

You Win With RCA P-N-P Power... New 2N5954 Family (2N3054 Complement)

This new RCA p-n-p transistor has the qualifications that can make winners of you and your designs. The 2N5954 is a silicon power unit in a hermetically-sealed TO-66 package. Complementing the 2N3054 (already widely known in sockets in military, industrial, and commercial equipment), the 2N5954 features controlled second-breakdown ratings. To be sure, each transistor is individually tested to meet specified parameters before it is shipped.

The new 2N5954 family with its multiple epitaxial structure and emitter ballasting techniques add up to a traditionally rugged RCA power device...giving you the design capability to achieve high performance levels in your equipment. One of three new RCA p-n-p types now offered for switching and amplifier applications, 2N5954 (or its family types, 2N5955 or 2N5956), together with its n-p-n complement, provide bi-directional control and phase inversion advantages.

P-n-p/n-p-n complements are particularly advantageous if you're trying to cascade four or five stages. In a power supply design, for example, the use of complementary types can eliminate voltage build-up that would be encountered if cascaded n-p-n, or cascaded p-n-p types were employed.

Check the chart on these new types. For more information, consult your local RCA Representative or your RCA Distributor. For technical data, write: RCA Electronic Components, Commercial Engineering, Section 52E-2 /UT8, Harrison, N. J. 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

Type No.	V_{CBO} (V)	V_{CEX} (sus) (V)	V_{CER} (sus) (V)	V_{CEO} (sus) (V)	I_C (A)	P_T (W) @ $T_C = 25°C$
2N5954	85	85	80	75	−6	40
2N5955	70	70	65	60	−6	40
2N5956	50	50	45	40	−6	40

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