VOL. 19 NO. 1

JAN. 7, 1971

Electronic Design

FOR ENGINEERS AND ENGINEERING MANAGERS

Automated systems will dominate mass urban transportation in the coming years. In the process they will provide opportunities and new challenges for many engineers. Command and control, communications, hazard detection, propulsion and power pickup are only some of the electronic areas involved. For details, see p. 71.


Dale RH and RS resistors are used in Burroughs' popular TC 500 on-line terminal computer.
Burroughs
TC 500
DALE RH-50
DALE RS-10
The everywhere resistors ...and why.
DALE WIREWOUNDS:
Found wherever power must be precisely dissipated. Why? Because of these unequalled advantages:
SELECTION—Dale's new resistor catalog gives you the industry's widest choice of standard precision power models—most of them ready to ship from your nearby distributor.
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DELIVERY—2-3 weeks on 1 watt MIL-R-26E models. Comparable fast times on all other popular styles.
If you think there's no difference in wirewounds—you haven't dealt with Dale. PHONE 402-564-3131 or write for our new expanded Resistor Catalog.
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INFORMATION RETRIEVAL NUMBER 181

No. 1: The 24-Second Q Meter

Think back to the last time you used a Q Meter. It was probably an ancient-looking monster that you couldn't operate without studying a manual. A lot of cumbersome controls took strength and patience to manipulate. Once you got the hang of it, you still had to spend about a minute to get a reading . . . and then, you had to multiply that reading by another to get the answer you were looking for.

No more. Now, there's HP's 4342A—the Q Meter that lets you take readings in 24 seconds or less, start-to-finish. A single indicator gives you Q directly, over a range from 5 to 1000; there's no Q-multiplier to contend with. Fingertip controls let you choose any frequency from 22 kHz to 70 MHz—a wider range than ever before. Likewise, you can select L, C, or △C scales effortlessly, in seconds.

The 4342A is just one of HP's family of "Useables"—easy-to-use instruments for testing components. For further information on the 4342A, or on any of the "Useables," contact your local HP field engineer. Or write Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

091/8

COMPONENT-TESTING INSTRUMENTS YOU CAN USE

The Useables:

No. 1: 4342A Q Meter, No. 2: 4270A Automatic Capacitance Bridge, No. 3: 4328A Milliohmmeter, No. 4: 4329A High Resistance Meter, No. 5: 4260A Universal Bridge, No. 6: 4470A Transistor Noise Analyzer.

VOL. 19 NO. 1

Electronic Design

FOR ENGINEERS AND ENGINEERING MANAGERS

JAN. 7, 1971

NEWS

TECHNOLOGY

PRODUCTS

Departments

Cover: Train, driven by a 2500-hp linear induction motor, developed by Garrett-AiReasearch Corp. in Torrance, Calif.

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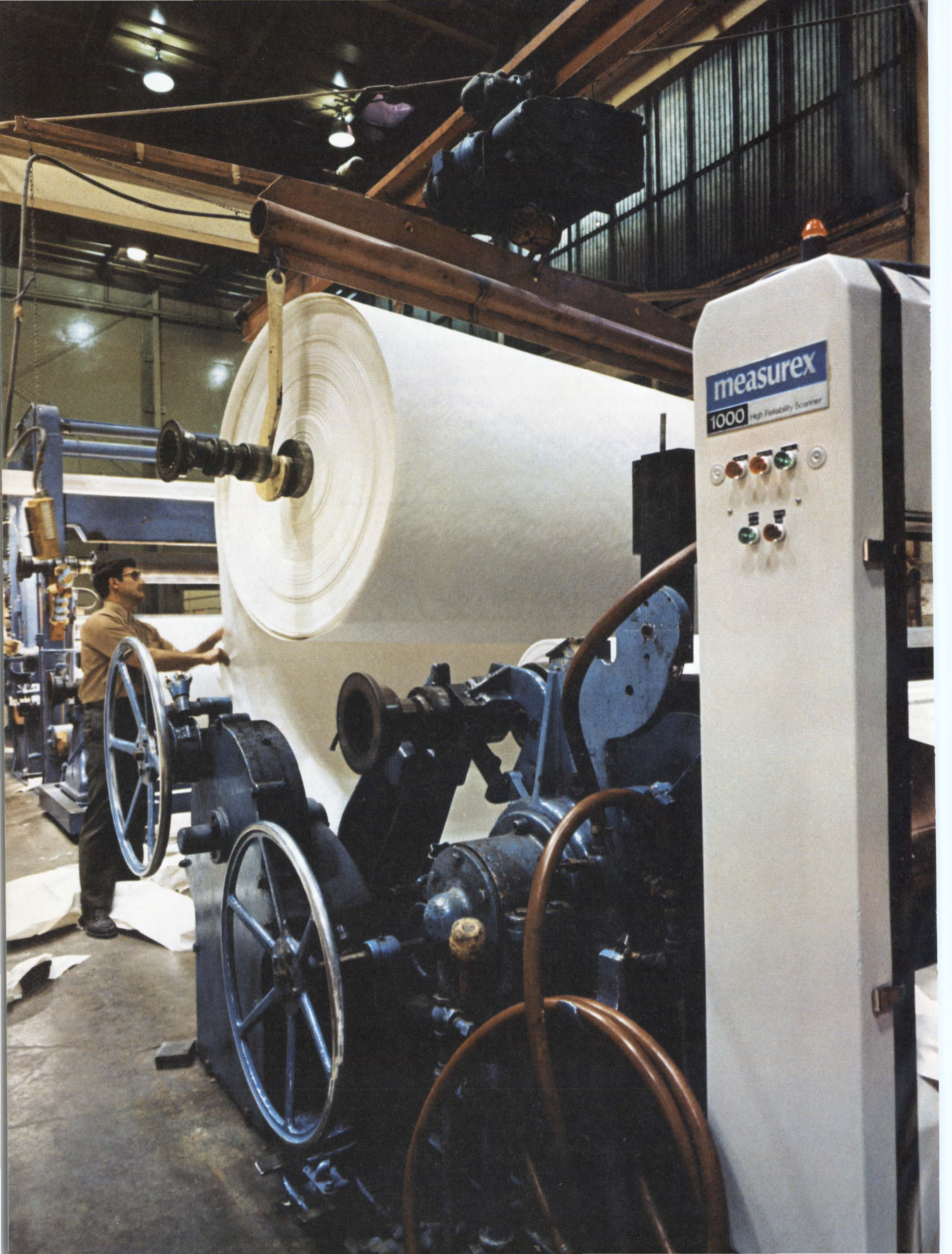
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letters

A little letter makes a great big difference

Sir:

Anyone who tries to drive a 10-Ω load with my LC oscillator (Ideas for Design, ED 20, Sept. 27, p. 65) will be quite disappointed. The text should have read "when driving a 10-kΩ load."

D. E. Wilson

Supvr., Support Systems
Lockheed Missiles & Space Co.
P. O. Box 4097
Patrick AFB, Fla.

Video discs are called true breakthrough

Sir:

The article, "Cassette TV players face 'war' on 5 fronts," by John N. Kessler, News Editor (ED 22, Oct. 25, 1970, p. 32) was a nice summary but poorly researched.

The true revolutionary breakthrough is the video disc, Teldec, which has been used for some time in other applications. An advantage for this type of video disc is that it could be used to give more than five hours of uninterrupted audio.

J. R. Popkin-Clurman

Electronic Consultant
134 Wheatley Rd., Brookville
Glen Head, N. Y. 11545

Kessler replies:

The point of my article on cassette TV players was that standardization is a problem facing manufacturers, designers and consumers. The article, which states that "there are at least a dozen incompatible systems," was not intended as a summary of the field.

While the Teldec video disc, developed by Telefunken AEG and British Decca, seems to be well designed, demonstrations so far have been limited to black and white, and running time per 12-inch disc is 12 minutes.

Even though aluminum discs have been used commercially for TV instant replays, the plastic Teldec system for the home market is so different from other contenders in this field that it will likely be unaffected by standards adopted by other major manufactuers.

This 'world's first' drops to second place

Sir:

Re the "Technology Abroad" item (ED 24, Nov. 22, 1970, p. 38), the first fully automated pipeline control system is not the one in Iran. The first successful system was developed and built in Houston, Tex. in 1958 for the Cherokee Pipeline Co. of Oklahoma by engineers at Southwestern Industrial Electronics Co.

The SIE system monitored and controlled seven pumping stations spaced roughly 100 miles apart, as I recall. Any station could be interrogated from a central point by means of a teletypewriter terminal, and would print back the requested flow rate, pressure, temperature, etc. It was a fully solid-state digital system, transmitting data via keyed tones over ordinary long-distance telephone lines. Noise and variations in transmission level over the phone lines was a leading problem at the time; the data available from AT&T was rather scanty and turned out to be optimistic. The SIE-Cherokee system was, however, completed and installed, and worked well.

L. Fleming

Innes Instruments
Box 5216
Pasadena, Calif. 91107

(More letters appear on page 16H)

Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Managing Editor, Electronic Design, 850 Third Ave., New York, N.Y. 10022. Try to keep letters under 200 words. Letters must be signed. Names will be withheld on request.

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The Fairchild TTL family offers the freedom-loving designer the broadest range of speed/power trade-offs and an extraordinary variety of logic and memory and interface support functions.

*Available January, 1971.

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Forget everything you've heard. Take a hardnosed look for yourself. Compare dollars against performance—right down both lines.

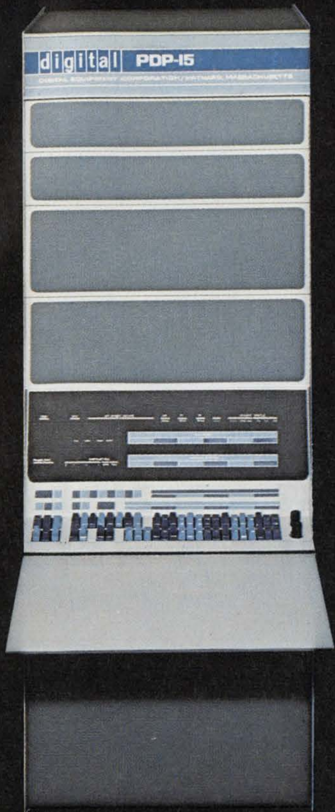
If you need large memory, compare SYSTEMS 72 with the PDP-8 and PDP-11. You'll find the SYSTEMS 72 has a little more speed and a lot more memory (max. 65,000 words of programmable memory —almost twice as much as the other two). On many applications, this will cut cost as much as 40%.

If you need more speed, you'll find the SYSTEMS 82 is 4-5 times faster than the PDP-8 or 11. And because it's designed for real-time systems use, you can hang on a wide variety of analog front ends and peripheral equipment.

If you need even faster speeds and heavier software, check out SYSTEMS 810B—the fastest field-proven 16-bit machine in the business. It comes with a whole library of software including FORTRAN IV and a foreground-background-middleground programming system called Real-Time Executive.

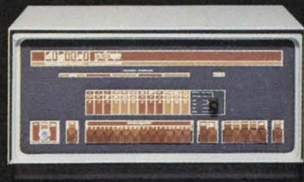
SYSTEMS also makes some very large, very fast real-time computers. But that's another story.

As far as small real-time computers go, don't take our word for it. Send the coupons.



PDP-15
Word length—18-bit
Cycle time—800 nanosec.
Maximum core memory—131

PDP-11
Word length—16-bit
Cycle time—1200 nanosec.
Maximum core memory—32



PDP-8 Series
Word length—12-bit
Cycle time—1200-1600 nanosec.
Maximum core memory—32

10

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I'd like to compare the DEC and SYSTEMS lines of small real-time computers. Please send me more information.

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Company____________________

Address____________________

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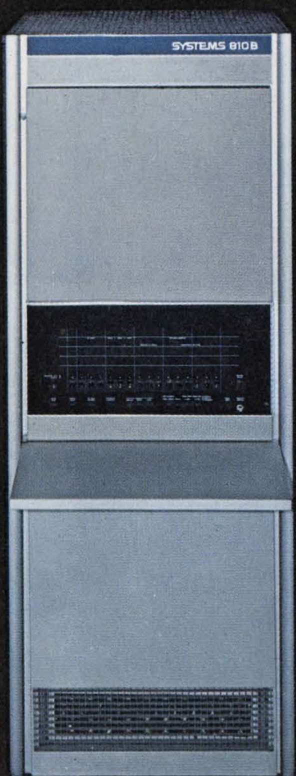
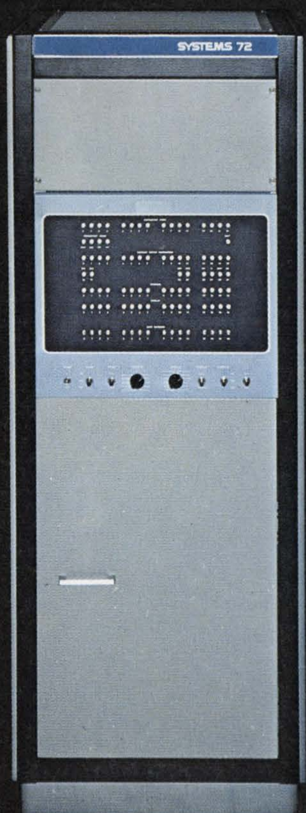


SYSTEMS 810B
Word length—16-bit
Cycle time—750 nanosec.
Maximum core memory—32



SYSTEMS 72
Word length—16-bit
Cycle time—880 nanosec.
Maximum core memory—65

SYSTEMS 82
Word length—16-bit
Cycle time—900 nanosec.
Maximum core memory—16

10

SYSTEMS Engineering Laboratories
6901 West Sunrise Blvd.
Ft. Lauderdale, Fla. 33313

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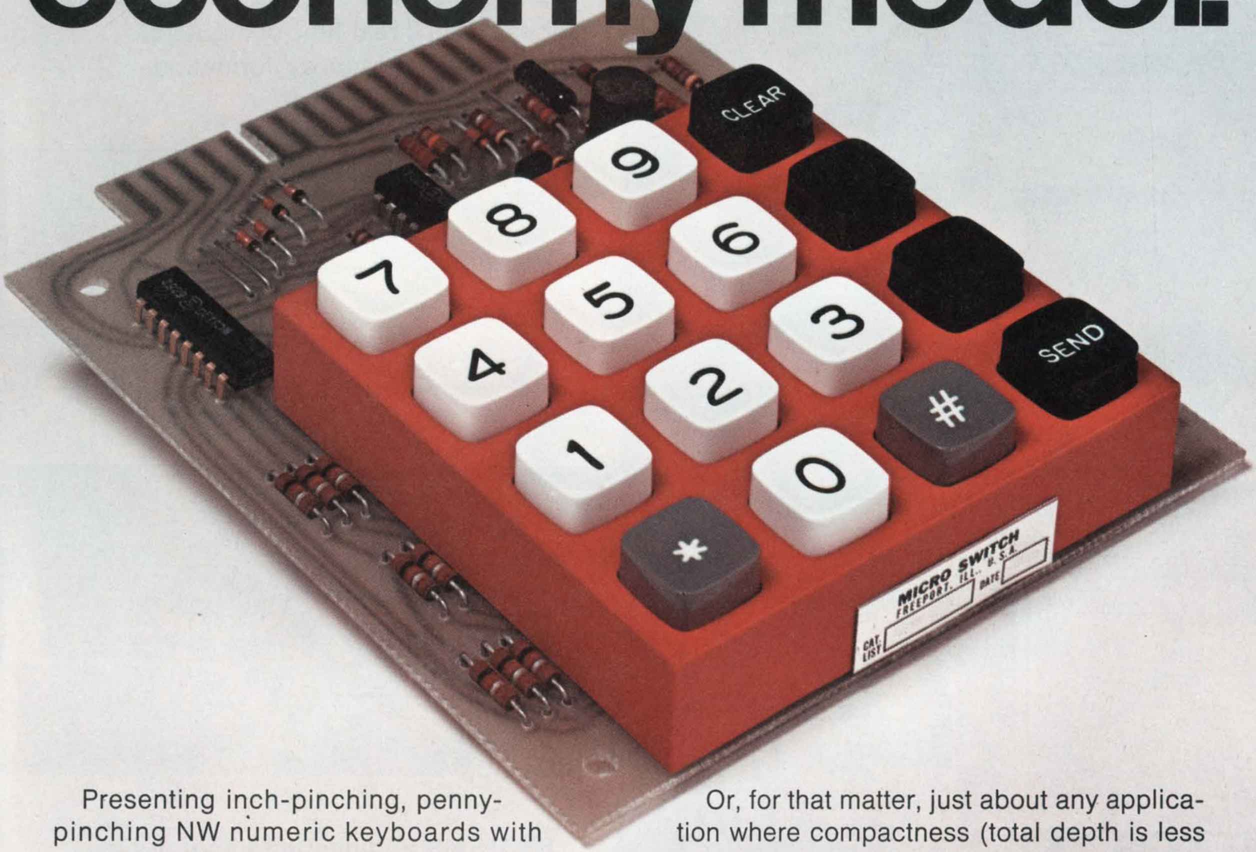
Our economy model.



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Key formats are available in "adding machine," Touch-Tone* or in custom colors and legends within existing housings. Which makes our new models ideal for desk top calculators, point of sale stations and credit verification equipment.

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INFORMATION RETRIEVAL NUMBER 9

designer's calendar

FEBRUARY 1971						
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						

Feb. 9-11
Aerospace & Electronic Systems Winter Convention (WINCON), (Los Angeles). Sponsors: IEEE et al. William H. Herrman, Wincon '71, IEEE Los Angeles Council, 3600 Wilshire Blvd., Los Angeles, Calif. 90005.

CIRCLE NO. 403

Feb. 17-19
International Solid State Circuits Conference (Philadelphia, Pa.) Sponsors: IEEE et al. Lewis Winner, 152 W. 42nd St., New York, N. Y. 10036.

CIRCLE NO. 404

MARCH 1971						
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			

March 22-25
IEEE International Convention and Exhibition (New York City). Sponsor: IEEE. J. M. Kinn, IEEE, 345 E. 47th St., New York, N. Y. 10017.

CIRCLE NO. 405

March 31-Apr. 2
Reliability Physics Symposium (Las Vegas). Sponsor: IEEE. O. D. Trapp, Fairchild Semiconductor, 464 Ellis St., Mountain View, Calif. 94040.

CIRCLE NO. 406

. . . MECL III HAS THE ANSWERS

As a chain is as strong as its weakest link so are system capacities limited by logic speed. MECL III nanosecond logic is providing the answers to today's increasing data handling demands. Answers in the form of high-speed memories operating at 2.5 ns access times, A/D conversion at 3.5 ns rates, a shift register capable of 300 MHz shift rates, gates with 0.9 ns propagation delay, and a master slave type D flip-flop toggling at 350 MHz.

But speed is only part of the MECL story. Designers have discovered that MECL's Complementary Outputs and the Wired OR Capability have increased circuit flexibility and reduced overall system package count. And if you have high fan-out requirements, MECL III is equal to the task.

MECL offers a definite advantage above 30 MHz by showing a minimal increase in power dissipation even with high capacitive loading or the driving of terminated lines. As the complementary MECL gate is switched from one state to another, power supply current remains constant within 5%. The result — fewer power supply decoupling problems and reduced system fabrication costs.

And take note of MECL's extremely low system cross-talk and noise generation . . . single supply operation . . . voltage and temperature compensated logic swing . . . and driving capability for 50 ohm lines . . . need we say more?

MECL III is now available in stud-mounted flat packs and 16-pin ceramic dual in-line packages to meet your circuit requirements. And in case you haven't noticed, MECL III offers a comprehensive family plus more on the way, all at new lower prices.

Get the whole MECL story. Just write to Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, Arizona 85036 and ask for the "MECL High-Speed Systems Design Library." It's full of FAST ANSWERS!

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INFORMATION RETRIEVAL NUMBER 11

These features of RCA's COmplementary Symmetry MOS IC's give you many opportunities to save space, weight, power and cost in your new and existing logic designs. And, you will find that no other digital IC devices offer as many circuit-design advantages as RCA's COS/MOS IC's.

RCA, the acknowledged leader in complementary MOS technology, today produces the industry's broadest line of these devices. Immediately available from RCA are production quantities of gates, flip-flops, hex buffer/logic-level converters, multiplexers, static-shift registers, counters, adders and memories.

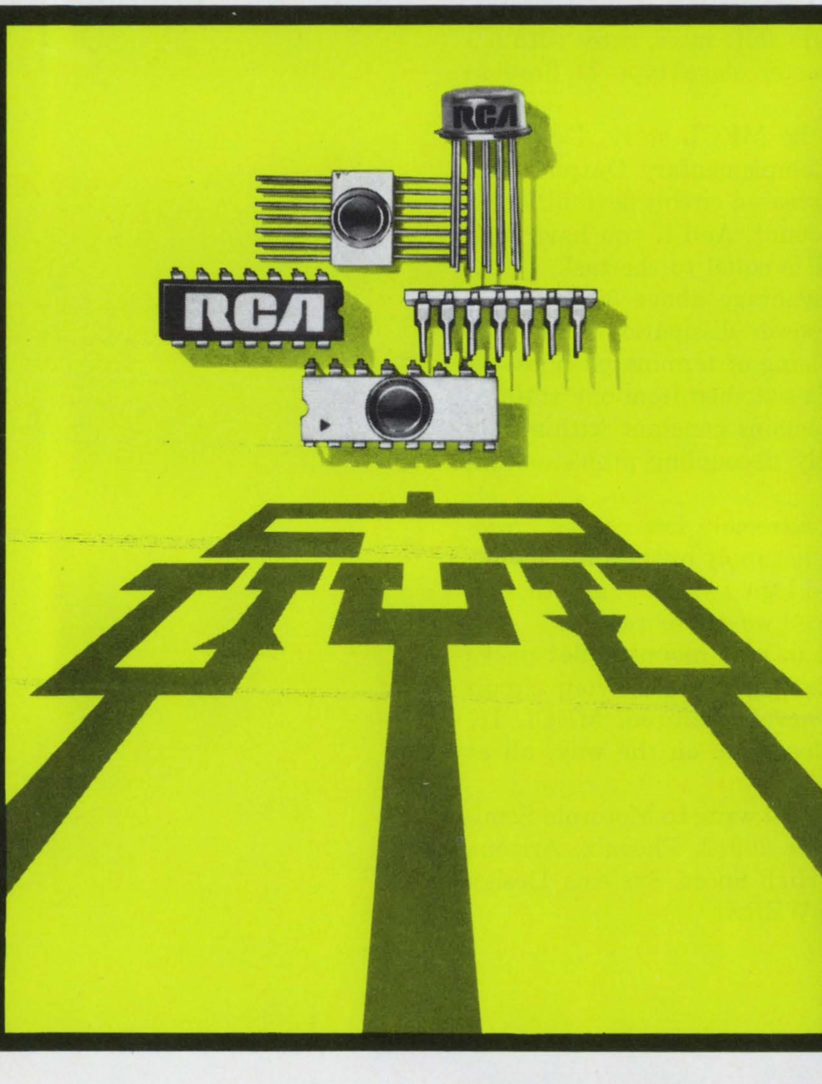
New CD4000E series: 19 economy-priced plastic-packaged COS/MOS IC's, another RCA "first" in COS/MOS technology, offer additional cost-savings and open up many new application areas in industrial and commercial logic systems.

New low prices for 28 ceramic-packaged COS/MOS IC's, in the CD4000 and CD4000D series, enable you to design cost-effectiveness into demanding military and aerospace applications.

RCA will also custom-tailor COS/MOS IC's to meet your special digital-circuit requirements and you are invited to discuss this capability with your RCA Representative.

For price, delivery or technical information on all current types of RCA's COS/MOS IC's, see your local RCA Representative or your RCA Distributor. To obtain a copy of the new Product Guide on COmplementary Symmetry MOS integrated circuits, write to RCA, Commercial Engineering, Section 57A-7/CD48, Harrison, N.J. 07029. International: RCA, 2-4 rue du Lièvre, 1227 Geneva, Switzerland, or P.O. Box 112, Hong Kong.

RCA COS/MOS Digital IC's: Unique! Challenging! Rewarding!



RCA COS/MOS PERFORMANCE FEATURES

Wide Operating Supply-Voltage Range: 5 to 15 V

Ultra-Low Power Dissipation:

- Gates—CD4000 and CD4000D Series:* $P_T = 10$ nW/pkg (typ) at $V_{DD} = 10V$
  —CD4000E Series: ** $P_T = 50$ nW/pkg (typ) at $V_{DD} = 10V$
- MSI Circuits—CD4000, CD4000D and CD4000E Series: $P_T = 10\ \mu W$ (typ) at $V_{DD} = 10V$

High dc and Dynamic Noise Immunity: 4.5 V (typ) at $V_{DD} = 10V$ over full operating-temperature range

Wide Operating-Temperature Range:

- CD4000 and CD4000D Series: $-55°C$ to $+125°C$
- CD4000E Series: $-40°C$ to $+85°C$

Single Phase Clock

Clock Voltage Equal to Supply Voltage

Compatible Gate Level and MSI Functions

High Fanout: >50 COS/MOS Loads

Protected Inputs and Outputs

*Ceramic flat-pack and dual-in-line packages
**Plastic dual-in-line package

RCA

Integrated Circuits

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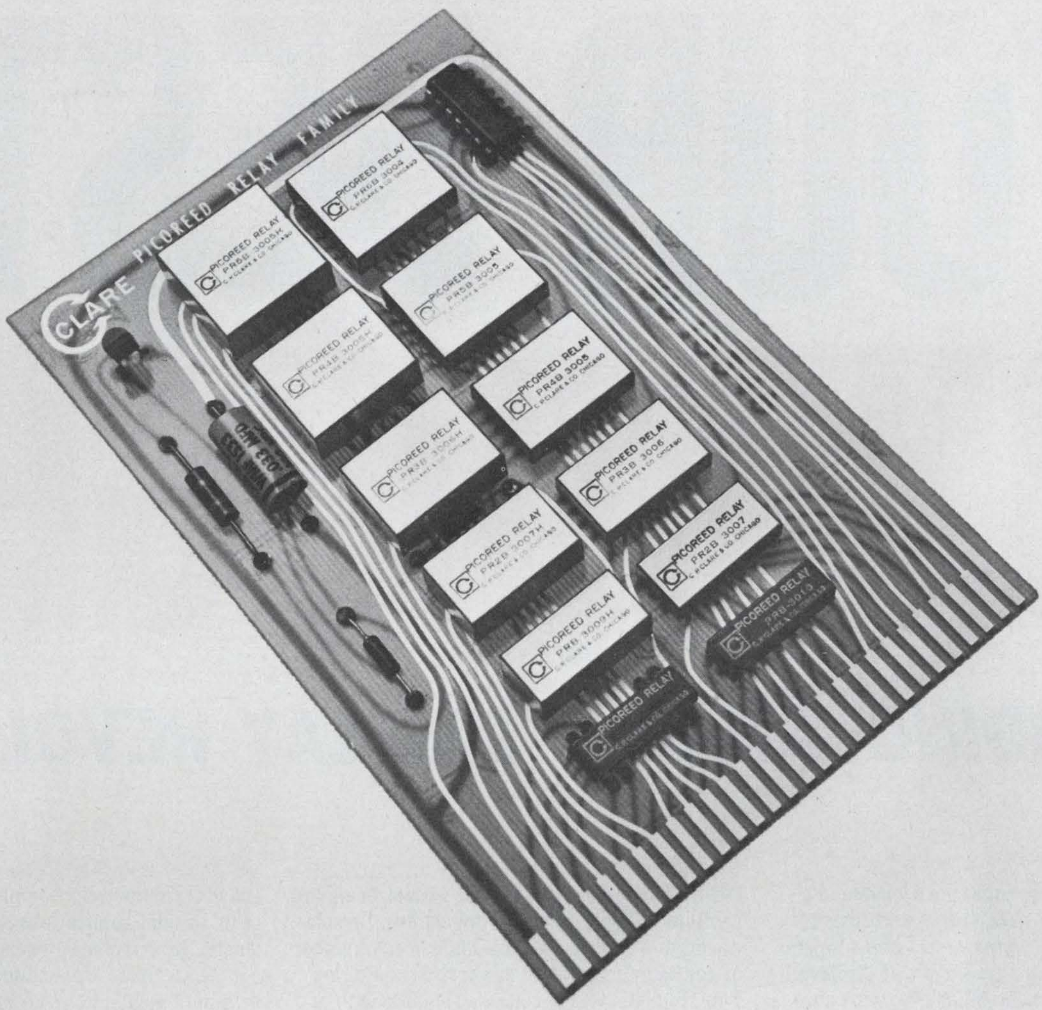

Widest choice of contact configurations. High density packaging. Low profile metal covers. High sensitivity.

Ultraminiature Picoreed relays in a wide range of contact configurations. If you want a 6 form A relay you get just that from Clare—not six,1 form A relays from somebody else.

Need a low profile Picoreed relay? Choose from 1 to 6 form A in our Type PRB line. They allow 0.375″ pc board mounting centers. Need a high sensitivity Picoreed relay? Choose from 1 to 5 form A in our Type PRBH line. They allow 0.500″ pc board mounting centers.

Now, observe the performance. Up to 100 million operations at signal levels (5V, 10mA) and 5 million operations at tough 28 Vdc, 125mA loads. Power requirements as low as 50 mW nominal. Fast operate times as low as 500 microseconds including bounce.

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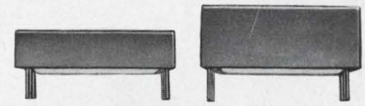

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PRBH High Sensitivity: 0.350″ high

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BURROUGHS NIXIE TUBE MODULES
Off-the-shelf, low-cost readout system flexibility for 3- to 15-digit numeric applications. Decoder drivers and counters are available in any number of configurations for all applications requiring 1 to 15 digits. Ready-to-use assemblies with or without bezel come complete with NIXIE Tubes. Plug-in modules used singly or in combination meet exact application requirements.

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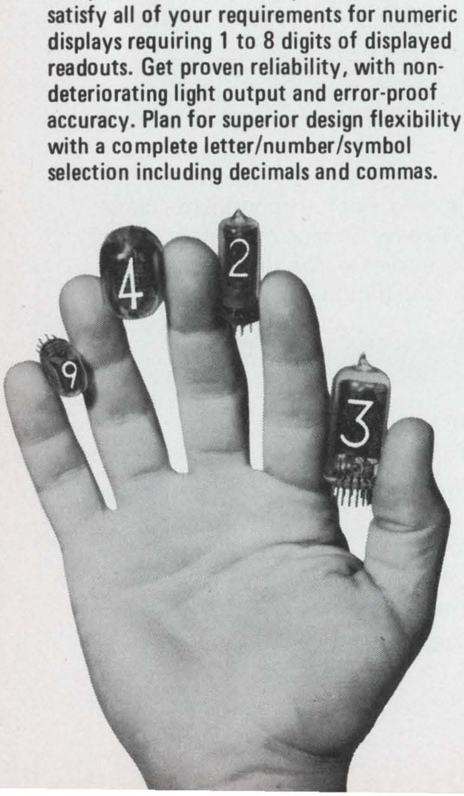
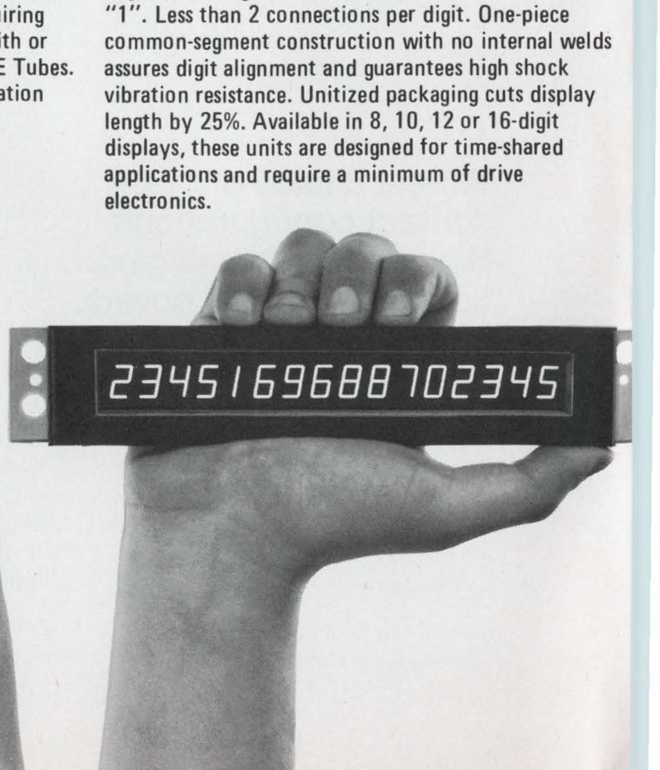
Lowest cost-per-digit, in-plane numeric readout for 8 to 16 digit applications provides a 150° viewing angle. Nine-segment format allows centered numeral "1". Less than 2 connections per digit. One-piece common-segment construction with no internal welds assures digit alignment and guarantees high shock vibration resistance. Unitized packaging cuts display length by 25%. Available in 8, 10, 12 or 16-digit displays, these units are designed for time-shared applications and require a minimum of drive electronics.





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32-, 18-, 16-CHARACTER SELF-SCAN™ PANEL DISPLAYS

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256-, 128-, 64-CHARACTER SELF-SCAN PANEL DISPLAYS

Alphanumeric displays equivalent to over 12,000 light-emitting diodes arranged in a matrix format. These lightweight, in-plane displays with dots on 0.040" centers are available in a variety of capacities including 256 characters (8 rows of 32 characters); 128 characters (4 rows of 32 characters); and 64 characters (2 rows of 32 characters). SELF-SCAN panel display subsystems are available as "panels only" for graphic or special applications or in any degree of system complexity, up to a full display system with a complete line of options.

For further information, write or call: Burroughs Corporation, Electronic Components Division, Box 1226, Plainfield, N.J. 07061 (201) 757-3400

Burroughs

INFORMATION RETRIEVAL NUMBER 122

The globetrotting 417 goes wherever the data is. (Even on a roller coaster.)

When you can't bring the data to the recorder, bring the 417 to the data. It's light (28 lbs.). Small (17″ x 15″ x 7″). Rugged (works under vibration and in any position). And accurate (equals large rack machines).

Made in wideband or intermediate models, it measures vibration, speed, air speed, G forces, shock, all kinds of physical data. On up to seven channels at once, IRIG compatible. Within the 417 series, direct frequency response ranges from 100 Hz to 375 KHz. FM frequency response, DC to 100 KHz at 30 inches per second.

For power (normally 13w) the 417 can use its self-contained battery. Or, with accessories, it can use any power: 12 to 28v DC, 110 or 220v AC, 50 to 400 Hz.

You'll spend your time recording, too, not tweaking. Because the 417 is simple to use. And it needs less maintenance than any other recorder you can carry. If you should ever have a problem, there are thirty-five helpful 417 offices throughout the U.S.

You can take off with a 417 for as little as $7,000. Around the lab, around the campus, or around the world. It's a go-getter.

For more intermediate and wideband specs, write: Mr. Bob Mei, Dept. 413-10, Lockheed Electronics Company, Plainfield, New Jersey 07061. Or call him at (201) 757-1600.

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WHAT THIS COUNTRY NEEDS IS A GOOD 5¢ RECTIFIER*

HERE IT IS...GENERAL INSTRUMENT'S 1N4004

1N4004

- **PIV = 400V**
- **I_O = 1.0A @ 75°C**
- **I_R = 5.0µA @ 25°C**
- **V_F = 1.1V @ 1.0A @ 25°C**

*Conditions of Sale

Minimum Order Quantity	: 25,000 units scheduled within 60 days
Minimum Delivery	: Minimum Shipment 10,000 pcs.
Packing	: Bulk Packing, 2000 unit/box
Marking	: Cathode Band, 1N4004, GI, Date Code
AQL	: 1%
Specifications	: per EIA

For full information write General Instrument Corporation, Dept. R, 600 West John St., Hicksville, N.Y. 11802, or call in New York: 516-733-3333; in Chicago: 312-774-7800; in Los Angeles: 213-641-7411. In Canada, call or write to General Instrument Canada, Ltd., 61 Industry St., Toronto 337, Ontario, Canada, Tel: 416-763-4133. (In Europe, write to General Instrument Europe S.P.A., Piazza Amendola 9, 20149 Milano, Italy; in the U.K., to General Instrument U.K. Ltd., Stonefield Way, Victoria Road, South Ruislip, Middlesex, England.)

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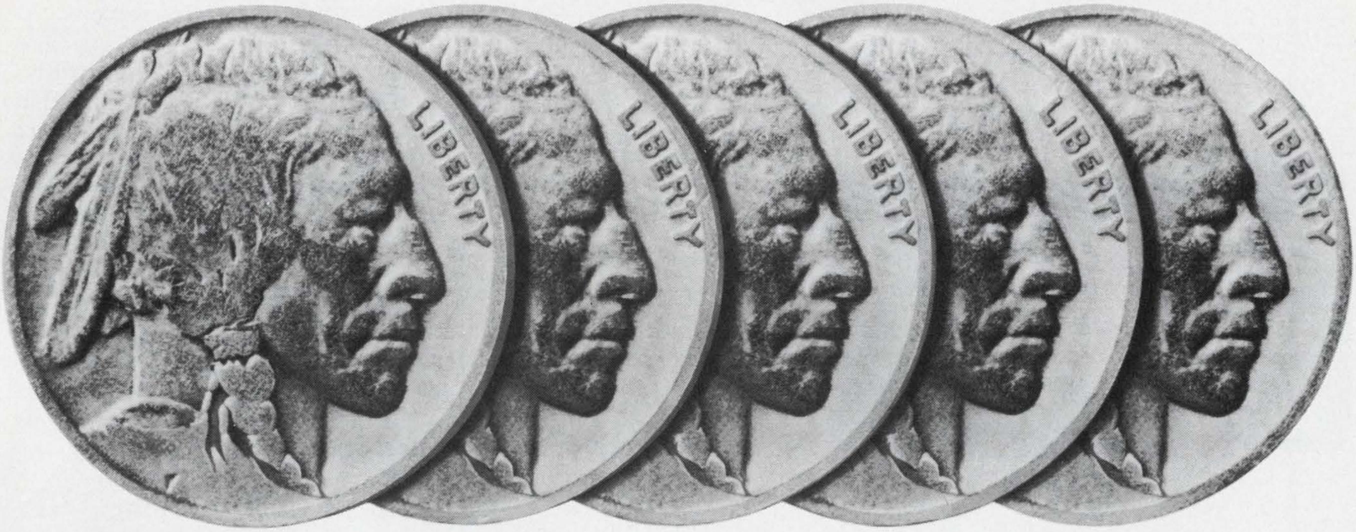
INFORMATION RETRIEVAL NUMBER 125

...AND A GOOD

25¢ SILICON BRIDGE RECTIFIER*



HERE IT IS...GENERAL INSTRUMENT'S WO4

WO4
- **PIV = 400V**
- **I_0 = 1.5A @ 50°C**
- **I_R† = 10µA @ 25°C**
- **V_F = 1.0V‡ @ 1.0A @ 25°C**

†Total Bridge ‡Per Element

*Conditions of Sale

Minimum Order Quantity :	10,000 units scheduled within 60 days
Minimum Shipments :	2,500 units
Packing :	Bulk
Marking :	WO4, AC and +, GI
AQL :	1%
Specifications :	As above

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GENERAL INSTRUMENT

GENERAL INSTRUMENT CORPORATION • 600 WEST JOHN STREET, HICKSVILLE, L. I., NEW YORK

INFORMATION RETRIEVAL NUMBER 126

(continued from page 7)

Slipup is spotted in number of addresses

Sir:

In "Simplifying Function Generator Design," (ED 21, page 86) the authors state, in effect, that a sine wave represented by 2048 discrete sample points (corresponding to a ROM consisting of 512 addresses containing values of the first quadrant of a sine wave) requires 2048 pulses per cycle of sine wave.

However, a simple analysis shows that only 2044 pulses are required per cycle. Observe that starting at address number zero (sin 0°) 511 steps are required to reach the peak of the sine wave (sin 90°). Similarly, 511 steps are required in the other three quadrants, resulting in a total of 2044 pulses for 360°.

In general, for a ROM comprised of N addresses, 4(N-1) pulses are required per cycle.

Eric Frankfort

Project engineer
Astrosystems, Inc.
Lake Success, N. Y. 11040

Authors reply

Mr. Frankfort's point is well taken. In our analysis we considered a sampled sine wave where the 512th sample occurred at $\pi/2$ rad, the 1024th at π rad, and the 2048th at 2π rad. Considering only the first 512 samples (where the first was not at 0°), the value of the function at 0°, which is equal to the value at 2π rad, is not included. It must, of course, be included to cover the complete range of sin $\omega_o T$ from 0° to $\pi/2$ rad. This would require 513 words in memory, which adds one bit to the memory address. In general, the number of addresses required to generate a sine wave with N samples per cycle should be $N/4 + 1$.

Our system as described using 512 words in memory does give 2044 samples per cycle.

D. F. Elliott
Allen D. Sypherd

Information Sciences Branch
Advanced Technology Department
Research & Technology Div.
Autonetics Div.
North American Rockwell
Anaheim, Calif. 92803

highlighting THE ISSUE

If you had a sinking feeling all last year that the electronics business was worse than everyone thought, you were right. For the first time in the history of the industry, annual sales are expected to show a drop instead of a rise.

Reliable sources say that when the tally for 1970 is complete, figures of the Electronics Industries Association will show sales down a full billion from the $25.7-billion in 1969.

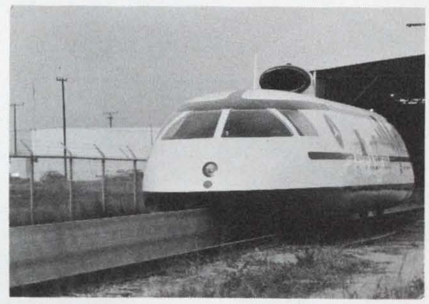
This year? EIA is looking for a slight rebound, the sources say. It expects a $100-million rise in sales. But that's $100-million above the 1970 figure—still $900-million below the total for 1969.

Page 25

A new solid-state LED numeric display features 5-V logic-level compatibility and a 4-by-7 dot matrix. It also includes a decoder-driver and a memory on the same substrate, plus a red filter, for a cost of only $10.

The display's matrix generates characters that are 0.29 inch high and 0.19 inch wide and uses only 75 mA of current. The entire display is mounted in a dual-in-line package.

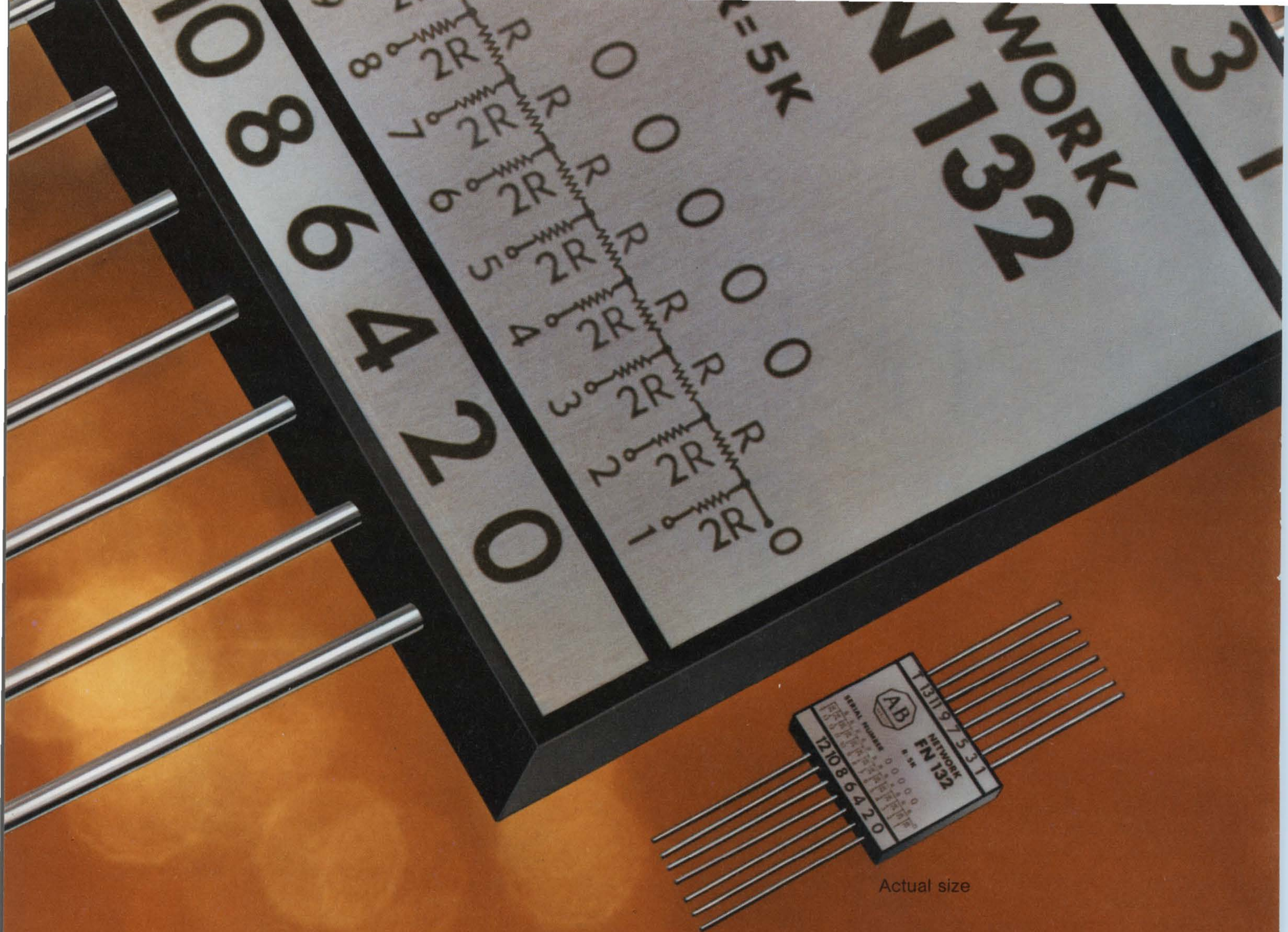
Page 115



Over the next five years, according to Government and industry estimates, more than $200-million will be spent on electronics for guided surface mass transportation.

All systems will have to meet tight performance and environmental specifications, but, unlike aerospace and defense electronics, one specification that will be found in all guided surface mass transportation requirements is that the system must be fail-safe. The designer will now be asked not only *when* the system will fail, but also *how* it will fail. This adds up to systems that are more reliable than those that have taken men to the moon.

Page 71



Actual size

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TCR TRACKING	± 5 ppm/°C standard to ± 1 ppm/°C special
TOLERANCES	Absolute to ± .01% @ +25°C Matching to ± .005% @ +25°C
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NEW DIMENSION ELECTRONICS

Japan forms LSI council to gain competitive edge

Japan is getting ready to compete with the U. S. in the world of LSI. Up to now, Japan has been using predominantly U. S. MSI and LSI.

However, unconfirmed reports from Tokyo and from Britain indicate that eleven Japanese electronics firms have formed what may be the first LSI council.

The member firms include Hitachi, Mitsubishi, and Nippon Electric. Their aim is to speed their technology to meet growing sales in their domestic market by U. S. companies.

Although officials at the Electronics Industries Association in Washington, D. C., and the Japan Trade Council, in New York City, cannot confirm this report, they conjecture that this may be a government-sponsored effort.

The purpose of the LSI council, according to a report in the British publication, Electronics Weekly, is to "standardize the number of pins and other basic structures of LSI units, to streamline manufacturing processes and shapes of LSI packages, and to standardize the different levels of efficiency by purchasing testing units from the member firms joint fund."

William C. Hittinger, vice president and general manager of RCA's Solid-state Division in Somerville, N. J., does not see a Japanese combine as a serious threat to U. S. industry. "Most people," he told ELECTRONIC DESIGN, "recognize that the Japanese—although working strenuously today—are behind the U. S. in technology, and their standardization efforts will be patterned after those already in use in the U. S."

Hittinger also pointed out that U. S. producers generally deal with a given set of vendors for LSI packages involving ceramic structures and that standards have been established on multileaded packages in terms of lead spacing and lead dimensions.

Howard Moss, assistance vice president at Texas Instruments and Chairman of the EIA's Joint Electron Device Engineering Council pointed out that EIA has published some "guidelines" for quality and reliability assurance, and outlines for 20 to 64 leaded LSI product carriers, headers and hermetic seals.

Two-way CATV arrives this spring

What is believed to be the first two-way (send-and-receive) cable-TV system is expected to be marketed by Scientific-Atlanta, Inc., Atlanta, Ga., by this spring.

The new system is intended primarily for security purposes like sounding fire and theft alarms. It can carry up to 32 inputs from the customers' end of the line, as well as normal outbound TV signals. An alarm is sounded by the simple flick of a switch. Equipment at the control center then records (via a printer) the time of the alarm and the point of origination.

Computer probes secrets of human chomosomes

Using the same edge-enhancement technique that brought out details of the craters on Mars, scientists at the California Institute of Technology have greatly increased the sharpness of photographs of human chromosomes.

With the system, developed at the Pasadena, Calif., laboratory, an operator watches via closed-circuit television as a slide, prepared from a blood sample, is automatically scanned under a microscope. When a cell with a suitably clear group of chromosomes is found, the focus of the microscope is enlarged and the chromosomes are photographed. The picture is transferred to the computer which sharpens the edges of the image. This takes about three minutes.

The chromosomes, which contain the genetic factors that determine all forms of life, are automatically paired by the computer and arranged in seven groups.

WEMA asks for a halt to trade-bill restrictions

The Western Electronic Manufacturers Association (WEMA) is urging Senate action against restrictive features in the proposed trade legislation now before Congress. Eben S. Tisdale, government-affairs manager for WEMA, has written to senators in the 13 western states, asking them to use their influence to separate trade provisions from the legislative package reported by the Senate finance committee and then to vote against those provisions.

The 648 member companies of WEMA do face competition from foreign manufacturers because of lower labor costs overseas, Tisdale wrote, but most of them have been able to maintain a technological lead over their foreign competitors.

WEMA firms fear retaliation from abroad if the import quotas and other protective features of the trade act became one law. "Our companies would be particularly vulnerable to retaliation," Tisdale noted, "because other countries would logically move to protect their own growing industries as they strive to catch up with our technology."

Furthermore, he observed protectionism abroad could force member companies to transfer more manufacturing to overseas locations to maintain their competitive market position.

"At a time when cutbacks in federal spending and the softness in the economy are already causing unemployment problems in the high technology industry in the West, we believe the Senate should be looking for ways to increase our participation in international markets, rather than passing legislation that would restrict it."

Tisdale emphasized that WEMA believes the answer lies in stimulation of U. S. exports, aggressive trade negotiations to knock down import barriers of other countries, and adjustment allowances for disadvantaged U. S. workers and industries.

Global weather net gets high-speed push

The United States has taken a big step toward improving world weather-data communications by tripling transmission speed. A new link between weather computers in Washington and Tokyo transmits data from observations at the earth's surface and from the upper atmosphere at the rate of 3000 five-character words per minute. The best previous speed was 1050 words per minute sent between Washington via undersea cable to London, Paris and Offenbach, Germany.

Transmissions between Washington and Tokyo are carried by an American Telephone and Telegraph microwave link from Washington to San Francisco and an RCA Global Communications undersea cable between the California city and Japan.

During the next five years, the global program calls for high-speed links to connect the three major world weather centers—Washington, Warsaw, and Melbourne.

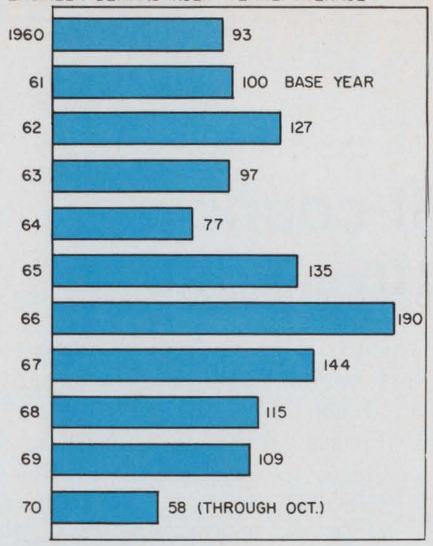
Demand for engineers reported at a low

The demand for engineers in 1970 was at a record low, according to Deutsch, Shea & Evans, Inc., technical manpower specialists in New York City.

Based on a demand index covering classified job ads in 41 publications in 20 major markets, the agency reported an index figure of 40.6 in October, using 1961 as a base for 100% demand.

In 1964, however, while defense firms were cutting back in manpower, many non-defense firms were staffing, something which is not occurring now, according to the Deutsch, Shea and Evans survey (see chart above).

ENGINEER DEMAND INDEX—YEARLY AVERAGE



Space rescue programs are in planning stage

The U. S.-Russian agreement to cooperate in rescue missions in space (see "U. S.-Soviet space docking?", News Scope, ED. 22, Oct. 25, 1970, p. 29), has already produced an exchange of technical materials on the following: radio guidance and rendezvous systems; the composition and characteristics of spacecraft atmospheres; and systems for voice communications. The responsible agencies are the National Aeronautics and Space Administration in the U. S. and the Academy of Sciences of the Soviet Union.

Present plans call for each agency to send the other a draft of technical requirements this month or next. In March or April the two groups are to meet and come up with common goals. After this each side will work out independently its own preliminary systems designs. Representatives from both sides will then study these designs to determine whether compatibility has been retained.

Areas being discussed include: the location and characteristics of passive reflectors for radio guidance systems and for an optical guidance system; the type and configuration of a radio guidance system using active radio signal transmission; lighting equipment for rendezvous and docking, and its elements, relative location and characteristics; a standardized voice and code communication system for use between spacecraft; constraints on the location of thrusters, solar batteries and other design elements that are important for docking.

Mailgram service wins own computer center

Mailgrams, which are part letter and part telegram—are sent from city to city by Western Union's network of land lines and delivered by the Postal Dept. They have proved so successful that Western Union has provided the system with its own computer center.

Using three Univac 418-11 central processors, the system reads zip codes on incoming messages, switches them to the right circuit for transmission, stores the messages on tape and bills the customer. It can handle 20,000 messages a day.

When mailgram began its market test in January, 1970, in 12 cities, a total of 35 messages were filed the first week. During the week ending Dec. 11, approximately 19,000 Mailgrams were transmitted.

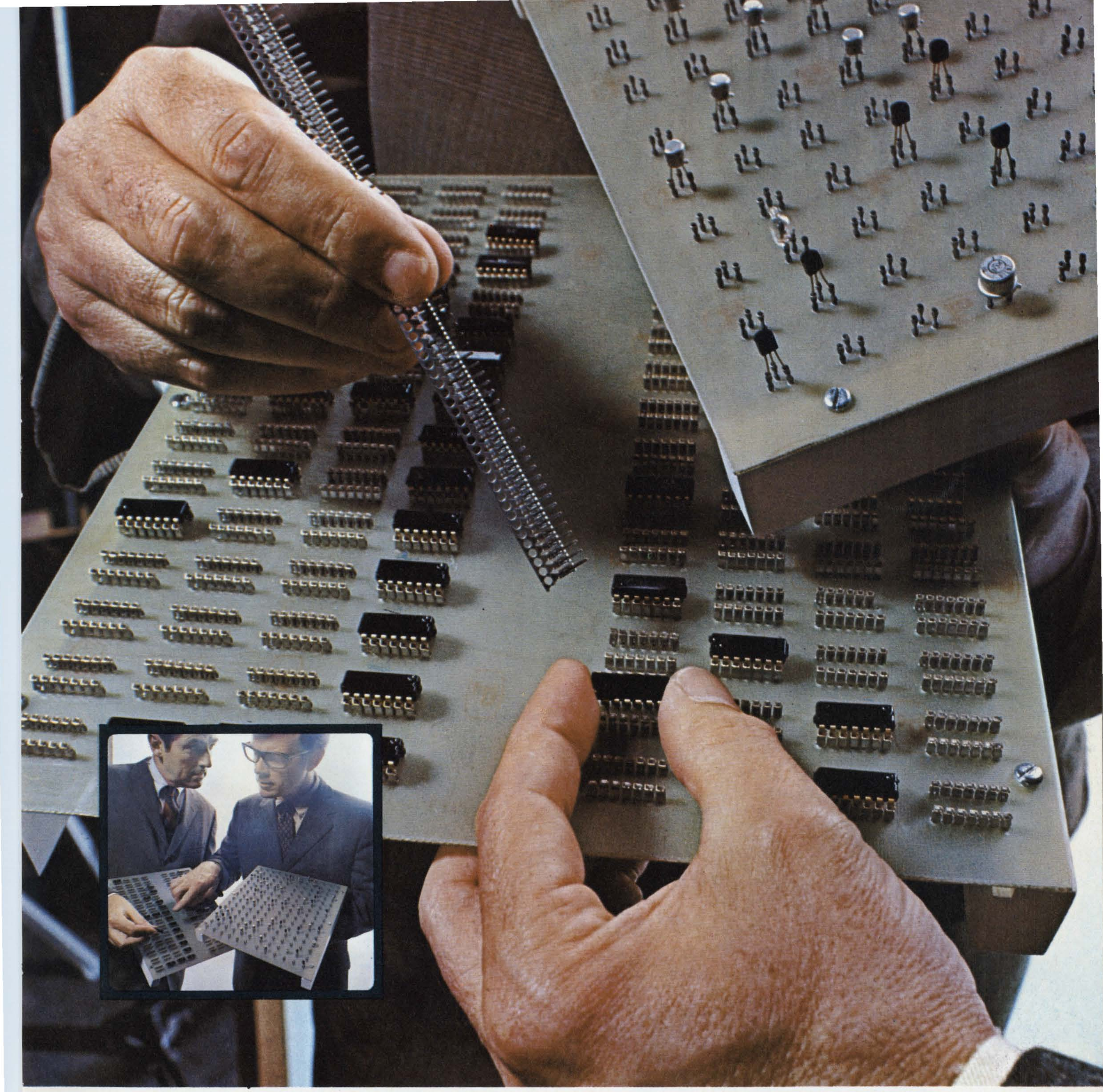
At present, Mailgram customers are restricted to business firms who must type their messages and send them to the computer center via a teleprinter. This summer, the general public will be invited to use the service; cost of a 50 word mailgram is $1.10.

Automated input to the network will be started on a development basis in the first quarter of this year. This will allow customers to send thousands of messages at one time by providing their zip-coded mailing lists on computer-ready magnetic tape.

"The present slump goes far beyond any previous decline in demand during the past two decades," a spokesman for Deutsch, Shea & Evans says. "And," he adds, "it is too early to predict that the drop in demand for bottoming out, since further cutbacks in technical staff continue to be announced."

On a comparative basis, the low figure during the previous slump year, 1964, was 76, with the high occurring in 1966.

In anticipation of the expected growth, Western Union plans to install another computer center a Middletown, Va. for Mailgram.



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A billion-dollar decline in sales estimated for electronics in '70

If you had a sinking feeling all last year that the electronics business was worse than everyone thought, you were right. For the first time in the history of the industry, annual sales are expected to show a drop instead of a rise.

Reliable sources say that when the tally for 1970 is complete, figures of the Electronics Industries Association will show sales down a full billion from the $25.7-billion in 1969.

At the start of 1970, EIA, taking into account an anticipated squeeze in the national economy, had predicted electronic sales would rise a modest 1.4%. But the sharp downturn in the general economy, with aerospace and defense industries especially hard hit, has shattered this cautious optimism.

The only bright spot for electronics in 1970 was the industrial segment of the market. Its estimated sales are up $400-million.

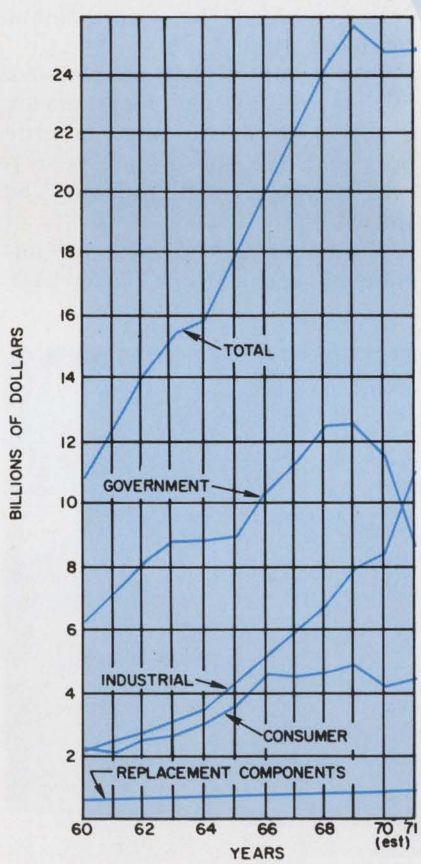
This year? EIA is looking for a partial rebound, the sources say. It expects a $100-million rise in sales. But that's $100-million above the 1970 figure — still $900-million below the total for 1969.

EIA is reported to be very reluctant to make any public predictions on how the electronics industry will fare this year. As of now, there are too many imponderables: the war in Vietnam, the Mideast crisis and the health of the national economy, which shows strong signs of recuperating. Given a robust economy this year, the electronics business could take off in a steep climb again.

John F. Mason
News Editor

Here's how the picture looks at this time, ELECTRONIC DESIGN's sources say:

- **Industrial market:** Last year's sales moved up from 1969's $7.9-billion to an estimated $8.3-billion. Predicted for 1971: $10.9-billion.
- **Government market:** The industry's mainstay dropped from $12.3-billion in sales in 1969 to an estimated $11.5-billion in 1970. The outlook for 1971 is a painful $8.7-billion.
- **Consumer market:** Fighting inflation, unemployed "customers" and foreign competition, this market dropped from $4.8-billion in sales in 1969 to an estimated $4.2-billion last year. It's expected to inch up to $4.4-billion in 1971.
- **Components market:** Estimated sales stayed level in 1970, matching the $700-million recorded in 1969. They should move up to $800-million this year.



The only bright spot in the sales picture for 1971 is industrial electronics —up $2.5-billion.

Vigorous industrial prospects

"Industrial electronics is growing because the buyer can see an immediate return for his money," says Frank Jaumot, director of research and engineering for Delco Radio, Kokomo, Ind.

One industry official sees the whole communications market as important, especially the new common carriers that plan to build microwave networks across the country.

Other promising industrial areas include mobile radios for the police and other security agencies; cable television—not only for home TV but for security systems; computer peripherals and communications terminals, especially if the Picturephone begins to move.

Another authority sees good business in point-of-sale data-processing systems for retail stores and credit-card validation systems for direct-charge sales. Law-enforcement equipment is a big potential—but one specialist says it's hard for newcomers to move into this area because the big computer companies have the market sewed up. Security systems for industry and homes, however, are a wide-open market.

The customer that really has gone sour for the electronics industry is the Government. And forecasting defense spending this year and next is particularly tricky. Public pressure is on Congress and the Pentagon to cut spending drastically. Some officials, however, predict the pendulum might swing back. Much depends on the international political scene—the Mideast, the SALT disarmament talks with the Soviet Union and comparable factors.

In a report to Congress last October, Rep. George H. Mahon, (D. Tex.), chairman of the House Committee on Appropriations, said: "Unless there is substantial progress in the current Strategic Arms Limitation Talks or some other arms limitation agreement, we may be required to begin another large step forward to buttress our strategic military strength."

With no agreement and no increase in appropriations for strategic weapons, the U. S. will "be strategically outgunned," Mahon said.

One industry official who believes that the Administration and Congress are increasingly aware of the need not to be "outgunned" is I. K. Kessler, executive vice president of RCA's Government and Commercial Systems Div. in Moorestown, N. J. Kessler told ELECTRONIC DESIGN: "There's a growing realization in Washington that it's possible to satisfy our civil needs and also maintain our military strength."

But just when appropriations for strategic weapons could be requested poses a problem. The budget request for fiscal 1972 is already completed; it will be read to Congress later this month. And with the SALT talks in progress, it's not likely that it contains a big request for strategic weapons.

One possibility, Kessler points out, is a supplemental request for strategic weapons if the need becomes glaring and the climate in Washington changes later this year.

But the first half of 1971 has got to be bleak, as far as new programs are concerned. The Defense Dept.'s Controller General, Robert C. Moot, says that the annual rate of contract awards in fiscal 1971 is down 45% from 1969's peak, and only 19% of this drop has been experienced so far. So the real drought begins now and lasts at least through June.

"But I think there will be a minor upswing in fiscal 1972," Kessler says.

Space spending stays level

The National Aeronautics and Space Administration finally got its fiscal 1971 budget approved last month ($3,268,000,000), and some officials predict it will probably get about the same amount for fiscal 1972.

Two Apollo flights are planned, Skylab will fly and more money is expected for the space shuttle program. The space station project, however, will probably be slowed.

A number of contracts for unmanned space work have been awarded and are under way with fiscal 1971 money. This work will continue into the second half of 1971 with new funds.

Approximately $15-million has been earmarked for Applications Technology Satellites F and G for the first six months of this year: $30-million for Earth Resources Technological Satellites before July, and an equal amount to start off the second half of the year; $15-million for the Nimbus weather satellite before July, and more after that; $10-million for a Synchronous Meteorological Satellite before July, and more after that; $34-million for Pioneer F and G and about the same in fiscal '72; $35-million in the first half of 1971 and several times that amount after then for Viking, the craft that is to orbit and land on Mars; $23-million before July for the Orbiting Astronomical Satellite, and the same sum in fiscal '72; $14-million for the Orbiting Solar Observatory before July and about the same in the next fiscal year.

The two programs NASA would like to get started after July are the High Energy Astronomical Observatory and the Grand Tour unmanned planetary fly-by.

Industrial electronics is the only bright spot this year. Why? "The buyer can see an immediate return on his money," one official says. Here, GE's Mark 7500 computer is driving a LeBlond machine tool.

Consumer industry hopeful

In the consumer market, I. L. Griffin, vice president and general manager of the Television Business Div. of General Electric, Hampton, Va., says this of television sales: "The chances are about 2 to 1 that the first half of 1971 will surpass the first half of 1970. We anticipate an increase in the neighborhood of 12%. For the year, the industry will be up about 15%, with nearly 6.25-million color and 6.4-million monochrome receivers being sold.

"Current trends in screen sizes in 1971 will continue with the 25-inch emerging as the mainstay of the color console business, while the 23-inch receiver will drop to the price-leader category. We anticipate a continued swing to the 18-inch and 19-inch screen sizes.

"We forecast that nearly 70 million new television sets will be sold in the U. S. during the coming five years.

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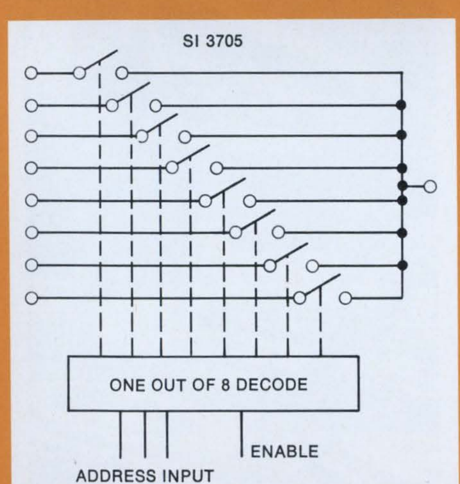

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"The increased incidence of solid-state and electronic tuning will continue to be evolutionary rather than revolutionary. Cost crossover on solid-state is still anticipated in 1972."

Component makers restrained

In the components market, the outlook for semiconductor sales is largely gloomy. Frank Jaumot, director of research and engineering for Delco Radio, Kokomo, Ind., says, for example: "I don't see how there can possibly be an upturn in 1971. Our sales to the industrial market are up, but not enough to offset the decline in consumer and military sales."

Leroy Gray, marketing manager of the Electronics Div. of Burndy Corp., Norwalk, Conn., says he believes the components business has flattened out and won't drop further.

"The coming year will be just about the same as 1970," says Leslie W. Chapin, manager of micro-circuit operations for the Helipot Div. of Beckman Instruments, Buena Vista, Calif.

"Two of our military aerospace programs have slowed down, due to funding, and we don't know when that will straighten out. The only upturn we see is in industrial applications—computer peripherals for one," Chapin continues.

On a more pessimistic note, he says: "I don't know what the stimulus for an upturn would be. There is inflation. People are tightening their belts, and they're no longer buying on an annual basis. They buy for 30-day periods.

"The only bright spot is that we're getting more inquiries than we did last quarter. They're up 25%, and this could be the prelude to more sales."

Business should pick up for semiconductor makers in the second half of this year, according to Jack E. Halter, vice president of products and marketing for Signetics, Inc., Sunnyvale, Calif. "Semiconductor IC inventories should be depleted by then," he explains. "Sales will go to the more significant and useful types of devices, though—such as digital MSI and MOS devices."

Harvey Miller, senior staff scientist for Quantum Science Corp., market researchers with offices in Palo Alto, Calif., and New York City, predicts that U. S. production of components will amount to $10.9-billion in 1971. This includes both "captive" production—components produced by one division of a corporation for use by another—and "outside" markets.

Stable computer sales expected

As for computers, James A. Stone, vice president of the Planning Div. for Quantum Science Corp., says:

"Computer sales for 1971 will stay at about the same level as 1969's—from $5-billion to $5.2-billion. The principal sales will be in the medium-size machine—those that rent for between $25,000 and $100,000 a month.

"Minicomputers will increase about 40% in 1971 over 1970, hitting $315-million.

"An important event in 1971 will be the deliveries of the first IBM 370 machines. If they work well, this will mean more orders for IBM. If there are problems—and I don't think there will be—it could, of course, mean strength to the independent producers."

Consumer sales are down $600-million in 1970 but are expected to rise $200-million in 1971.

The major technological computer advance in 1971 will be increased use of IC memories, says Robert Colten, vice president of Samson Science Corp. in New York, a subsidiary of Quantum Science. "IC memories will be used for 10^7 to 10^9 bit memory machines," he says. "After that, plated wire will be used."

Stone comments on the hardware end of the business: "One of the biggest challenges to the hardware designer is to devise equipment to handle memory management, as seen by the cache buffer. The IBM central processor is so much faster than the core memory that a cache buffer had to be built. Equipment design will be modular to enable equipment updating with a minimum of operational interruption."

Instrument market is changing

Robert L. Boniface, vice president of marketing for Hewlett-Packard, Palo Alto, Calif. says:

"Current instrument markets are changing rapidly. At one end of the price spectrum we are finding interest in complex, automated instrument systems that include computational and control capabilities. On the other end, customers are asking for low-cost, basic bench instruments with vastly improved performance.

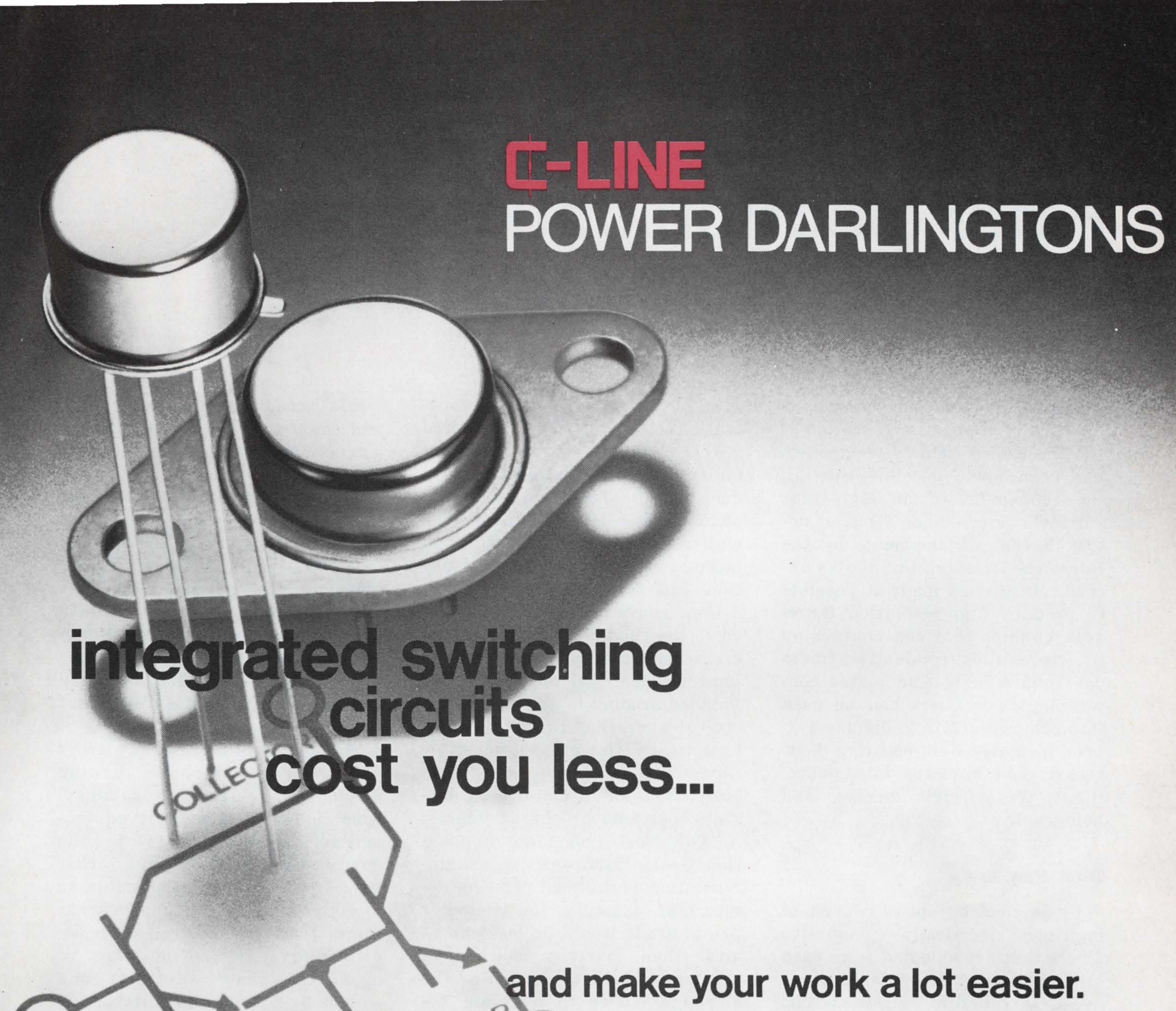
"We expect domestic business to remain relatively flat during most of 1971. International markets, however, are expected to continue to grow, but at a somewhat slower pace than during the past few years."

Ted Brandt, director of marketing for Monsanto Instruments, West Caldwell, N. J., says:

"We're not sure what the market for instruments will be in 1971, but we're planning to go out and be active. We're hiring salesmen, and we're setting our sales goal at 25% above this year's.

"Lower-cost instruments—under $500—are coming out, and some new kind of marketing techniques will be needed."

Quantum Science predicts that sales of instruments for testing and analysis in nuclear and biomedical work and for industrial production and laboratory needs will reach $1.6-billion this year.■■



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Fiber electron optics: New uses for an old technology

A wealth of exotic, as well as practical, applications, throughout the entire field of electronics has been made possible through the refinement of an eight-year old technology—fiber electron optics. Recent developments by the Burrowes Research Co., West Concord, Mass., has made it possible to produce high-resolution large-area bundles that can contain up to five million conductive fibers per square inch. And plates containing these fibers can be used in discharge printing, display systems including light-emitting diode arrays, LSI circuitry interconnections, piezoelectric arrays and holography.

What they are

Fiber electron optics consist of multiple electrically conductive fibers that are shielded from each other and from the outside world by a surrounding glass matrix. Burrowes has developed a conductive glass-metal mixture that allows fibers to be drawn down to diameters of only a few microns with controlled resistance.

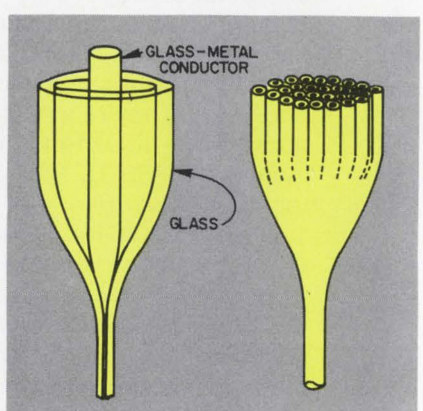
Explaining the manufacturing process, president Curt Burrowes said, "Metals and oxides are held in solution in a glass material during drying. We then precipitate out the conductive portion of the material. The result is an extremely fine fiber that can be drawn and redrawn without sacrificing shielding integrity."

Individual fibers start out as glass-coated wires whose size does not present handling problems. These "large" fibers are then stacked and redrawn into a bundle of very fine fibers—one-tenth the size of the glass-coated wires. Bundles can be restacked and redrawn so that final arrays can contain from several thousand to five million fibers. The end result is a high-resolution large-area array with low distortion and full shielding.

Lucinda Mattera
New Products Editor

Conductive caps are then bonded to the ends of each fiber to increase effective fiber area and to improve electrical efficiency. The finished product is a fiber electron optical plate that can be polished to optically flat or spherical surfaces. This plate can be used to store, transfer or amplify electrostatic patterns or charge images.

"The most immediate application," said Burrowes, "is a high-resolution high-speed printing device, for example, for computer printouts. It would be less expensive than current mechanical printers—about one-tenth the size and easier to maintain because there are no massive moving parts. The printout paper would accept an electron charge and could then be developed with a toner process, like the one used in Xerox machines."



Fiber electron optics begin as glass-coated wires (left) that are stacked and drawn into multifiber bundles (right). A new glass-metal conductor makes possible these large-area high-resolution arrays.

For display applications, the array could be used to address small portions of an active thin film like an electroluminescent phosphor. The bundles could also be used in conjunction with a CRT display. If a phosphor is put on the back of the plate, electrons would excite the phosphor and charge could be stored for a brief time.

"If the plate were transparent with fine conductors running through it," Burrowes explained, "one could get something equivalent to a light pen. However, the device would detect charge rather than light. It is even possible to directly readout the charge that comes from the electron beam by displaying it on the phosphor, in much the same way that one would look with an interactive light-pen display."

Addressing LSI circuits

Large-scale integrated circuitry loses a great deal of its power, according to Burrowes, because it is lead-limited. He pointed out that ICs may contain as many as 100,000 active elements, but frequently have only 50 to 60 input/output leads. A fiber electron optical plate could contain as many leads or more than the number of active elements so that it could be used to directly address an LSI circuit.

"For example," Burrowes added, "if light-emitting diodes were inexpensive enough, you could build a display containing 100,000 LEDs. These could be controlled directly by an LSI circuit that is addressed with one of our plates.

You would then have display control circuitry that is no larger than the LED array itself. System volume could probably be reduced by a factor of one hundred compared to conventional connection techniques."

Holography fits the picture, too

Fiber electron optical plates can also be used to form quasi phase holograms. One way, Burrowes said, is to induce relatively small distortions in a piezoelectric plate that is scanned with an electron beam via their fiber plate. The result would be a phase hologram showing either laser deflection or a laser display. However, there would be a good deal less information in this hologram than is contained in the typical optical hologram.

Burrowes pointed out, "There are many appliccations where you do not want a vast number of points. Since our plate can be addressed by the laser itself, the resulting image is the optical transform of the hologram that is induced on the material supplying the displacement. A defective point in the quasi hologram shows up directly in the display. On the other hand, a defective point in an optical hologram would just degrade the contrast of the display slightly since all information is contained in any one portion of the hologram. The real advantage here, I think, would be an image analysis and image pattern recognition where one would rather work with the transform of the object rather than the object shape itself."

Control is simple

Control circuitry at the input end of a fiber-electron-optic bundle need not be complex. With respect to display systems, there are essentially three methods of addressing. One is with an electron beam, another is by optical scanning, and the third is to use a cross-grid array. The latter consists of conductors that connect individual columns and rows. By addressing the appropriate row and the appropriate column, you can address an individual element in the bundle. ■■

Use of LSI in consumer areas picks up, but problems remain

The age of medium and large-scale integration is at hand for a host of consumer products, including an alarm-clock radio with digital readout, electronic musical instruments, small calculators home appliances and wrist watches. But according to a survey by ELECTRONIC DESIGN a number of problems remain to be solved—namely cost and device testing.

Benefits of MSI or LSI over discrete components or small-scale ICs include generally improved performance and high reliability. While, at the present state of the art, costs are generally higher than for previous designs, mass production will ultimately lower them.

LSI makes debut in clock-radio

Details on the first application of LSI to an AM/FM clock radio with electronic digital readouts were disclosed by Bruce C. McIntosh of General Electric's Audio Electronics Operation, Utica, N. Y., at the recent National Electronics Conference in Chicago. In this radio, an LSI chip containing 822 MOS transistors operates the timing, and it controls the digital readout numerals in four 7-bar, blue-green fluorescent tubes like those used in computers and desk calculators.

Jim McDermott
East Coast Editor

The LSI-MOS circuitry performs the timekeeping electronically, in contrast to using a synchronous motor. The basic clock driving the timing circuits is the 60-Hz line voltage, which is also stepped down and regulated at 27 and 13 V dc to provide power for the LSI and other circuits.

One of the toughest problems that GE licked, said McIntosh, was that of both internally and externally generated noise. He also pointed out that the design job would have been a lot easier if the LSI package had 40 pins instead of being a standard 16-pin, dual-in-line, plastic unit. This could have simplified the external circuits and eliminated the need for strobing the display tubes.

This GE clock radio has an 822-transistor LSI chip. The time is displayed from 1:00 to 12:59 in one-minute steps, while the alarm is set in increments of 10 minutes.

Cost is the main drawback

The cost of the LSI chip is still relatively high, McIntosh said, calling for a list price of $100 for the radio. But high-volume production will reduce this considerably, he predicted.

Earl Gregory, vice president of marketing for Electronic Arrays, Inc., Mountainview, Calif., agrees.

"Today," he told ELECTRONIC DESIGN, "I think that the physical capacity is there but that the industry has some way to go in terms of producing a cost-effective product. As far as MOS/LSI for calculators is concerned, we're there, but for things like washing-machine timers and other consumer items, we haven't arrived."

Don Schare, product manager for custom circuits, at General Instrument, Hicksville, N. Y., is more optimistic.

"Four years ago," he said, "we started working on LSI timers for appliance manufacturers. These timers would replace the complex, mechanical cam-operated units found in washing machines. By the end of this year I feel that the market will be ready to take off."

Testing has special problems

Testing of some MSI/LSI consumer devices creates certain peculiar problems. Schare pointed out that one of their appliance timers has a 45-minute cycle, operating from the line as a basic clock. To test it under normal conditions would take three-quarters of an hour.

Whereas it is frequently impossible to test LSI with a fast enough clock rate, the reverse is true here.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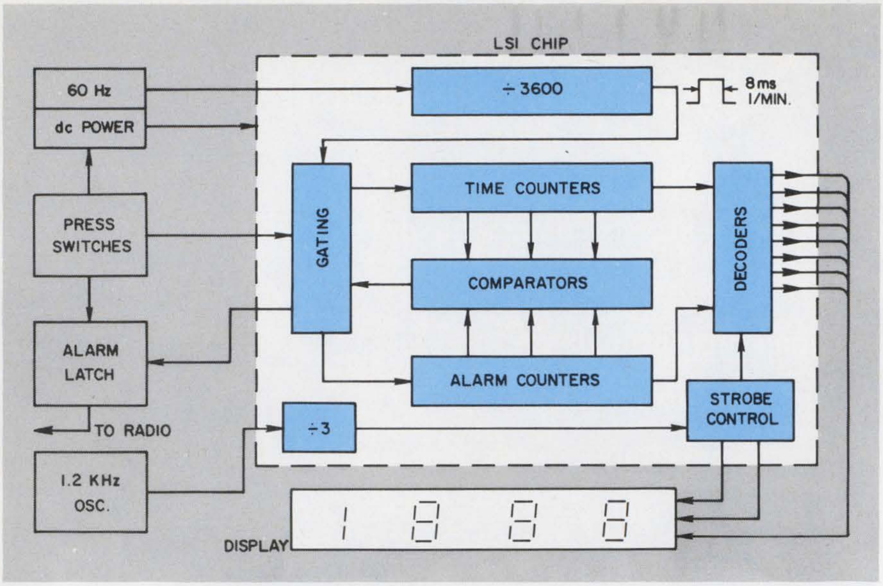

The LSI chip in the clock radio contains timekeeping and alarm circuits that drive the digital readouts. The timing system is controlled by the 60-Hz line. Either the time or alarm-time setting is displayed on command. The cost of the chip is high but will come down in volume production.

Sharp calculator is mechanized with four MOS/LSI chips and a clock generator. Each chip contains 900 MOS transistor equivalents.

This timer is tested using a 60-kHz to 100-kHz clock in order to reduce test time to a fraction of a second.

Agreement seems to be universal that the particular problems associated with LSI testing will tend to keep costs up.

Electronic Arrays' Earl Gregory says: "Testing is one of the biggest problems facing the industry today. For example, the automotive market can use millions of these circuits annually. But I think that the cost of testing is sufficiently high to keep LSI out of that market."

But Ralph Greenburg, manager of consumer applications for Motorola Semiconductor Products, Inc., Phoenix, Ariz., feels that the pressure of pollution-control and safety requirements will, nevertheless, force the adoption of complex under-the-hood electronics for cars.

The pollution requirements are getting so tight, he says, that the engine people are looking at electronics for more efficient operation of the motors and consequently less exhaust pollution.

"This means that you've got to monitor a number of quantities such as engine temperature, engine speed, vacuum, timing and other factors. These will be fed to fairly elaborate logic to tell the plug when to fire and to control the mixture. For this purpose, a small computer will have to be used," Greenburg notes.

"With stringent controls to be put into effect in California in 1974 and nationwide possibly in 1975, we are convinced that this will be a big market. And the same might be said of other safety features such as a maximum speed control and an antiskid system."

How about linear applications

Charles V. Kovac, vice president of marketing, North American Rockwell Microelectronics Co., Anaheim, Calif., doesn't see LSI going into linear applications in consumer products.

"The vast majority of MOS/LSI produced in 1970 went into electronic calculators," he says. "The MOS/LSI circuits operate as binary devices; hence they provide control and memory circuitry."

Earl Gregory disagrees. He sees no reason why linear functions can't be created in Large-Scale Integrated form.

Musical instruments are using more and more MSI and LSI for both tone generation and control. Don Schare points out that MOS/LSI is being used in a number of electronic organs for frequency division. These instruments use one oscillator for each tone of the chromatic scale and divide these down, using dividers with 20 or 30 stages on each chip. Other LSI chips are used for mixing harmonics and chords.

The Muse, by Triadex, Inc., Upper Newton Falls, Mass., (see page 36) uses MSI for its logic circuits. But the next generation will probably have all of its circuitry on one LSI chip, according to Robert Phillips, chief engineer. And North American Rockwell is producing a microelectronic control system for selection of stops on church and institutional organs (see page 38).

LSI in wrist watches

That LSI is firmly established in the electronic wrist-watch business was signaled by the recent announcement of Electro/Data, Inc., Garland, Tex., that it placed an order for over $1-million with RCA for chips. These chips will go into the electronic circuitry of the Hamilton all-electronic watch. (See ED 11, May 24, 1970, page 30.) According to George Thiess, president of Electro/Data, some of the chips have 350 transistor elements on them. Discrete transistors are also used.

He feels that eventually an all-electronic wrist watch will have but one chip with all the required elements on it. But as of today, the current drain for certain devices is too high for MOS transistors, so bipolars are still needed for that part of the circuitry. ■■

RCA TWTs...for ECM sleight of hand

You see it, but where? That's the protection of electronic countermeasures. And high gain over octave bandwidths at microwave frequencies makes RCA traveling-wave tubes key components for ECM systems.

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Along with customized TWTs for RF memory subsystems, there's a wide range of standard product for both ground-based and satellite microwave radio communications systems, too.

RCA has been deeply involved in every chapter of TWT development and has participated in most major ECM systems. Tubes cover the frequency bands from L through Ku, and offer diverse combinations of power, gain, size and weight. Check the chart for a few of them.

For more information on these and other RCA TWTs, see your local RCA Representative. For technical data, write: RCA, Commercial Engineering, Section 57A-7/ZM9, Harrison, N.J. 07029. International: RCA, 2-4 rue du Lièvre, 1227 Geneva, Switzerland, or P.O. Box 112, Hong Kong.

New ECM TWTs			
A1378	7-11 GHz	10 watts	40 dB gain
A1397	5-10 GHz	4 watts	43 dB gain
A1428	7-11 GHz	2 watts	40 dB gain
A1429	4 - 8 GHz	2 watts	40 dB gain
Customized RF Memory Subsystems			
New TWT Amplifiers with Integral Power Supplies			
J2053	7.5-12 GHz	200 mW	40 dB gain
J2055	4 - 8 GHz	100 mW	40 dB gain
Communications TWTs			
A1378	7.9 - 8.4 GHz	20 watts	46 dB gain
A1390	10.7 - 11.7 GHz	20 watts	40 dB gain
A1427	7.9 - 8.4 GHz	5 watts	50 dB gain

RCA

For today's young Beethoven: A computer that composes

There are computers for guiding missiles, computers for keeping books, computers for making airline reservations . . . and now—a consumer computer for making electronic music.

Over 14 trillion different melodies or tonal patterns can be programmed with the front-panel slide switches of the new musical computer, called the Muse.

Designed for the young musician or student who wants to create, the Muse produces tones of the diatonic major scale: C, D, E, F, G, A, B, C, etc., with no sharps or flats. The model currently in production has a total range of six octaves, compared with seven in a piano, but only two octaves can be used in any one setting.

Will such a contraption sell in today's competitive electronics market? According to Alvin R. Mulica, vice president of Triadex, Inc., Upper Newton Falls, Mass., producer of the instrument, the company already has $1-million in advance sales. The list price is $300.

Jim McDermott
East Coast Editor

A total of 29 integrated-circuit TTL logic elements gives the Muse all the features of a regular computer, says Triadex's chief engineer, Robert Phillips. This includes flip-flops, gates, a hexidecimal counter ($\times 16$), and a 31-bit serial register. The loudspeaker is driven by the output of one of the logic elements, providing 0.5 W maximum output power.

Switches control music functions

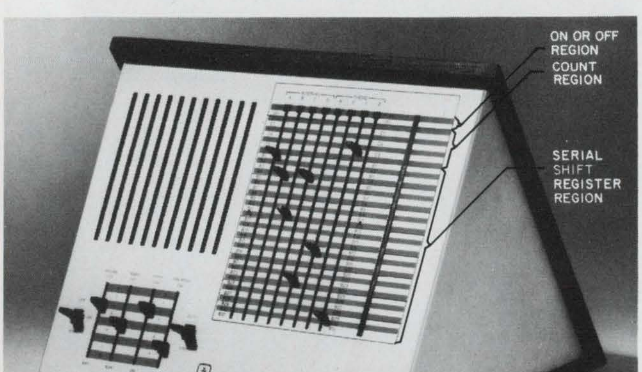
Four short slide switches underneath the speaker control the volume, tempo, pitch and fine pitch. Eight long slide switches to the right of the speaker control the interval, or notes, to be played, as well as the theme, or sequence, in which the notes are heard.

Leaving the interval and theme slides in their upper regions produces simple music with a pronounced beat. Moving the slides down into the shift-register section gives more complex tonal patterns.

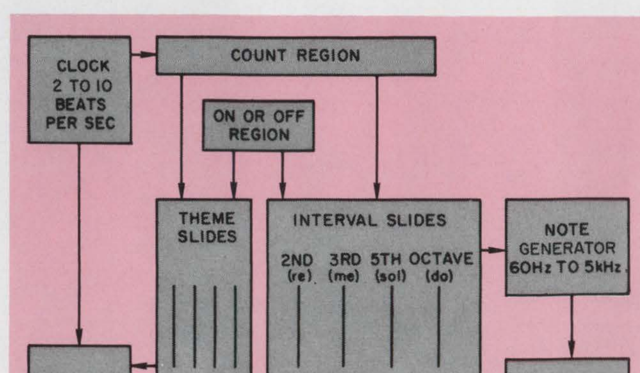
The tones from the loudspeaker are the result of logical ONES and ZEROES gating the tone generator. The tone generator has a hexidecimal counter that is capable of generating 256 tones, but since only eight of these are related to the musical scale, the rest are suppressed. In operation, the basic range of tone generation is from 30 kHz to 1 MHz, but it is counted down by the operation of repeated subtraction in the hexidecimal counter to give the basic output range of 60 Hz to 5 kHz.

To develop new and unique patterns, the shift register is loaded by some combination of ONES and ZEROES, supplied by the decision gate in response to inputs from both the clock and the theme slides. The slides are set at arbitrary positions of the shift register.

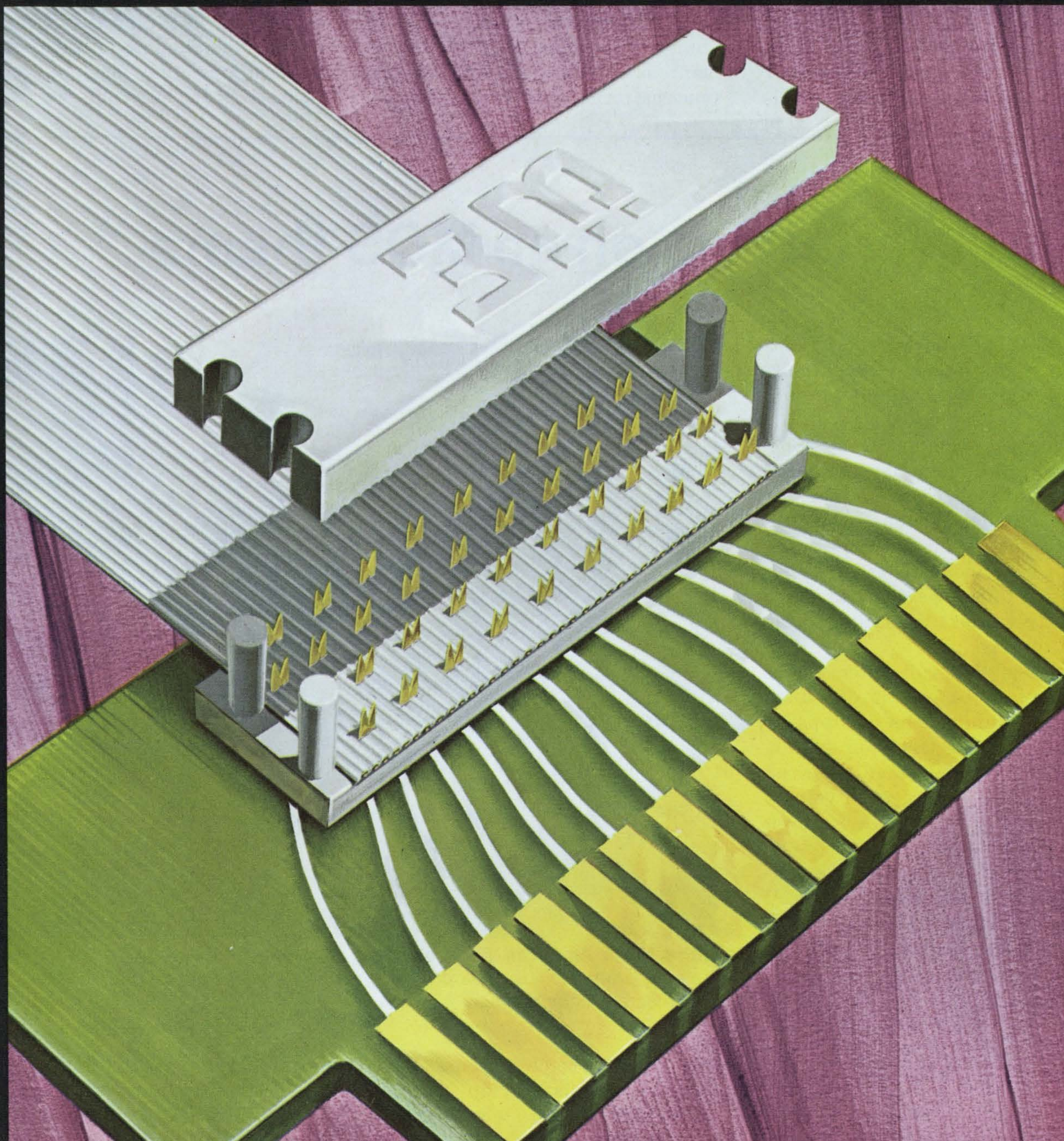
Each of the 31-bit positions in the register has both a ONE and ZERO to which the selector may be set. The theme slides pick off outputs and recirculate them back through the decision gate and again into the register, so that a specific



The Muse, a new electronic musical computer, creates unique tonal patterns and melodies. It is essentially a melody synthesizer that uses a computer clock, logic and storage elements.



Musical decisions are made by the Muse when a composer manipulates the slide positions, thereby creating complex logic patterns. These decisions control the variations of a melody.



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group of notes is repeated after an interval.

Because there are eight slides and 40 possible positions of each, there are 40^8 possible tone patterns, or more than 14 trillion.

Two or more Muses can be linked together by using one as a master clock to control the others. In this manner, two, three or even four-part harmony can be produced.

The Muse creates one note at a time, and is not a synthesizer in the conventional sense of being able to add or subtract harmonics to or from a basic tone. But the instrument is capable of synthesizing tone patterns that are dependent of logic decisions derived from the positions of the interval and the theme slide switches.

While some of the music produced is rather simple, other patterns can be intricate. For example, it is possible to create some compositions that do not repeat themselves for 30 years. ■■

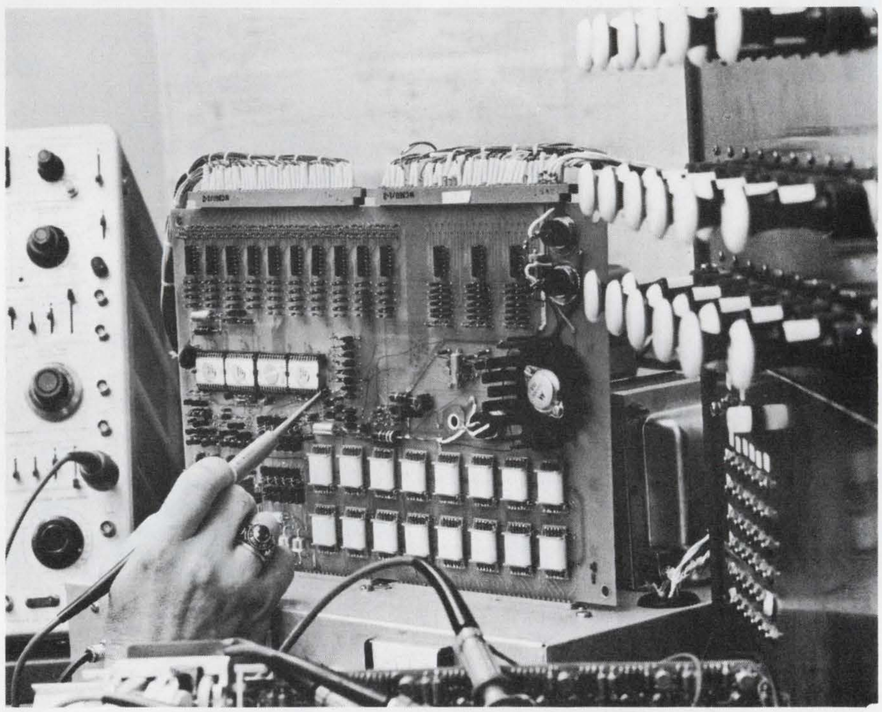
Organ variations on an MOS theme

An MOS/LSI package is giving concert organists a richer selection of tone colors—and making it easier to play the organ, too.

In playing complex selections, organists are sometimes limited by the time required to depress a large number of stops—the keys that produce such tones as flute, oboe or saxaphone. There are only so many stops a person can press manually without interrupting the music unduly.

Electro-mechanical systems have been devised to permit organists to select combinations of stops by depressing a single piston switch. But these systems have required a box some 36 cubic feet in volume and current of 40 to 50 A for even moderate-sized organs.

The MOS/LSI package—designed by North American Rockwell Microelectronics, Anaheim, Calif., for the Allen Organ Co. of Macungie, Pa.—is 1/100th the size of electro-mechanical units, and it draws only about 150 mA.



Entire North American Rockwell organ stop-selection system is contained on a single printed circuit board. The system contains four MOS/LSI arrays and 550 discrete components.

34 musical combinations

According to Milton Nelson, chief engineer for Allen Organ, it allows the organist to set 34 piston switches for different combinations of stops. Twenty-four of the switches can each be set for from one to 20 stops. And 10 of the switches will give combinations of from one to 80 stops.

Thus it's theoretically possible for the organist to hit one switch and get the tones from 80 stops of the organ. Imagine trying to do this manually on some of the larger concert organs!

Three HEX 80-bit shift registers in the electronic package remember the stop combinations. Each MOS shift-register chip contains six 80-bit shift registers. The chip also contains a two-phase clock generator and a two-to-four-phase clock converter. Over 1500 MOSFETs are contained in a die 0.153 by 0.134 inch to mechanize 158 distinct logic functions and 480 bits of shift-register memory.

A control MOS chip provides reference timing circuitry for the entire system, including the shift-register chips. It also controls some modes of operation and has decoding with multiplexing to select the appropriate shift register. The control circuit contains 10-bit parallel/serial and 10-bit serial/parallel converters, three polynomial counters and two binary counters. Over 1000 MOSFETs are employed in mechanizing 330 logic functions on a die 0.168 by 0.169 inch.

These four MOS/LSI chips are of the p-channel, high-threshold variety and make up the bulk of the electronics in the system.

According to Ralph Deutsch, program manager at North American Rockwell Microelectronics, "The MOS/LSI stop-selection system can also be used in such applications as the control of stage and theater lighting and automatic valve monitoring and control in various industries." ■■

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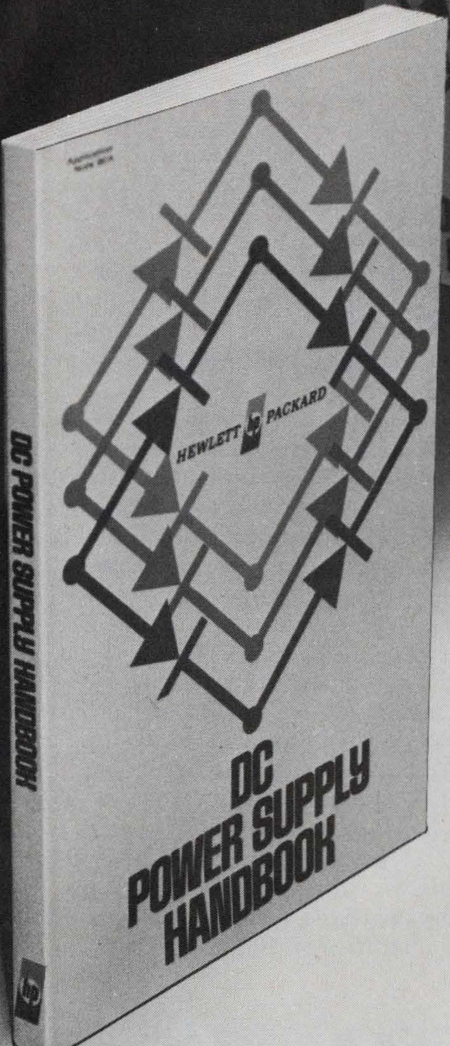

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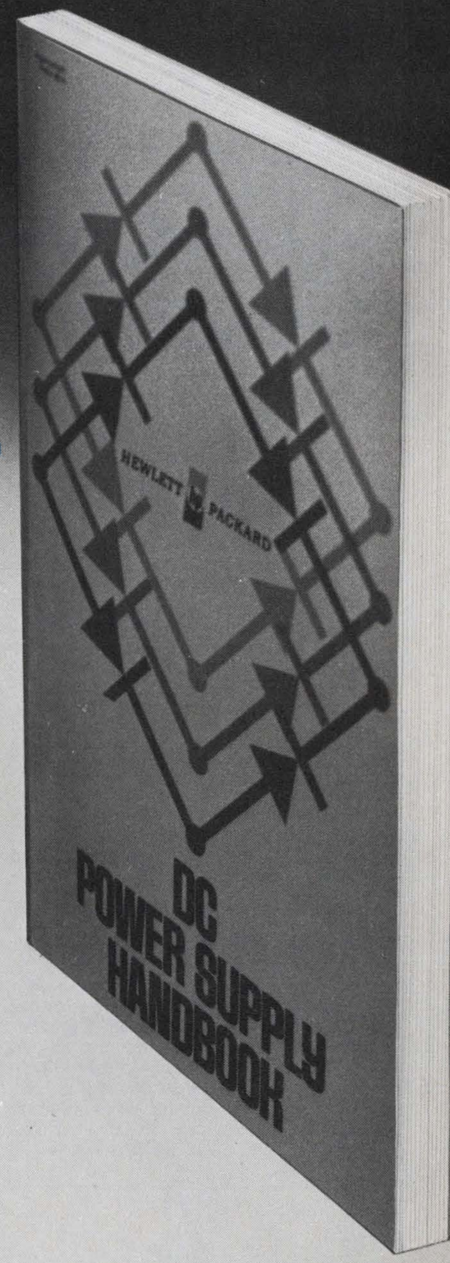

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INFORMATION RETRIEVAL NUMBER 320

Those aren't movie reels—they're 35-mm rolls of ICs

Rolls of 35-mm film are replacing metal lead frames in a new IC packaging concept introduced by General Electric's Integrated Circuit Products Dept., Syracuse, N. Y. The package, called miniMod, uses a copper-laminated, plastic film strip, similar to movie film, for mounting ICs. These indexed strips are assembled and sold on reels, which makes them well suited for high-volume, automatic handling, assembling and testing.

The miniMod package is formed by attaching a monolithic silicon IC chip to a lead frame that is part of a film strip. The chip is then encapsulated in epoxy to complete the package.

It comes in continuous lengths

The strip, made of polyimide plastic that is inherently flat and withstands 300°C temperatures, comes in continuous lengths and is perforated with indexing holes for mechanized processing and testing. Other holes are made in the strip to later accept the IC chip and to provide access to the copper leads for attachment to the user's substrate. To this perforated strip is laminated a 1.4-mil-thick copper ribbon. Photolithography is used to etch a lead frame into the copper ribbon at each index point of the film strip. The lead frames are then tinned in preparation for chip attachment.

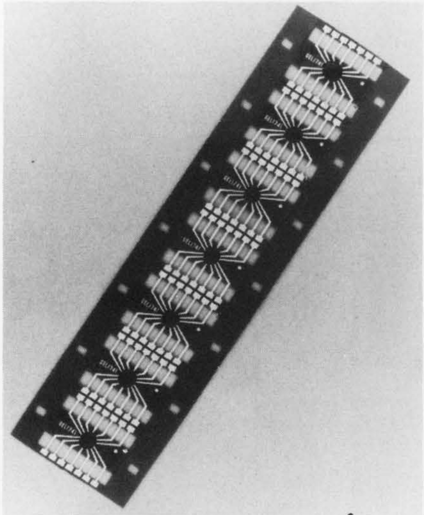
Each copper lead is etched down to a 4-mill-wide finger at the point at which it is to be bonded to a gold bump on the chip. The finger is cantilevered over the hole that receives the silicon chip. Away from the chip, the copper leads are widened to become the package leads.

The chips to be mounted on this lead frame are standard silicon IC chips that have been processed for solder-bump bonding. A glass overcoat is deposited over the entire circuit except for the bonding-pad areas. Gold bumps are plated into the exposed bonding areas. To assemble the chip to the lead frame, it is simply aligned under the cantilevered fingers, and a gang bonding tool applies heat and pressure to all fingers simultaneously thus forming a gold-tin eutectic bond capable of withstanding temperatures in excess of 280°C.

After bonding, the chip and interconnection system are surrounded with an epoxy to enhance thermal conductivity and to protect the chip from mechanical damage.

The first products available using this packaging technique are the GEL-1741 op amp and the PA-1494 threshold detector. The 1741 is GE's version of the internally compensated 741 op amp in a dual-in-line package. According to D. J. Harrington, the department's marketing manager, other products will be announced on a monthly basis.

List prices of the 1741 are competitive with other 741 op amps. The suggested price is $2.25 each, in quantities of 100 to 999. ■■



Silicon IC chips are attached to lead frames that are part of a plastic film strip in GE's new miniMod package. The chips are then encapsulated in a protective epoxy.

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GENERAL ELECTRIC

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- Temp. range . . —55C to 125C

Subminiature Tantalum Wet-slug Capacitor
In military and high-performance industrial miniature applications where an extremely small unit with highest volumetric efficiency is required.
- Voltage range . Up to 60 VDC
- uf range . . . . . 3.3 to 450 uf
- Temp. range . . —55C to 85C

technology abroad

Hybrid packaging systems from Ferranti's Aircraft Instruments Div., Bracknell, Berkshire, England, have reportedly obtained full NATO approval. The division began work on its Multilin hybrid microcircuits as a direct result of the T.SR 2 program. This advanced project, a rival concept to the F-111, was scrapped in a government economy move. Now Ferranti has in production some 20 NATO-approved hybrid microcircuits, including servo, power and misalignment amplifiers, ac/dc amplifiers, and bipolar amplifiers. The Multilin system uses ICs, transistors and diodes mounted on ceramic substrates; gold Nichrome resistor arrays; and ceramic chip capacitors. These assemblies are hermetically sealed in a Kovar package. Interconnection techniques are made by thermocompression bonding fine gold wire.

An IC technique to replace the traditional Rube Goldberg-like string-and-pulley drive for radio-receiver frequency indicators has been demonstrated for the West German subsidiary of Texas Instruments in Westphalia. The receiver's local oscillator frequency is sensed with a 100-kHz quartz oscillator, frequency dividers and some logic circuitry. The frequency then is displayed on a new monolithic numerical display illuminated with GaAs light-emitting diodes. Though relatively expensive, the system is said to be much more accurate than the traditional string-and-pulley—and costs could be reduced by utilizing large-scale integrated circuits.

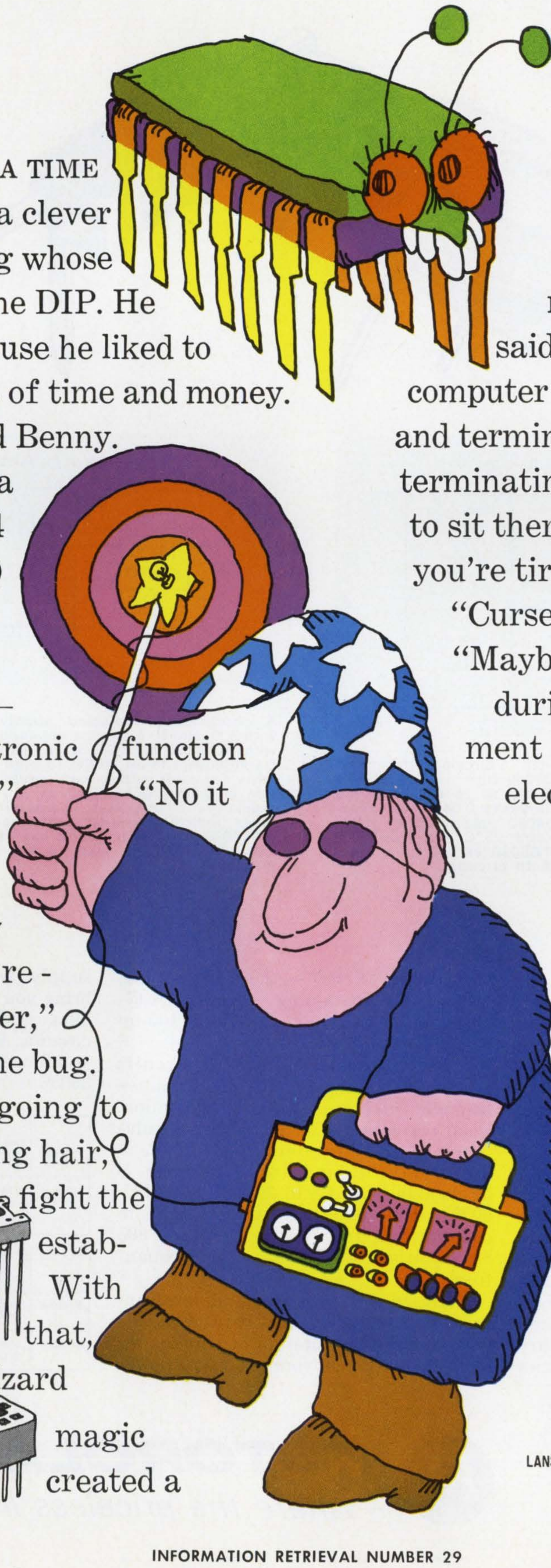
Large-screen data displays, high-speed microfilm printing, and optical mass storage with bit densities of 10^6 to 10^7 are just some of the applications for a digital laser beam deflector that has been developed by Philips Forschunglaboratorium, Hamburg, Germany. An alternating series of 16 Kerr cell polarization switches and 16 calcite prisms is used to deflect the beam. The beam can thus be randomly switched to any position in a 256 × 256 raster matrix in just 0.2 μs. Screen size is just under 5 feet square.

An elegant optical technique that could ease the critical task of aligning the integrated-circuit mask with the wafer has been developed by IBM Deutschland Gmbh Sindelfingen. During alignment the mask has to be held above the wafer to prevent its surface being damaged. But because of the microscope's limited depth of focus, either the wafer surface or the masks is slightly blurred. IBM engineers compensate for the difference in path lengths by rotating a glass plate that focuses the microscope alternately onto the two object planes.

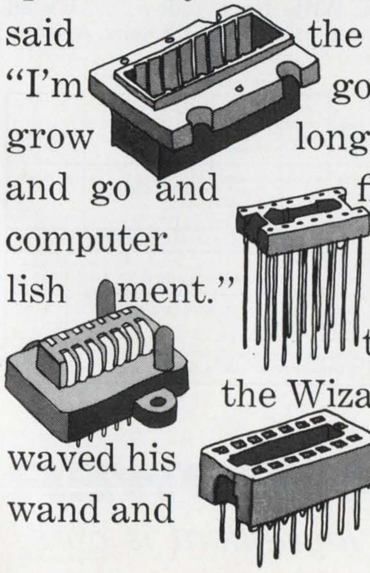
An extraordinarily compact 36-kΩ computer memory that fits on a single printed circuit board has been developed by Marconi-Elliott Microelectronics, Witham, Essex, England. The memory was developed for possible use in GEC's new range of process-control computers. On it are mounted six ceramic substrates, each around 3 by 4 inches square and of four of the substrates carry nine 1,024-bit random-access memory chips. Each silicon-gate MOS chip is beam-leaded down to the substrate onto which are printed thick film connections.

A new 600-A thyristor, capable of handling up to 2000 V in converter applications was recently demonstrated by the Swedish ASEA Co., Vasteras, Sweden. Also shown was a 900-A 2000-V diode for heavy-current applications, as well as a 300-A thyristor. This latter unit, with a short turn-off time of 20 to 30 μs, is intended for power-inverter uses. ■■

How the Wizard of Barnes foiled Benny the DIP.



ONCE UPON A TIME there was a clever little electronic bug whose name was Benny the DIP. He got this name because he liked to rob computer folks of time and money. "I like my job," said Benny. "I can lie down on a PC card, put my 14 (and sometimes 16) feet right into an overly hot tub of solder and Zap! – out goes my electronic function – isn't that fun?" "No it isn't," said the wise old Wizard. "It's time you grew up and recognized responsibility." "Never," said the bug. "I'm going to grow long hair, and go and fight the computer establishment." With that, the Wizard waved his magic wand and created a magic socket. "There," said the Wizard, "Now the computer people can plug you in and terminate the socket without terminating you. You'll just have to sit there and work. And when you're tired, you'll be replaced." "Curses!" exclaimed the bug, "Maybe I can cause problems during handling and shipment or 'turn on' with static electricity." "Sorry, bug," said the Wizard, "I've created magic carriers and test contactors to stop that, too." "Foiled again," said the bug. "Why don't you go pick on Flat Packs?" "I already have," said the wise old Wizard. Moral: Never bug a Wizard.



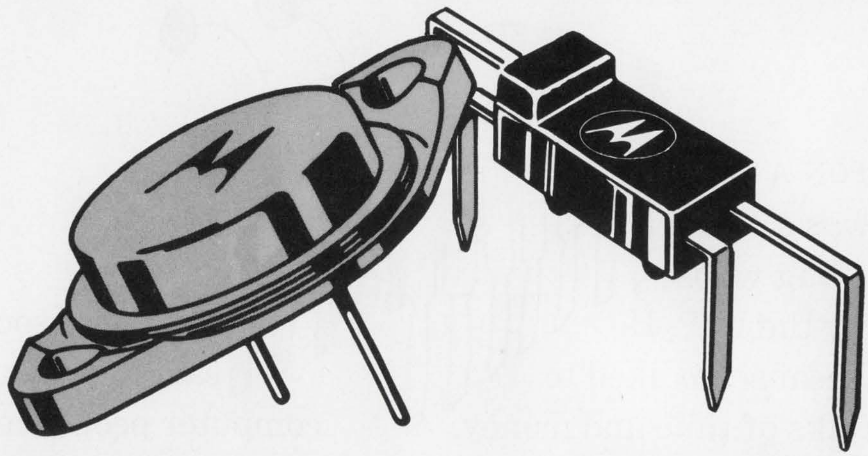
barnes CORPORATION

LANSDOWNE, PA. 19050 ■ (215) MA 2-1525

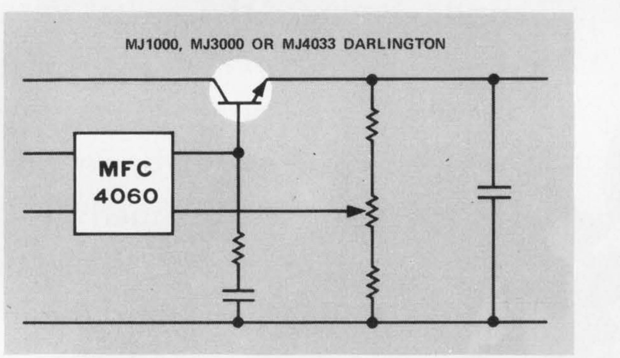
INFORMATION RETRIEVAL NUMBER 29

Now You Need All This To Build A Power Supply:

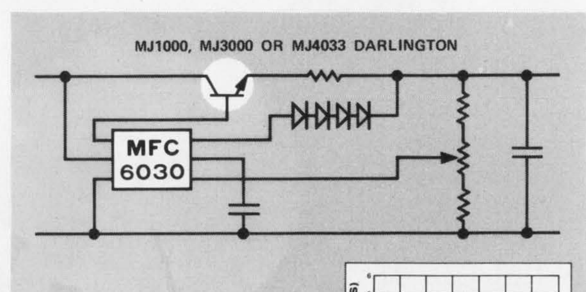
1.
Darlington Power Transistor
$1.57

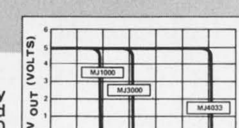


2.
Functional Circuit
90¢



Economical "Darlington + Functional" circuit performs as 3, 5, or 10 A, 5 V regulator. An MJ1000 (I_{OUT} = 3 A) affords load regulation of 0.02% @ 0°C, 0.2% @ 25°C and 0.04% @ 75°C. An MJ3000 (I_{OUT} = 5 A) furnishes 0.04% load regulation for each temperature. An MJ4030 (I_{OUT} = 10 A) yields load regulation of 0.04% @ 0°C and 25°C and 0.06% @ 75°C. MFC4060 is the same as MFC6030 except for current limiting 30 V outputs possible for both circuits.





SHORT CIRCUIT CHARACTERISTICS

A short-circuit protected supply with 3, 5, and 10 A outputs obtained with MJ1000, MJ3000 or MJ4030 Darlingtons and an MFC6030 regulator. For each output, load regulation is 0.08% when used as 5 V regulator. Short-circuit characteristics indicate limiting performance with each Darlington. MFC6030 Functional Circuit has 38 V maximum input voltage, 200 mW maximum load current and 3 V minimum voltage differential.

Just 2 Active Components!
. . . that's all it takes now to build reliable, regulated power supplies for your commercial / light industrial / computer peripheral equipment.

One Darlington and one "functional" eliminates a dozen or more resistors, diodes and discrete devices . . . PLUS their associated wiring . . . PLUS the cost involved in their assembly!

Power Darlingtons furnish state-of-the-art performance and design simplicity in most any relay and solenoid drivers, audio amplifiers, servo amplifiers and series pass regulators by forever obsoleting conventional, "one-for-one" driver and output transistors and associated base-emitter resistors. Complementary in polarity, the metal and plastic series offers many "firsts" — 2,500 typical h_{FE}, up-to-100 V sustaining voltage, 5 A-@-30 V safe operating area and 100-up prices low as $1.35.

MFC4060/6030 functional circuits afford industrial-quality performance through precision voltage regulation. Load regulation is 0.2% and line regulation is 0.03%/V maximum at 30 V. T_C = ± 3.0 mV/°C and output voltage is adjustable from 4.8 to 35 V. The MFC-6030 can be externally programmed to current-limit from 100 to 200 mA. 90¢ buys you an MFC4060 in 100-up quantities!

Both are new, both offer unique advantages individually, both are available now from your Motorola distributor for team evaluation on your prototype power supply workbench. Your inquiry will bring you a complete package of product data and how-to-do-it power supply circuits. Write for it today . . . it's all you'll need. Box 20912, Phoenix, Arizona 85036.

POWER DARLINGTONS

PNP/NPN Series	I_C Range (cont) A	V_{CEO} (sus) V	h_{FE} @ I_C (min)	P_D W	SOA	Price Range 100-up
MJ900 to MJ4033	4-16	60-100	750-1000 @ 1.5, 3, 4, 5 & 10 A	75-150	3 A @ 25 V to 5 A @ 30 V	$1.35-5.35

FUNCTIONAL VOLTAGE REGULATORS

Type	Outstanding Characteristics	Price 100-up
MFC4060	Ultra-low cost, precision, series pass regulator in 4-lead plastic	$ .90
MFC6030	Short-circuit protected, 6-lead version programmed to current limit from 100 to 200mA	$1.78

MOTOROLA POWER
—where the priceless ingredient is care!

INFORMATION RETRIEVAL NUMBER 27

washington report

DON BYRNE, WASHINGTON BUREAU

Airport-aid money diverted to cover FAA operating expenses

Money being paid into the new airport-airways trust fund is being used to meet Federal Aviation Adminstration operations and maintenance expenses, rather than to improve and build new airports, complained the Air Transport Association and the Airport Operators Council in a joint press briefing here. Some \$246-million of the fund—which comes from airways user taxes and is allocated by the Administration—has been earmarked for FAA housekeeping expenses with only \$40-million for airport construction and improvement. Some industry groups say that using the money for anything besides airports is illegal. But the Administration maintains it can use the money as it sees fit.

Maker of electronics kits asks for FCC changes

The Heath Co., manufacturers of do-it-yourself electronic kits, has asked the Federal Communications Commission to come up with new certification rules for microwave ovens. Heath asked the FCC for prototype rather than pre-use certification, claiming the present FCC regulations cost the company the 1970 Christmas market.

The petition claimed that Heath had made an investment of \$450,000 "in the good-faith belief that this product could be made and sold legally." A prototype approval, "which is available to all factory-assembled microwave ovens, is not available for kits," the complaint stated. It added that the alternative, pre-use certification, "would be so costly and burdensome to the purchaser as to be totally impracticable." Heath claimed further that the commission rules handed over the entire microwave-oven market to manufacturers of factory-assembled products, both domestic and foreign.

Electronics a major factor in 1970 export increase

Figures for the first nine months of last year indicate that 1970 was a bumper year for both exports and imports, according to the Commerce Dept. Exports rose about 14.5% to \$42.7-billion while imports climbed 9.5% to \$39.4-billion.

Electrical machinery exports climbed about 12% to \$2.209-billion, with computers and parts accounting for \$777-million, up \$275-million over a like period a year ago.

Semiconductors were up \$73-million to \$321-million, and other office machine exports were up \$100-million to \$328-million. Exports of power machinery, switchgear and measuring and controlling instruments also increased. The biggest purchasers of computers and other office machinery were Japan and Western Europe.

On the other side of the coin machinery imports totaled \$2.69-billion with office machines accounting for \$376-million, up from \$264-million a year ago. Sales of electronic calculators from Japan totaled \$42.1-

million while sales from all other countries including Japan reached $43.5-million. Last year Japan sold $11.7-million in calculators. Data-processing equipment imports totaled $42.9-million compared with $22.1-million last year. More than half came from Canada.

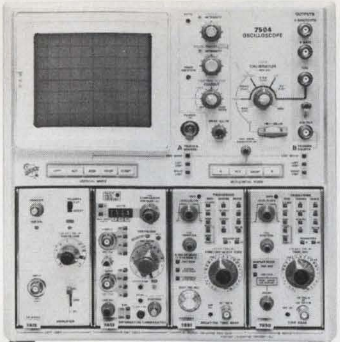
NASA survives first round in budget battle

NASA has won the first round in its fight to keep manned space flight at, or close to, its present level. The space agency had maintained it would need the same money—$3.3-billion—that it received last year if the program was to continue. Informed sources told ELECTRONIC DESIGN that after some fairly bitter wrangling the Bureau of the Budget okayed $3.26-billion for NASA in the coming fiscal year. There had been reports that anything less would have meant the scrubbing of Apollo flights 16 and 17, but a NASA source said that both flights are "very much all systems go right now." NASA's budget must still, however, survive trips to the White House and Congress.

GAO panel to standardize accounting procedures

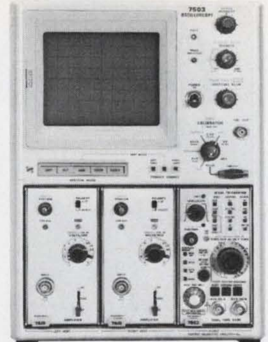
A five-man board will begin meetings sometime within the next week or so at the General Accounting Office to draw up a set of federal cost-accounting standards. Defense contractors—and probably all Government contractors, eventually—will be bound by what the board decides. Industry trade associations look upon the board and its functions with some apprehension. Proponents of the bill, which was passed last August, argued that standard accounting procedures would save billions in defense dollars, but industry spokesmen said it would eventually lead to higher prices for Government work because of reduced flexibility and increased costs in running accounting departments. GAO says it will probably take about three years to complete the work.

Capital Capsules: **SST gainsayers are now arguing that the U. S. should have joined the British-French team** to build the slower Concorde instead of going it alone with the much faster U. S. model. They forget that eight years ago Najeeb Halaby who was FAA administrator then tried to do just that but had the door slammed in his face by the British and the French . . . **FAA has named Gen. Spencer S. Hunn** (USAF, Ret.) to be director of its National Airspace Systems Program Office and Brig. Gen. Gustav Lundquist, associate administrator for Engineering and Development . . . The White House has withdrawn the nomination of Sherman E. Unger to the FCC leaving the impression that it did so because Unger had tax problems. Insiders feel the more realistic reason is an Unger clash with the White House staff. **Thomas J. Houser, deputy director of the Peace Corps, has been named in Unger's place . . .** House and Senate have given the new Environmental Protection Agency **the power to set limits on emission of pollutants from aircraft and to set health standards for aircraft fuels . . .** The Air Transport Association told a press conference here that the **airlines will lose $192-million in 1971 if fares don't go up.** Five months ago ATA predicted that the 1971 loss would be around $500-million . . . **The National Academy of Sciences has strongly rapped NASA for taking risks with the lives of astronauts** in the Mercury, Gemini and Apollo programs by paying little or no attention to the effects of prolonged space flight. NASA has responded by setting up the new position of Director of Life Sciences in the Office of Manned Space Flight. Maj. Gen. James W. Humphreys, Jr., (USAF, Ret.)—a medical doctor—was named.

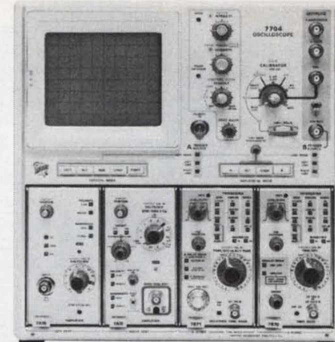


7504 90 MHz

7514 90-MHz Storage

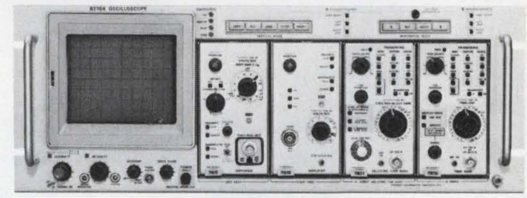


7503 90 MHz



7704 150 MHz

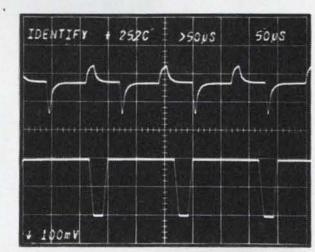
the time savers



R7704 150-MHz Rackmount

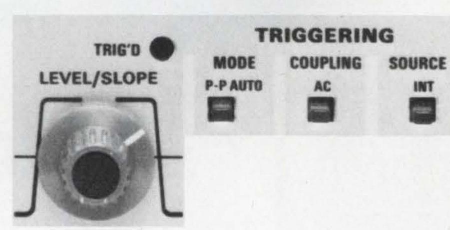
Today, oscilloscope manufacturers offer many sophisticated oscilloscopes. Unfortunately, solving a measurement problem with them often takes more valuable hours than need be. TEKTRONIX recognized this, so when we developed the 7000 SERIES (five mainframes and seventeen plug-ins), several features were incorporated that take the guesswork out of oscilloscope operation.

■ **CRT READOUT** is exclusive to Tektronix. It labels the CRT with time and frequency; volts, ohms, temperature (C), and amps; invert and uncal symbols; and automatically corrects for attenuator probes and magnifiers. A trace identify push button on each amplifier unit (also on the P6052 and P6053 Probes) deflects the appropriate trace and identifies the correct readout. With CRT Readout you look in only one place for accurate data.



■ **PEAK-TO-PEAK AUTO TRIGGERING** is the only *truly automatic* triggering. It makes triggering as simple as pressing three push-button controls: P-P AUTO AC INT

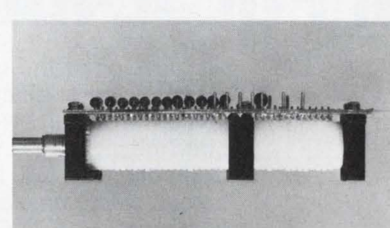
Now a triggered sweep is obtained regardless of the LEVEL/SLOPE control position.



■ **PUSH-BUTTON CONTROLS** do more than conserve front panel space. Because they are lighted and single function, time is not lost identifying them.

■ **AUTO-FOCUS CIRCUIT** eliminates the need for continuous refocusing with intensity changes.

■ **COLOR-KEYED FRONT PANELS** conveniently relate controls to functions. For example, green identifies all trigger controls.



■ **CAM SWITCHES** require 75% less torque than normal wafer-type rotary switches. They are just as convenient as power steering in an automobile.

When you require a new oscilloscope, evaluate the Tektronix 7000 Series; it has been designed to solve *more* of your measurement problems *easier* and *quicker.* For a demonstration, contact your nearby Tektronix field engineer or write: Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005.

TEKTRONIX®

committed to technical excellence

Tektronix lease and rental programs are available in the U.S.

INFORMATION RETRIEVAL NUMBER 30

All toroids look alike.

Our PULSE-RATED™ toroids really are alike.

We developed the concept of *pulse rated* toroids to eliminate tedious selection problems. Now we've developed new materials. Fully proven. Component tested. So you get guaranteed performance over a temperature range of 0° to 60° C.

Pulse-rated toroids not only simplify your selection process, they practically eliminate scrap. So you get 100% yield in your pulse transformer production.

Specifications provided for every *pulse-rated* toroid include pulse inductance, volt-microsecond product, and temperature behavior under pulse conditions.

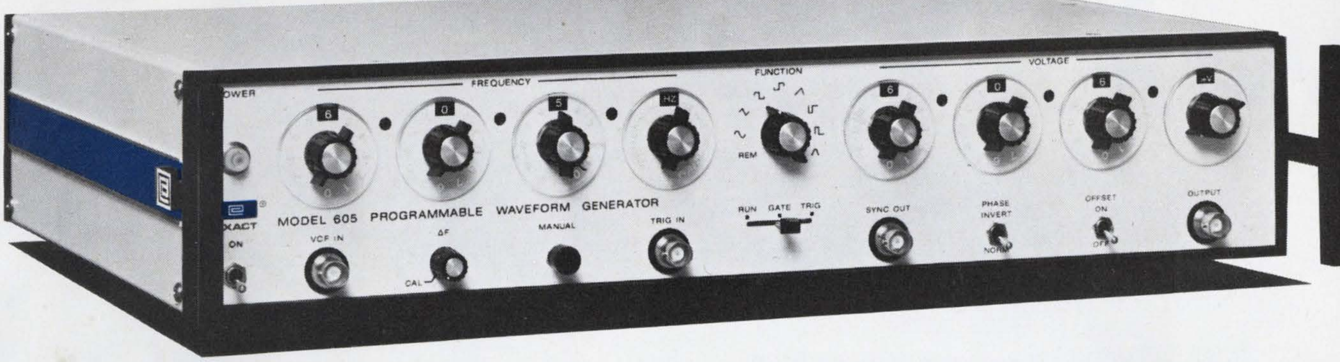
Parylene-coated *pulse-rated* toroids in sizes and specifications to suit your design requirements are now available for off-the-shelf delivery. Want some? We welcome the opportunity to send you samples. And hot-off-the-press spec sheets. And to consult with you about your design problems. Write Indiana General, Electronic Products, Keasbey, N. J. 08832.

indiana general

a division of Electronic Memories & Magnetics Corporation

INFORMATION RETRIEVAL NUMBER 31

SYSTEM SOURCERY



EXACT announces a programmable waveform source designed for trouble-free system interface

- **Remote or local programming of frequency, waveform, amplitude, trigger, gate, D.C. offset and phase.**
- **Produces sine, square, triangle, ramp, pulse . . . symmetrical about ground or with programmed D.C. offset. Programming trigger or gate modes produces single-shot or burst output.**
- **Programming inputs compatible with DTL, TTL, contact closure.**
- **Frequency range 0.001 Hz to 1.1 MHz (usable to 0.0001 Hz).**
- **Voltage controlled frequency (VCF) with 1000:1 ratio.**
- **Two models . . . Model 605 with remote and local programming . . . Model 606 with remote programming only.**

Exact's Model 605 and 606 Programmable Waveform Generators are designed for use with the most advanced automatic test systems. Commanded by any standard digital logic, they can produce the waveforms needed to drive high speed systems without disturbing the integrity of the system itself.

Trouble-free system interface is accomplished by several design features. Programming and signal grounds are isolated for flexibility and safety. Less than 1 milliamp of sink current (less than 1 TTL load) per programming line eliminates the need for buffers. And, up to 50 volts can be applied to programming lines without damage.

The Model 605 (shown above) can be programmed remotely or by front-panel local controls. The operator can program all functions remotely or all locally, or he can program some remotely and some locally. All front panel connectors are paralleled at the rear for added convenience. The Model 606 is identical to the 605 except it is programmed remotely only.

Call or write Exact for a demonstration of these versatile generators. Or circle the reader service number for complete specifications.

Model 605 (remote/local programming) $1,450
Model 606 (remote programming only) $1,250

Waveform generators from $295

EXACT electronics, inc.

Box 160
Hillsboro, Oregon 97123
Telephone (503) 648-6661

A subsidiary of
Vector Management Corp.

INFORMATION RETRIEVAL NUMBER 32

Improve your image—put The Bright Ones in your system

Easy-to-read displays enhance any system, because nobody likes to squint and strain to keep track of what's going on. HP X-Y displays are easy to read. They're brighter than the others, by more than a full order of magnitude. That's why we call them "The Bright Ones."

Our 1331, for instance, displays information at 100 ft-lamberts (as compared to the competition's 3 ft-lamberts), and gives you 1 MHz bandwidth, variable persistence, and flicker-free storage. This latter feature eliminates the need for display refresh in computer-controlled systems, saving valuable processing time.

Display brightness lets you observe data even under the brightest lighting conditions; you don't have to turn your work area into a "darkroom." And the 1331's storage-mesh CRT lets you show information with Z-axis shades of gray—an HP exclusive.

The 1331 takes up only one half of a standard-width systems rack, and is available in two versions. The 1331A has front-panel controls; the 1331C, a programmable version, has the controls and programming input connector in the rear.

Price of the 1331A or 1331C is only $1575, with OEM discounts available. For applications where variable persistence and storage capability are not required, we offer the 1330A. It costs only $800, with OEM discounts also available.

Whether your system will be used for electronic testing, communications work, chemical or nuclear analysis, spectrum analysis, military, aerospace, commercial, medical or educational applications, one of HP's "Bright Ones" can help solve your display problems.

For further information on these and other HP X-Y displays, contact your local HP field engineer, or write to Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

081/2

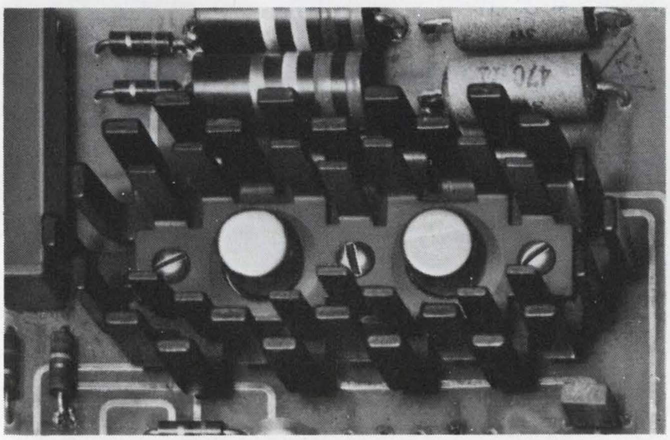
HEWLETT hp PACKARD

OSCILLOSCOPE SYSTEMS

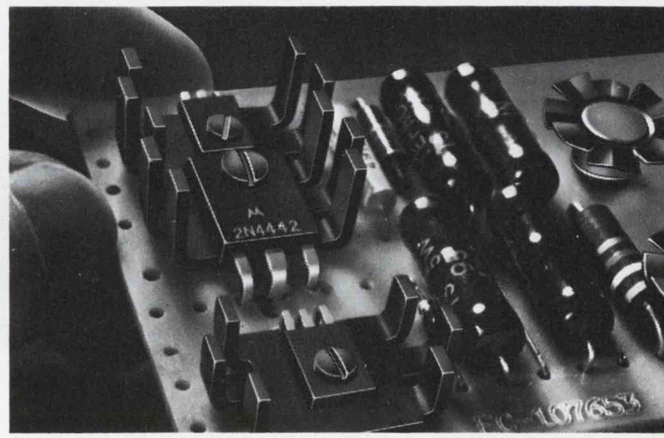
INFORMATION RETRIEVAL NUMBER 33

Tips on cooling off hot semiconductors

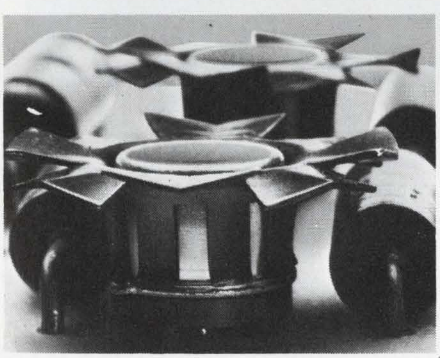
As power levels go up and up and package size shrinks, circuit designers are keeping semiconductors cool with IERC Heat Sinks/Dissipators. Reducing junction temperature gives many benefits: faster rise and fall times, faster switching speed and beta, fewer circuit loading effects and longer transistor life and circuit reliability.



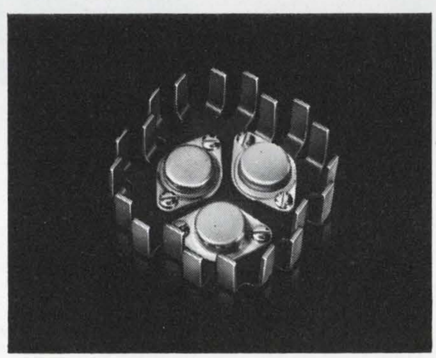
Thermal mating of matched transistors, such as these TO5's shown on a dual LP, maintains matched operating characteristics. The LP's unique multiple staggered-finger design (both single and dual models) maximizes radiation and convection cooling, results in a high efficiency-to-weight and -volume ratio.



Power levels of plastic power devices such as X58's, MS9's, and M386's can be increased up to 80% in natural convection and 500% in forced air when used with PA and PB Dissipators. PA's need only .65 sq. in. to mount; PB's 1.17 sq. in. Staggered finger design gives these light-weight dissipators their high efficiency.



TO5's and TO18's in high density packages can be cooled off with efficient push-on Fan Tops that cost only pennies. T-shaped, need no board room, let other components snuggle close. Spring fingers accommodate wide case diameter variations. Models for RO97's, RO97A and D-style plastic devices also.



High power TO3's, TO66's, TO6's, TO15's, etc. can be operated with much more power when used with HP's. These compact, lightweight staggered finger devices accommodate from one to four TO3's. Provide the same heat dissipation as an extrusion that's three times heavier and one-third larger.

Heat problems? IERC engineers welcome the opportunity to help solve your heat dissipation problems. As the world's largest manufacturer of heat sinks/dissipators for lead and case mounted semiconductors, they can come up with a practical, low cost solution.

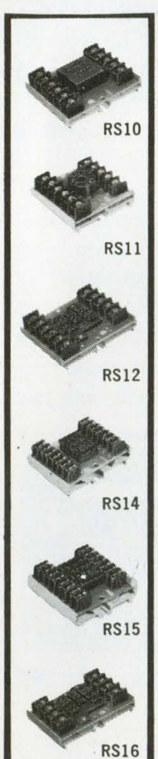
Free four-page Short Form Catalog. Send for your copy today.

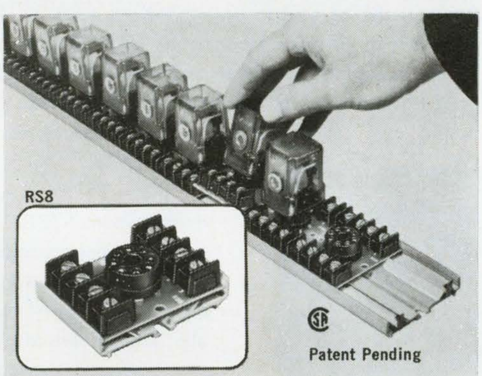
Heat Sinks/Dissipators **IERC**

INTERNATIONAL ELECTRONIC RESEARCH CORPORATION / A CORPORATE DIVISION OF DYNAMICS CORPORATION OF AMERICA / 135 WEST MAGNOLIA AVENUE, BURBANK, CALIFORNIA 91502

INFORMATION RETRIEVAL NUMBER 34

INFORMATION RETRIEVAL NUMBER 35





CURTIS

TRACK-MOUNT RELAY SOCKET ASSEMBLIES

Now the widest choice ever to mount most any relay or timer. Features P.C. board construction with barrier-type screw or clamp type terminal blocks. Up to 24 sockets snap in-or-out of 48" pre-punched vinyl track using only two or three mounting screws.

Send today for further information.

CURTIS DEVELOPMENT & MFG. CO.
3236 N. 33rd St. • Milwaukee, Wis. 53216

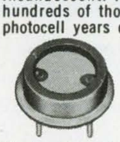
NEMA MEMBER

INFORMATION RETRIEVAL NUMBER 36

DESIGN PROBLEMS?
solve them with
PIONEER PHOTOCELLS

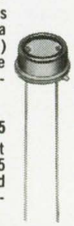
CDS-9

A 1" photocell, especially designed for numerous applications in outside or inside lighting, flame control, and relay applications where the light source is incandescent. Proven by hundreds of thousands of photocell years of service.



CDS-7

Has the same general characteristics as the CDS-9 but a smaller size (½") for use where space is at a minimum.



CDS-5

A very compact unit with a T.O. 5 housing, produced to your specifications.

Our engineering department will work with you on any special application of photosensitive layers.

STANDARD MODELS
Curves for load line design available for each model.

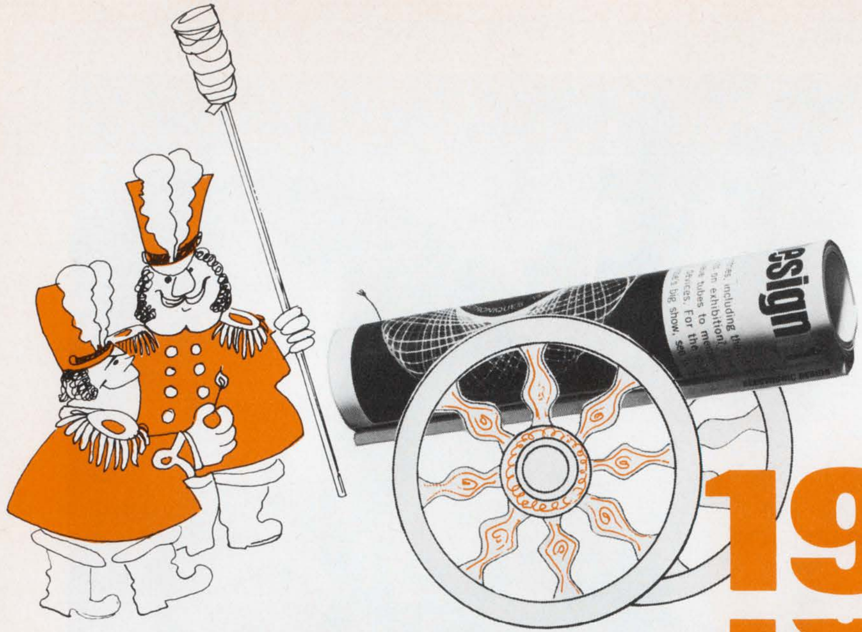
CDS Type No.	1 FC Simulated Daylight 50 V AC Mean* Output	Nominal Resistance 50 FC 2800° K Incand.	Max. Dark Curent** or Min. Dark Resistance	Max. Dissip.	Max. Volt Dark
701	1.5 ma		25 ua		500 V
702	3 ma		25 ua	all rated	500 V
703	6 ma		40 ua	¼ watt continuous	350 V
710		1330 ohms	4 meg.	1 watt	500 V
711		670 ohms	4 meg.	1 minute	500 V
712		330 ohms	2.5 meg.		350 V
901	1.5 ma		25 ua	All	1000 V
902	3 ma		25 ua	rated	1000 V
903	6 ma		40 ua	½ watt	700 V
904	12 ma		200 ua	contin-	500 V
910		1330 ohms	4 meg.	uous	1000 V
911		670 ohms	4 meg.	2 watts	1000 V
912		330 ohms	2.5 meg.	1 minute	700 V
913		165 ohms	0.5 meg.		500 V

*Range of values in any category equal to ±33% of mean.
**Measured at 100 V, 5 seconds after 50 FC light extinguished.

THE *PIONEER*
ELECTRIC & RESEARCH CORPORATION
Subsidiary of PENN Controls, Inc.
743 Circle Ave., Forest Park, Ill. 60130
Telephone: (312) 771-8242

INFORMATION RETRIEVAL NUMBER 37

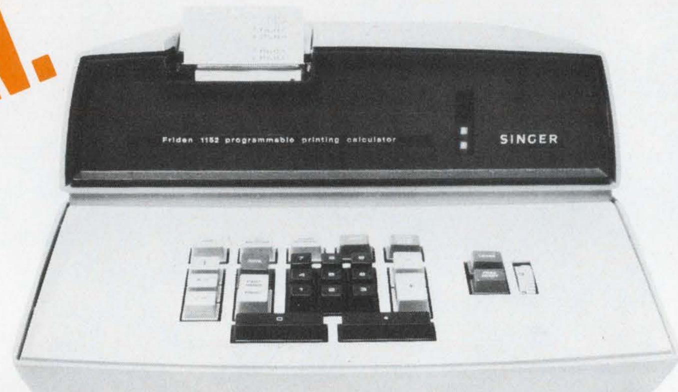
INFORMATION RETRIEVAL NUMBER 38



NEW PRIZES!

1971 TOP

WIN:



Friden Programmable Printing Calculator

1st PRIZE FRIDEN MODEL 1152 PROGRAMMABLE PRINTING CALCULATOR

Ideal for use at home as well as office. The Friden 1152 Programmable Printing Calculator with square root speeds business and scientific figurework by eliminating repetitious intermediate steps. After initial programming, only the variables are entered.

SECOND PRIZE: Friden 1114 Electronic Display Calculator. This compact calculator features a 14-digit display window and a "floating decimal." The lightweight machine is a little larger than a telephone directory.

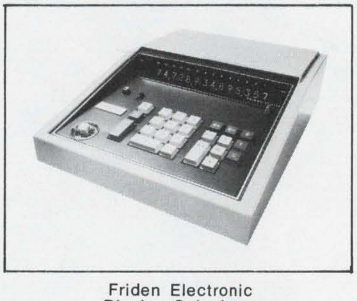
THIRD PRIZE: Friden Model 213 Adding Machine (with automatic recall). Adding and subtracting with a constant and/or a grand total, short cut multiplying, and calculating with non-add data entries are featured. The last printed number is held in memory, ready for recall.

4th and 5th PRIZES: EICO Model AX-5 4 ft.-high "Light Fantastic" Audio Lighting System. When hooked up to hi-fi system or radio, full spectrum color lighting in translucent dome pulses, leaps, and falls in response to music.

6th through 13th PRIZES: Bulova Accutron® "Spaceview" transistorized wrist timepieces. Tiny tuning fork vibrates 360 times a second, permits accuracy guarantee to within 60 seconds a month.

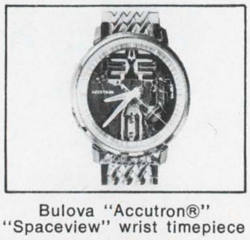
14th through 75th PRIZES: Copies of the **"Standard Dictionary of Computers and Information Processing"** by Martin H. Weik. Reliable definitions and explanations for more than 10,000 hardware and software terms in use. 326 pages. Hardbound.

WIN:

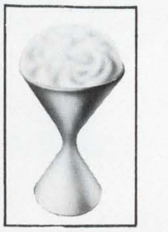


Friden Electronic Display Calculator

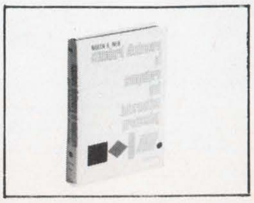
Friden Adding Machine (with automatic recall)



Bulova "Accutron®" "Spaceview" wrist timepiece



EICO "Light Fantastic" Audio Lighting System



"Standard Directory of Computers and Information Processing"

NEW RULES! NEW EXCITEMENT!

TEN CONTEST

HERE'S ALL YOU HAVE TO DO TO ENTER:

1. **Pick the 10 ads that you think will be best read in this issue . . .**
2. **List your selections on the Top Ten entry blank . . .**
3. **Mail to Electronic Design before midnight February 28, 1971.**

Try your skill . . . see if you can pick the *Top Ten* . . . 75 valuable prizes await the winners. There are no slogans to write, no hidden tricks. All you need to do is examine this issue of Electronic Design carefully. Pick the ten advertisements that you think will be best-read by your fellow engineer-subscribers. Then list these advertisements (in the rank order you think our readers will select them) on the special entry forms bound in this issue.

THERE'S A CHANGE IN RULES THIS YEAR Instead of selecting the top ten ads on the basis of "Recall **Seen**" scores, the judges will base their decisions on the "Recall **READ MOST**" category of Reader Recall —Electronic Design's method of measuring readership in the issue. This means that flashy ads will probably step back in favor of those ads which have a product story to tell . . . ads which are more informative, interesting, and useful to the reader. Remember, in making your choices, be sure to consider not only your own interests in the subject matter of each advertisement, but also those of the other 73,000-plus subscribers to this magazine.

Read the rules carefully, examine the ads, mail in your entry blank . . . maybe this year *you* will be the first prize winner!

ENTRY BLANKS ARE ON THE INFORMATION RETRIEVAL CARDS BOUND IN THIS ISSUE

1971 TOP TEN READER CONTEST RULES

1. Enter your *Top Ten* selections on the entry blank provided, or on any reasonable facsimile. Be sure to indicate the names of the advertiser and page number for each of your choices. These choices should be placed in the order you think readers will rank them. (Ads placed by Hayden Publishing Company in Electronic Design *should not* be considered in this contest.)

2. No more than one entry may be submitted by any one individual. Entry blank must be filled in completely, or it will not be considered. The box on the entry blank marked "Reader Contest" must be checked. Electronic Design will pay postage for official entry blanks only.

3. To enter, readers must be engaged in electronic design engineering work, either by carrying out or supervising design engineering or by setting standards for design components and materials.

4. No cash payments, or other substitutes, will be made in lieu of any prize.

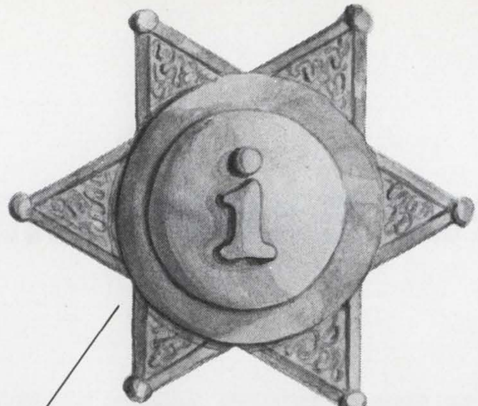
5. Contest void where prohibited or taxed by law. Liability for any taxes on prizes is the sole responsibility of the winners.

6. Entries will be compared with the "Recall Read Most" category of Reader Recall (Electronic Design's method of measuring readership). That entry which in the opinion of the judges most closely matches the "Recall Read Most" rank, will be declared the winner.

7. In case of a tie, the earliest postmark will determine the winner. Decisions of *Top Ten* contest judges will be final.

THERE IS A SEPARATE CONTEST— SEPARATE PRIZES FOR ADVERTISERS

Each advertisement ranking in the *Top Ten* will receive a free rerun. In addition there is a separate contest, separate prizes for advertisers. The six winners can also receive free ad reruns. SEE THE LAST PAGE OF THIS ISSUE FOR RULES AND PRIZE INFORMATION.



Don't get held up by a masked ROM.

Let Intersil guard you from masking costs and delays with an electrically programable ROM. All you need to code it is a few seconds and a simple program box. No masks. No eight weeks for delivery.

It's the IM5600, our 256-bit 40-ns T²L ROM packaged in a 16-pin DIP or flatpack. A pin-for-pin replacement for the 9034 and its second sources, only faster. And it's off-the-shelf from our distributors.

TWX-a-Code or Code-a-Card.

For super-fast service, TWX your code to us or your nearest Intersil distributor. We'll program up to 100 ROMs directly off the wire and have them in the mail to you right away.

Another time saver. Order quantities of blank ROMs, mount them on your own PC cards and stock them. When you need it, program a complete card at a time, plug it in and go!

Penny a bit, anyone?

Price for the IM5600 (0 to +75° C version) is $25.70 in 100-piece lots. But if you're interested in really large quantities we can bring the price down to a fraction of that. Any takers?

See your friendly Intersil fellow.

Intersil stocking distributors. Schweber Electronics; Century Electronics; Semiconductor Specialists; DeMambro Electronics; R. V. Weatherford Co.

Intersil area sales offices. Los Angeles (213) 370-5766; Metropolitan New York (201) 567-5585; Minneapolis (612) 925-1844; San Francisco Bay Area (408) 257-5450.

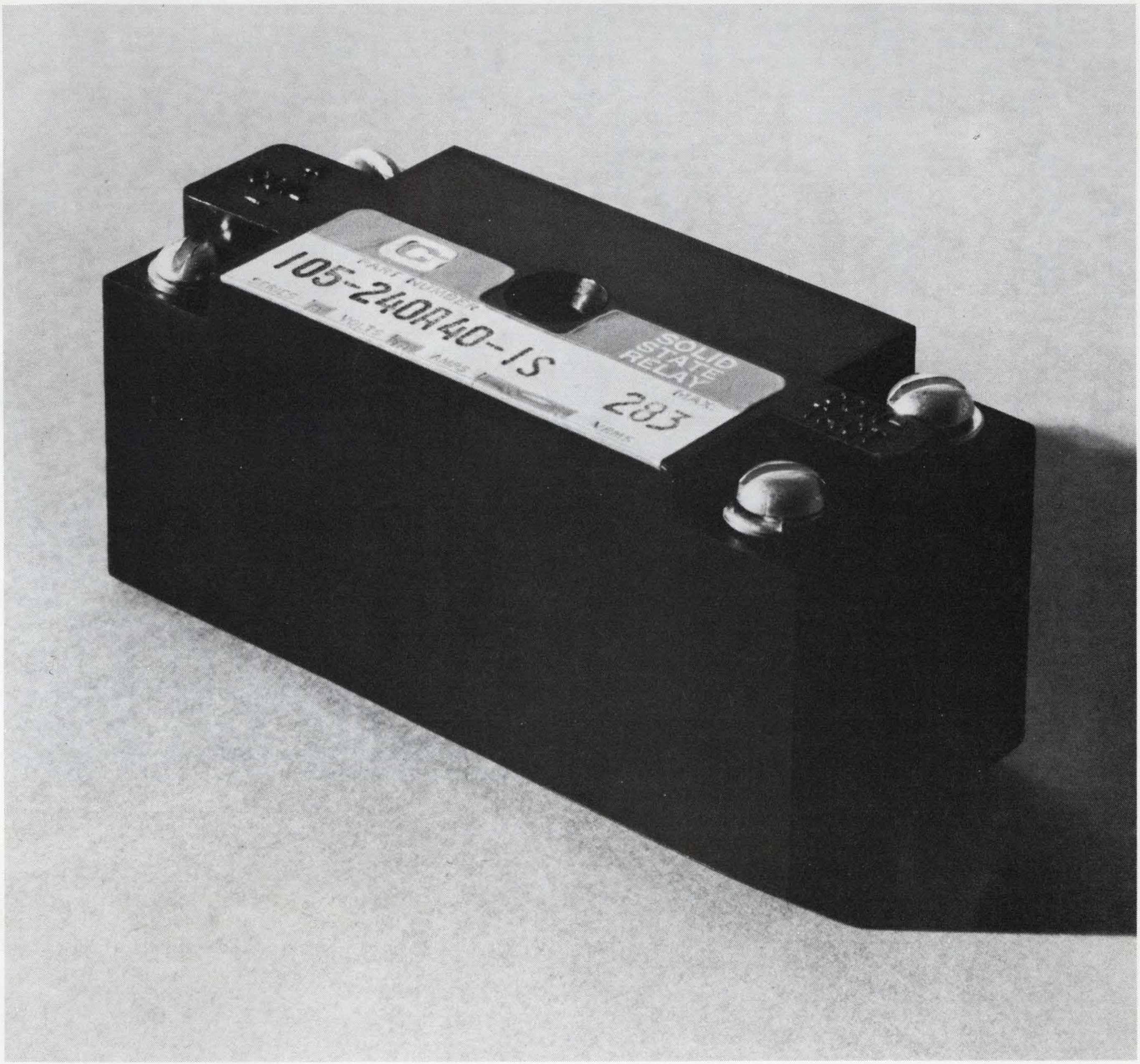
Overseas representatives. Clichy, France: Tranchant Electronique. Amsterdam: Klaasing Electronics. Tokyo: Internix. Zurich: Laser & Electronic Equipment. London: Tranchant Electronique. Munich: Spezial Electronics.

U.S. representatives in all major cities.

Intersil

INFORMATION RETRIEVAL NUMBER 41

Solid state, for 1000x reliability.



Genistron, for high-amp ratings.

Get it all. The whopping improvement in cycle life that solid state relays switch on: 100-million operations vs. 100,000 from horse-and-buggy EM. Plus the fullest range going in high-amp solid state. All the way to 40 amps—twenty more than the nearest competition.

Up through 240 Volts AC, 40 VDC, Genistron isolated SSR's are fully encapsulated for ruggedness. With barrier-strip screw-type terminals for easy connections. And our AC Syncroswitch Relay has zero-axis switching to eliminate RFI. (Just what you'd expect from the same people who bring you Genistron EMI filters.)

Catalog and specs, yours for the asking. Call or write Genistron Solid State Relays, Genisco Technology Corporation, 18435 Susana Road, Compton, California 90221. (213) 774-1850.

GENISTRON SOLID STATE RELAYS

INFORMATION RETRIEVAL NUMBER 42

The Great Idea...by Kelvin, Varley, Poggendorff and Porter.

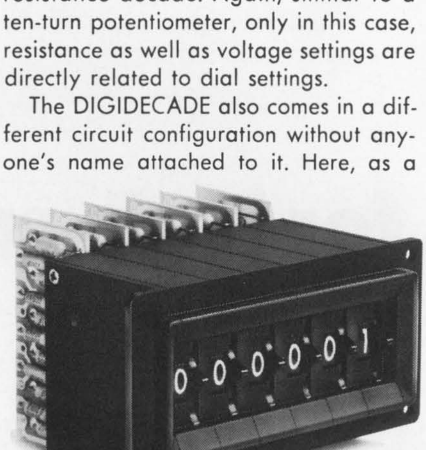
Porter is the gentleman seated second from the left. With a little help from his friends, Hank Porter came up with a great idea. Or really, two great ideas. The DIGIVIDER® and the DIGIDECADE®.

The DIGIVIDER is a voltage divider that comes in two configurations. The Kelvin-Varley-Porter version and the Poggendorff-Porter configuration. They are Thumbwheel Switches that act like ten-turn potentiometers, only better. Now you can "click" the dial settings to whatever voltage you want (as an output) and that's exactly what you get. And you don't need a magnifying glass to read the digits.

DIGIVIDER accuracies range from 0.1 to 0.025% full scale voltage ratio (0.01% available) with resolutions to 0.0001% and input impedances from 100 to 100,000 ohms. Trimming options are also available.

The Poggendorff-Porter DIGIVIDER configuration can also be used as a resistance decade. Again, similar to a ten-turn potentiometer, only in this case, resistance as well as voltage settings are directly related to dial settings.

The DIGIDECADE also comes in a different circuit configuration without anyone's name attached to it. Here, as a resistance decade, it utilizes a weighted code of 1-2-2-2-2-, using five resistors to achieve nine discrete steps of resistance from (0-9) or multiples thereof. It is a linear progression that yields the desired total resistance.



DIGIDECADES have accuracies to 0.1% of setting, resistance ranges from 10 ohms to 1 megohm and step sizes of 1 to 100,000 ohms.

As with all DIGITRAN products, you can count on stability and quality. You won't get more than a 5 milliohm change in contact resistance through 100,000 accurate switching operations.

So, write for our new catalog on DIGIVIDERS and DIGIDECADES, or even better, give us a call. That's a great idea too.

THE DIGITRAN COMPANY

A Division of Becton, Dickinson and Co. B-D

855 South Arroyo Parkway, Pasadena, California 91105 • Phone: (213) 449-3110, TWX 910-588-3794

Pictured l. to r.: William Thompson Kelvin, 1824-1907, England, Hank Porter, U. S. A., Cromwell Fleetwood Varley, 1828-1883 England, Johann Christian Poggendorff 1796-1877, Germany.

INFORMATION RETRIEVAL NUMBER 43

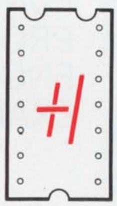
99¢

GaAsLITE Update

Hooray! Price reductions for both red and amber GaAsLITEs.

Effective immediately, prices (suggested resale in 1,000 quantities) on our red light-emitting diodes MV 50, MV 10B and our amber GaAsLITE MV 1, have been cut to 99¢. Smaller quantity prices have gone down, too. Get the details from your distributor.

If you've been considering GaAsLITEs in sockets where you need good brightness, low power drive, high reliability, and ready availability, it's time to stop thinking and send a P.O. Wow! 99¢.

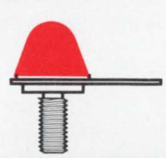


MAN 1001
New: Polarity and overflow display

Customers who have bought and used our MAN 1 displays asked us to build a ±1 device to integrate into digital readout displays, cockpit instruments, and industrial controls.

Voila! the MAN 1001. Same size and package as the MAN 1 GaAsLITE display. Same high brightness (typ. 350 ft-L @ 20 mA) and IC-compatible power requirements (3.4V typ. forward voltage per segment @ I_F = 20 mA).

Suggested resale price, 100's: $11.50 each.

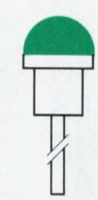


Meet Big Red, the MV 4
The GaAsLITE becomes an illuminator

Photography fans will be delighted to hear that we've developed the MV 4 series of light-emitting diodes. They put out 5,000 ft-L @ I_F = 1.0 A in the 6700 Å region, well above the sensitivity range of most photographic emulsions. Mounted in a TO-5 stud-type header, the MV 4 can take up to 1A continuous current in an efficient heat sink.

MV 4's will also serve well as high intensity locators and warning indicators when pulsed. They will handle peak currents of 25A at 1 μsec, 300 pps limits.

Price: (resale, 100's) $9.25.
Delivery: off the shelf.



MV 2:
The green GaAsLITE is GO . . .

We are now in full production with our green solid-state light, the MV 2. Its active gallium phosphide puts out a very bright 300 ft-L in the 5600Å range @ 650 mA.

Packaged in a TO-18 header, the MV 2 completes the stop-wait-go color choices that display designers have been looking for.

Suggested resale price, 1,000's: $3.75.

. . . and it's in our new GaAsLITE Answer Kit.

Creative display designers want new answers for panel indicator light problems. They'll find them, complete with applications ideas and design help, in our GaAsLITE Answer Kit, available from any Monsanto distributor worldwide for only $9.95. Contains a volume of GaAsLITE Tips, two MV 50 and MV 10B red GaAsLITES, two MV 1 amber solid-state lights, and one of our new green answers, the MV 2.

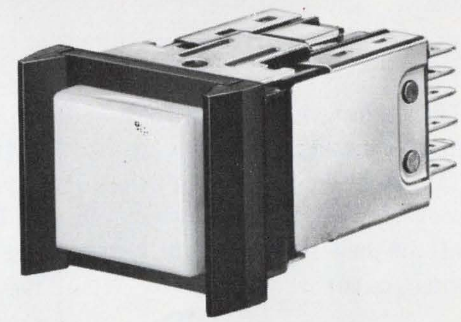
Get out a purchase req and start working with all kinds of GaAsLITEs now.

Monsanto

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

INFORMATION RETRIEVAL NUMBER 44

A NEW FIELD-OF-ONE IN LIGHTED PUSHBUTTON SWITCHES.



ACTUAL SIZE

Switchcraft's "PUSH-LITE" switch offers reliable leafspring switching in a neat little package.

This whole new field of compact ($1'' \times 1\frac{1}{16}'' \times 1\frac{3}{4}''$) pushbutton switches reduces the size of your control panels, consoles—and cost, too! Our new field-of-one consists of 6 series—including non-illuminated and illuminated single and twin-lamp units in two housing colors (black or grey). Up to 4PDT switching in momentary and push-lock/push-release functions. Ratings range from dry circuit switching, up to 3 amps., A.C., non-inductive load.

A rugged molded housing encloses the highly reliable leafspring switching and protects against dust, dirt and mishandling.

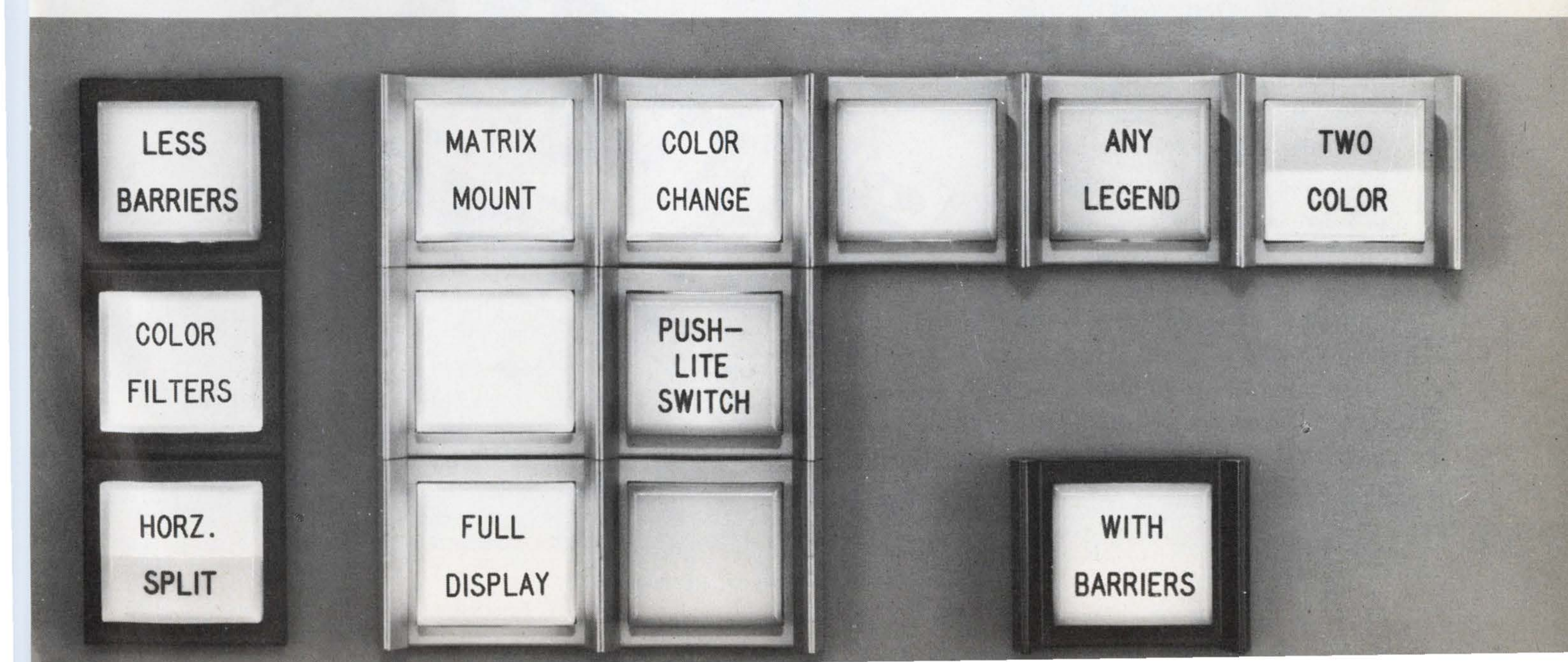
Pick from flange or barrier mounting—individually or in matrix configurations. Series PL "PUSH-LITE" switches mount from front of panel with clamp brackets, simply and quickly. No mounting screws show!

Design with up to two lamps and either full or split display screens—vertically or horizontally. Full display provides up to 3 lines of 6 characters each. Virtually unlimited lighting versatility provided by 7 different colors of pushbuttons, insert filters and silicone boots.

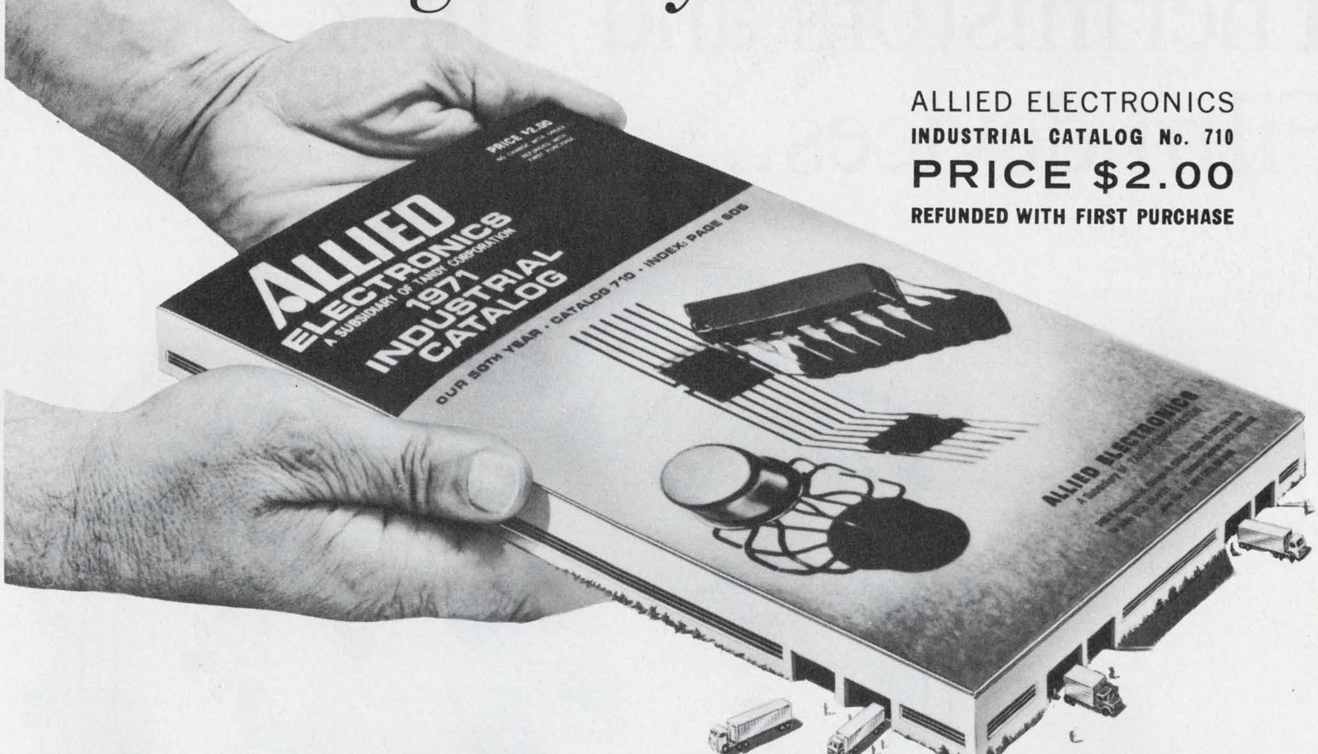
For additional information, contact a Switchcraft Representative or write for Catalog S-345. SWITCHCRAFT, INC. 5529 N. Elston Avenue Chicago, Illinois 60630

SWITCHCRAFT® INC.

INFORMATION RETRIEVAL NUMBER 46



It's like having a 450,000 sq. ft. electronics supply house right in your hands!



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I Enclose $2.00 (Credited to my first Order)

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INFORMATION RETRIEVAL NUMBER 49

editorial

Get ready now for tomorrow's civionics era

Although few engineers are thinking of a career change during these uncertain times, a growing number will want to hop on the civionics (civilization-electronics) bandwagon in the years ahead. But before a job switch is even contemplated the engineer must have specific answers to some key questions. Are his present skills transferable to the new technologies, for example? What are the opportunities for advancement? Where are the companies located? What are the salary levels?

Civionics special reports, such as the one on mass surface transportation (p. 71)), will provide an insight into hardware needs and circuit problems, but the designer will need to know a great deal more about the field. He should:

1. **Take courses at local colleges or universities.** A growing number of institutions are providing engineers with special courses in a variety of civionics areas, such as pollution, medical electronics design, and technology in education.

2. **Attend conferences, seminars and meetings.** Practically all of the major professional groups are offering an increasing number of special technical sessions on the subject of civionics. For example, the National Telemetering Conference (Washington, D. C., April 12-15) will focus on the theme: "Telemetry and the Environment: Accepting the Challenge." Technical papers will be given on subjects such as telemedicine, monitoring of earth resources, and traffic control and police data systems.

3. **Talk to engineers** who are presently employed in civionics-related industries. Arrange for a company visit.

4. **Join some of the newer professional groups and societies** such as the Institute of Environmental Sciences, 40 E. Northwest Highway, Mt. Prospect, Ill., and The Alliance for Engineering in Medicine and Biology, 3900 Wisconsin Ave. N.W., Suite N-300, Washington, D. C.

5. **Write to the Engineers Joint Council,** 345 47th St., New York City or Deutsch, Shea and Evans, Inc., 49 E. 53rd St., New York City, for further information on engineering salaries, demand and placement services.

6. **Read trade publications** and the growing number of books dealing with the subject of civionics.

The designer not only can take these steps, but he must—now. So that when the trend to civionics gains momentum—as it will—he will be ready for the opportunities that await him.

RALPH DOBRINER

Ralph Dobriner

civic

Electronics to serve the public

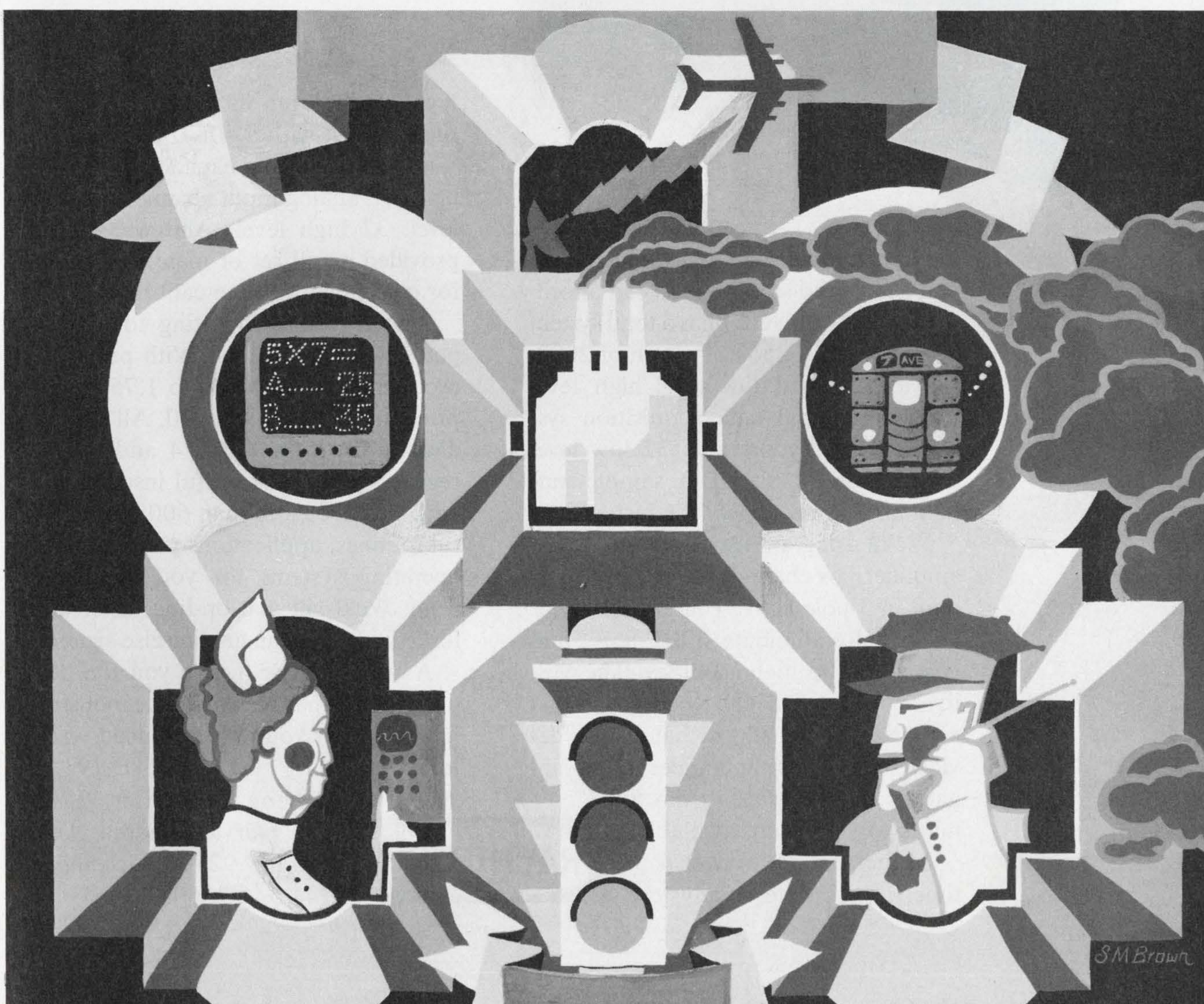
Winds of change are sweeping the country, and design engineers are being caught up in them. Aerospace and defense are no longer the unrivaled priorities they once were in national councils. Instead there is increasing concern with environmental quality, housing, transportation, medical care, education and crime. Engineers are being asked to come up with dramatic solutions to long-festering problems in these areas.

This year will be a crucial one for the electronics industry as shifts from space and defense to socially oriented programs begin to accelerate. Recognizing the importance of these shifts, ELECTRONIC DESIGN plans to carry a series of special reports on emerging areas of technology that should have a profound effect on the industry and provide new opportunities for design engineers. The first article in this series — on mass surface transportation — appears in this issue. Other areas that will be covered in the months ahead include: anticrime and educational electronics, pollution monitoring and control systems, medical electronics, nuclear electronics, air-traffic control and automobile-traffic control.

All of the articles will be strictly hardware and design-oriented, not merely "blue sky" surveys. They will inform readers of hardware needs, as well as circuit and system problems and proposed solutions.

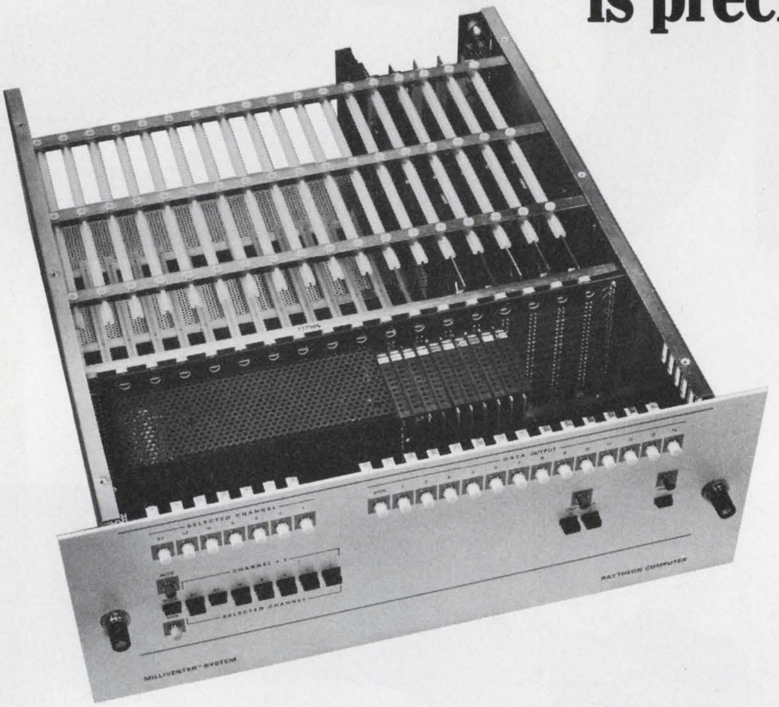
These are new directions in engineering — so new that ELECTRONIC DESIGN has coined a word to describe the technology. Civionics. It's a word you'll be hearing more of this year. And who knows? You may be a civionics engineer before long.

nics



Looking for high accuracy in a low level system?

Raytheon Computer's new Milliverter™ is precisely right for you.



Now you can have all the accuracy you need. And at prices you can afford.

Our new Milliverter has a total system accuracy of .0625% at a gain of 2000. It's a combined low level/high level fully differential data acquisition system. And it's yours with 32 low level channels, a 14 bit ADC, sample-and-hold and power supply for just $5800.

We're using an instrumentation type amplifier-per-channel, each having a built-in 3-pole active Butterworth filter to virtually eliminate 60Hz noise and give you ultra high accuracy. The Milliverter provides high accuracy signal conditioning for all low bandwidth devices such as thermocouples and strain gauges. Signal ranges from 5 mv fs to 10 vfs are available.

In fact our Milliverter is 3 times as accurate as any low level multiplexer in its class. And 4 times as fast with a 40KHz throughput rate. We've got the capacity too. With up to 96 analog input channels. 64 low level. 32 high level. And we've even provided a full set of manual controls for convenient off-line calibration.

And if you're inputting to a computer, try one of ours. With processor cycle times from 900ns to 1.75μs, and prices from under $10,000. All include direct I/O to the CPU, 4 addressable registers and 74 powerful instructions. And we have more than 600 programs, subroutines, applications packages and operating systems for you to choose from. We'll get you on-line faster and for less money than anyone else around.

As we said, we'll give you the best price/performance ratio in the industry. If that's what your systems need, write today. Ask for Data File E-191.

RAYTHEON

Raytheon Computer, 2700 South Fairview, Santa Ana, California 92704. Telephone (714) 546-7160.

The only thing Raytheon Computer does is your job. Precisely.

INFORMATION RETRIEVAL NUMBER 50

Mass Surface Transportation

An Electronic Design Special Report

civionics

America's unabated enchantment with the automobile is on the wane. Metropolis after metropolis is discovering that cars cannot move great masses of people efficiently. Even a city like Los Angeles, with its miles of carefully blueprinted, pretzel-like freeways, has learned that squeezing more concrete ribbon into the available land space only makes for grander traffic jams and more irritating air pollution. In New York City proposals are under serious consideration to ban all private auto traffic during working hours from at least half of Manhattan Island.

With the rise of megalopolises—vast regions composed of city next to city—the traffic jam has spread to become an intercity problem. How will these monumental crises be solved? In large part, civic planners believe, through the design and construction of revolutionary, rapid mass-transit systems, both inside and between cities.

At this point the electronic design engineer moves to center stage. For the demand is for automated systems. Present mass transportation is limited by at least three major bottlenecks: breakdowns in equipment, human errors and relatively slow speeds. To overcome these, engineers must design fail-safe, automated systems that can carry passengers on or above a guideway at up to 250 mph.

Computers, circuitry, sensors, propulsion units, communication networks and complicated software are involved.

Challenging work? It's considered more demanding even than designing for the aerospace field. For one thing, reliability must be virtually 100%. Suppose a sensor designed to spot obstructions on a guideway fails. How do you get the computer in the system to "see" the obstruction and halt oncoming traffic? Engineers are working on problems like these.

The impetus for developing these new systems is expected to come largely from governmental bodies—federal, state and municipal. But business interests are pushing strongly for them, too. Because solving today's traffic problems is more than a nice convenience for impatient city dwellers. It will spell the difference between financial life or strangulation for some metropolises.

Over the next five years, according to Government and industry estimates, more than $200-million will be spent on electronics for guided surface mass transportation.

Typical of the electronic needs are these:

- Fail-safe computer systems and signaling systems for command and control.
- Gigahertz bandwidth communications systems, such as dielectric waveguides, not only for control but also for passenger convenience.
- Quiet, efficient, reliable, nonpolluting electrical propulsion systems, such as linear induction motors, and the associated electronics to control them.
- Methods for getting large quantities of power to a rapidly moving vehicle that might even be floating on a cushion of air, such as highly trackable sliding contacts.
- A means of detecting hazards on the guideway several miles in front of the vehicle, such as optical detection. (A one-inch stone could do a great deal of damage to a tracked air-cushion vehicle traveling 3/4 inch off the ground at speeds of 250 mph.)

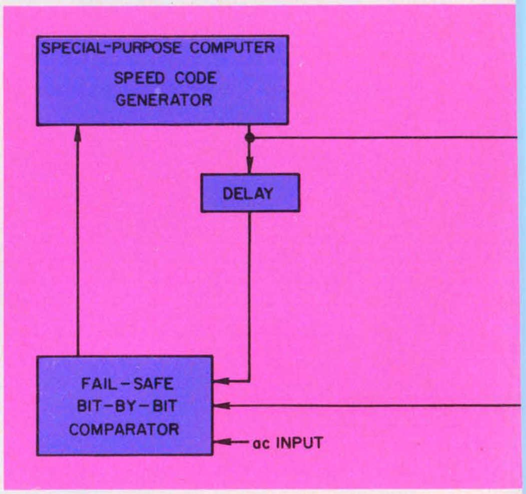
All of these systems will have to meet tight performance and environmental specifications. And unlike aerospace and defense electronics, one specification that will be found in all guided surface mass transportation requirements is that the system must be fail-safe. This means that if anything goes wrong, the system must revert to a mode that does not endanger the passenger. The designer will not be asked for a reliability number only, for that merely defines *when* the system will fail. He will also be asked *how* the system will fail. This adds up to systems that are more reliable than those that have taken men to the moon.

Why the big push to develop modern, automated transit systems? One look at the traffic tieups and automobile generated air pollution in major cities of the United States provides the answer. With efficient mass transportation, a city acquires mobility without overdependence on cars. A high-speed train between two cities can get people to the center of each metropolis faster than they can make it now by flying to an outlying airport, then creeping in the rest of the way by bus. Automation is the key to better transportation.

For such a system to operate in an automatic mode, there must be a great deal of command and control electronics, placed in fixed positions along the guideway, as well as sensors, monitoring circuits, communications equipment and perhaps a large central computer. The function of a command and control system is to monitor the location and condition of all vehicles and passengers on the system and to control the actions of each vehicle for maximum efficiency.

Designing tomorrow's 8:05 express

David N. Kaye West Coast Editor



Command and control systems can be broken down into two basic types:

- **Fixed block.** The guideway is divided into a series of sections, usually all of the same length. Each section is called a block. Only one vehicle is allowed in a given block at one time, and as the vehicle moves through the block, its communication system receives only the information designated for that particular area. The location of vehicles on the system is coded by block number at any instant in time. By merely determining which blocks are occupied and which aren't, a controller knows the location of all vehicles in the system. The length of the blocks is chosen to provide an adequate stopping distance between vehicles in case of emergency.

In some systems a headway of several blocks is required between vehicles.

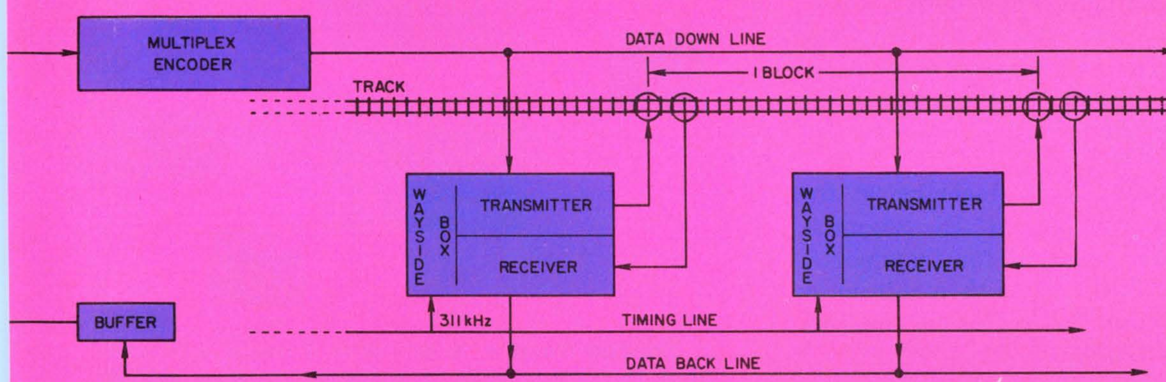
- **Moving block.** The guideway is divided into a series of sections, or slots, that constantly circulate around the system. When a vehicle is inserted into a slot, the slot moves with the vehicle. The slot, or moving block, is an electronically-determined distance which, when occupied, cannot be infringed upon by another vehicle. Slot size can be made variable, so that when the vehicle speeds up, the slot gets larger to compensate for increased stopping distance in an emergency.

Different computers—different functions

Each of these two basic types of systems requires computer control. Fixed blocks can be controlled either by a large central computer or by small, special-purpose computers placed around the system—or by a combination of the two. Variable-size, moving block systems require an enormous central computer for control. Fixed-size moving blocks can be controlled best by a group of small, special-purpose computers. In all cases, a central computer is the best way to achieve general supervision and monitoring of the equipment. A central computer must be available for rapid analysis of system failures.

Most advanced of the command and control systems being built today is the Bay Area Rapid Transit (BART) system, which will serve the San Francisco Area. Westinghouse designed the command and control system for BART. One of the most interesting parts of the system is a multiplexed speed-code and block occupancy (see Fig. 1). This tells the vehicles how fast to go and also informs a special-purpose computer of the location of the vehicles. It is typical of the electronics necessary for the command and control of sophisticated transportation systems.

BART is a fixed-block system, with small, special-purpose computers placed periodically at stations and along the wayside. A large central computer performs merely supervisory and monitoring functions. Each special-purpose computer generates digital speed codes and determines block occupancy for up to 30 blocks of track. According to Dr. Robert H. Perry, supervisor of the engineering systems group at Westinghouse Electric Co. in East Pittsburgh, each block has two wayside boxes of electronic equipment: one at the beginning and another at the end of the block. The speed-code generator (a special-purpose computer) sends digital signals to the wayside boxes at the beginning of each block on a multiplexed line. These signals tell a vehicle in that block how fast to go. A transmitter in the wayside box couples the signal into the track, using inductive loop coupling. If there is no vehicle in the block, the signal is received by the wayside box at the end of the block of track. If a vehicle is in the block, it receives the signal, shorts out the block, and the signal never gets to the receiver at the end of the block. By comparing the signal received with the signal transmitted, a special-purpose computer determines whether the block is occupied or not. To keep the signal from one block from propagating into the next, a shorting bar is positioned at the end of each block. Detection of occupancy forces the speed-code generator to consider the speed codes for all blocks and to adjust them where necessary.



1. **Speed commands** on the Bay Area Rapid Transit system will be sent to up to 30 wayside boxes simultaneously on a single line with this multiplexed communication system. The comparison of data received with data transmitted in the fail-safe, bit-by-bit comparator yields vehicle location information as well.

In most of the United States, equipment for wayside use must be designed for temperatures of $-10°$ to $+45°C$, humidity of 5 to 95%, winds up to 94 mph; vibration of 1/4 g sustained at frequencies from 0 to 25 Hz, shock of 4 g's and rain of two inches for 24 hours. To withstand this environment, the equipment includes a heavy outer box for protection against animals and people, O-ring seals and a polyurethane conformal coating on circuit boards for enduring humidity and rain, potting of circuits for shock and vibration protection, and heavy-duty sealed connectors. Equipment designed for use on or under the vehicle must withstand temperatures of $-50°$ to $+75°C$, humidity of 5 to 95%, vibration of 1 g sustained at frequencies from 0 to 60 Hz, shock of 20 g's on 3 axes and, if the equipment is outside the vehicle, rain of two inches for 24 hours.

In addition wires must be run through steel conduits, antennas mounted under the vehicle must be sealed in a substance like fiberglas, O-ring seals must be used on all closures and circuit boards should never be cantilevered.

To protect against electrical interference from internal circuitry, such as chopper drives, and from external interference, including radio station antennas, electric power lines and steel bridges, the chosen frequencies must not fall in the harmonics of the chopper, narrowband interference filters must be used, wire must be run either as a shielded cable or twisted pair, single-point grounding should be used and transmission lines must be balanced to cancel out external fields. Any digital circuitry must use high noise-immunity logic.

Among other environmental factors that must be guarded against are acid and alkaline washing of the underside of the vehicle, stones kicked up off the track, grease on the track that might break the electrical contact of the car to the track, and unusual resonances due to distortions in the guideway or track.

David Cooper, director of engineering at the International Rectifier Corp. in El Segundo, Calif., points out that equipment for transportation systems must be designed with a minimum lifetime of 15 years and be relatively maintenance-free as well as fail-safe.

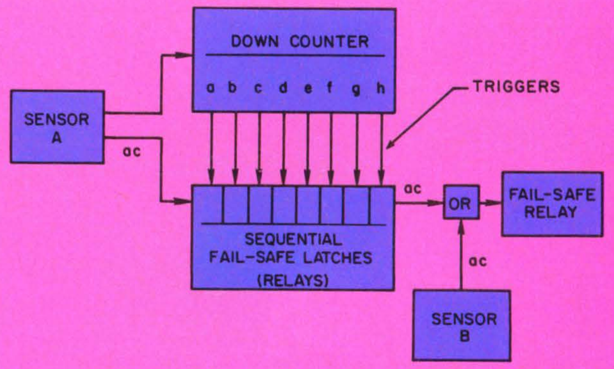
If the central computer in the BART system were to become completely inoperative, the system could still operate. Special-purpose computers would continue to run the vehicles. Since no one yet knows how to make a central computer control all operations in a fail-safe mode, most automated transit systems proposed have these small, special-purpose computers.

An example of fail-safe, solid-state electronics is a system of timing developed by Westinghouse to stop small passenger vehicles automatically at Tampa International Airport in Florida (see Fig. 2). According to David H. Woods, supervisor of train control at Westinghouse:

"The timer uses a device called a fail-safe latch. The latch is a solid-state relay that requires an ac signal to it to activate it. There is a trigger input also, as with any relay. The timer is configured such that a series of these latches are cascaded together with their trigger inputs connected to taps on a down-counter. The taps are outputs that appear as the counter reaches a preset count point.

"The down-counter has been designed so that the minimum counting time occurs when the outputs come in their proper sequence. At the end of the count, an ac signal appears at the output of the final latch. Fail-safety can be built into a system using this timer, since the timer can only fail by counting for too long and never for too short a period of time. Since the mode of failure is known, a system can be designed around this timer, which is fail-safe."

Moving-block command and control systems do not yet exist, outside of experimental models. The first moving-block system is to be built in the next few years in Morgantown, W. Va., with funds supplied by the Urban Mass Transportation Administration in Washington. The system will connect the two campuses of the University of West Virginia by means of a large number of small, rubber-wheeled vehicles on a guideway. The most interesting part of this system is the method by which the vehicles reach the proper speed. James Bryden, a member of the technical staff at the Jet Propulsion Laboratory in Pasadena, Calif., notes:



2. **Fail-safe timing** of a vehicle as it moves from one point to another along a guideway is done with a down counter and a cascaded series of solid-state latches. A vertical plate is mounted on the guideway at the beginning and end of timed areas. Sensor A and Sensor B are optical transmitter-receiver pairs. As the transmitter-receiver pairs pass over the vertical plates, transmission is interrupted. Sensor A starts the count. A minimum time must elapse between the triggering of these optical links, or a fail-safe relay will be tripped, stopping the vehicle.

"The car has on board a receiver, a decoder and an up-down counter that counts the number of pulses transmitted by a central computer. While the car is speeding up, the number of pulses the car receives is greater than the number of pulses generated off a shaft encoder that measures the wheel speed. When the number of pulses received from the computer equals the number of pulses generated by the shaft encoder, the appropriate speed has been reached. The car slows down by the same process in reverse."

Typical of the intriguing problems facing transportation system designers is that of how to detect the location or presence of a vehicle with rubber tires. In Morgantown it will be done with magnetic detectors implanted in the guideway. A vehicle passing over a detector will disturb the magnetic field, and a signal will be sent to a computer, which will record the presence of the car. This is fine in concept. However, when the time comes to design such a fail-safe magnetic metal detector, the story may be different. If the detector fails, the computer—if the system is to be fail-safe—must somehow sense any obstacle at that point and must stop the cars behind it or an accident might result.

Another rubber-tire vehicle system under construction is one to move people from terminal to terminal at the Seattle-Tacoma International Airport. Dr. Perry at Westinghouse considered magnetic detectors, load detectors, optical sensors and check-in, check-out devices for use on this fixed-block system. Because of the difficulty of designing any of the other conceptual systems in a fail-safe way, Perry decided on a check-in, check-out approach. The system uses an optical sensor at the beginning of the track to denote an initial block occupancy in a fail-safe way. If the sensor fails, the block reads "occupied." As the vehicle enters the next block, it will trigger a receiver at the wayside that will pull a fail-safe latching relay into an "occupied" state. At the same time the receiver will signal the preceding block to switch to "unoccupied." Therefore as a train enters a block, it signals "occupied," and when it leaves the block, it signals "unoccupied." If anything fails, an "occupied" signal will always remain behind the train to avoid a rear-end collision.

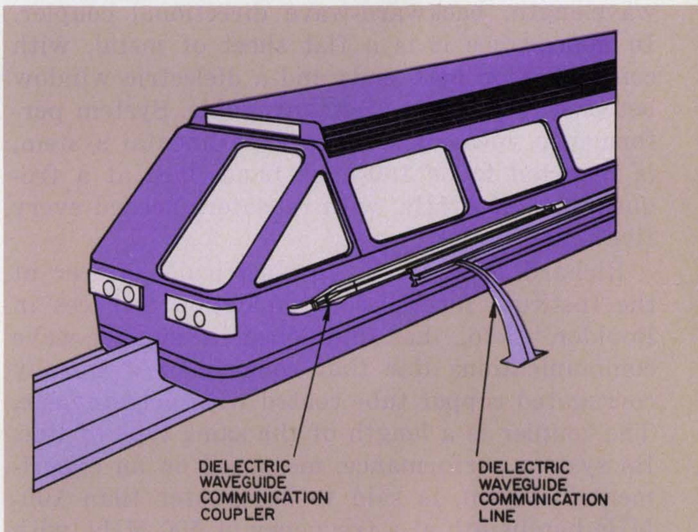
Gigahertz or kilohertz?

To have an automated command and control system, the controller must be able to communicate with the vehicles. According to Stuart W. McElhenny, manager of automation engineering at General Electric's Transportation Div. in Erie, Pa., "I can't imagine ever needing more than a few kilohertz of bandwidth for all command and control functions." If, in fact, no more than tens of kilohertz of bandwidth are needed, then the solution is simple. Data can be transmitted on a two-wire transmission line and can be picked up by the vehicle with an inductive loop coupler. The transmission line may even be the rails. As Dr. Perry of Westinghouse notes:

"Communications in BART are via a two-wire inductive loop system [the rails of the track]. Two frequencies between 5 and 10 kHz are shift-keyed at 18 Hz. Information is communicated with a 6-bit, comma-free code. BART has 9 six-bit speed commands."

Why then is the Office of High Speed Ground Transportation funding programs to develop communication systems with bandwidths on the order of 100 MHz to 1 GHz? Sources at the Dept. of Transportation have told ELECTRONIC DESIGN that the system of the future will not only have automatic command and control systems but will also have a great deal in the way of passenger conveniences. Such things as television, Picture Phones and other entertainment and communication services will one day ride the trains. Already telephones on the present Metroliners, traveling between Washington, D.C., and New York, are very heavily used. Each of these services requires many megahertz of bandwidth. An inductive line system will not do the job.

Most promising of the systems proposed for broad-bandwidth communications are a variety of guided microwave links (see table). These



3. **Bandwidths of up to 500 MHz** are possible with a dielectric waveguide communications link. A length of waveguide on the vehicle couples energy from the line. The waveguide consists of a semicylindrical rod of polyethylene, bonded to a metal shield.

range from a leaky, circular waveguide from Sumitomo Electric Industries in Osaka, Japan, to a dielectric image line from General Applied Science Laboratories in Westbury, N.Y.

Sumitomo developed a circular wave-guide with a continuous line of coupling holes down its entire length. As the vehicle passes by, a coupler on the vehicle collects energy from the radiated field of the leaky waveguide. The coupler proposed is a traveling-wave antenna with an elliptic reflector. System performance, measured on an experimental system, is reported to be about 85 MHz bandwidth at a frequency of 7.5 GHz, with repeaters needed every eight miles.

General Applied Science Laboratories has developed a dielectric waveguide (see Fig. 3) that consists of a strip of semicylindrical polyethylene mounted on a copper shield. The coupler is another length of dielectric line mounted on the vehicle. System performance, measured on an experimental system, is reported to be 500 MHz bandwidth at a frequency of 4 GHz, with repeaters needed every five or six miles. Tests have also been run on a 9-GHz prototype. This system had substantially more than 500-MHz bandwidth capabilities.

TEM waveguide has 100-MHz bandwidth

Wheeler Laboratories in Smithtown, N.Y., has developed a TEM waveguide that has a square outer conductor with one side open but protected by a cover of dielectric sheet. It has a round inner conductor supported by beads of dielectric sheet. The coupler on the vehicle is a quarter-wavelength, backward-wave directional coupler. In appearance it is a flat sheet of metal, with connectors on both ends and a dielectric window between it and the main waveguide. System performance, measured on an experimental system, is reported to be 100-MHz bandwidth at a frequency of 250 MHz, with repeaters needed every five or six miles.

Richard FitzGerrell, an electrical engineer at the Institute for Telecommunication Sciences in Boulder, Colo., has developed a surface-wave communications line that consists of a spirally corrugated copper tube coated with polyethylene. The coupler is a length of the same type of line. Its system performance, measured on an experimental system, is said to be greater than 100-MHz bandwidth at a frequency of 500 MHz, with repeaters needed every two miles.

TRW Systems in Washington, D.C., has completed a study of a variable parameter transmission line. It is basically a leaky wave transmission line, with ferrite material mounted in the coupling holes. When the magnetic field at the coupling holes is varied, the amount of coupling varies. Therefore the coupling is increased when the vehicle is present and decreased when it is not there. The advantage of this scheme is that the loss of the leaky waveguide would be greatly diminished, due to the fact that energy would not leak unless it was desired. Theoretically, according to David J. Bryant, head of the TRW electromagnetic systems section, repeater spacings could be increased to over 20 miles, while system bandwidths of over 500 MHz could be achieved. This system has not been as thoroughly tested as others, so experimental results are not available.

Sources in the Dept. of Transportation indicate that the General Applied Sciences dielectric line is the front-runner at present. Each line has problems with rain, snow and ice. All are fairly expensive—although this is miniscule compared with the cost of the guideway.

Propulsion of trains requires very high torque at 0 speed. This is most easily achieved by using dc motors, and therefore all major transit systems at present use such motor drives. But some future systems may use variable torque rotating ac induction motors, with pulse-width modulator control. "Small size," "inexpensive" and "maintenance-free" are words used by ac induction motor exponents. And the SCRs and integrated circuits necessary for the pulse-width modulator are now available.

Prior to the BART project, cam controllers were used for at least a century to set the dc motor speed. A cam controller is a rheostat with a set of discrete resistors that can be switched into and out of the field circuit of the motor. But for BART, cam control is being replaced with chopper control. Choppers have been around for many years, but the railroad industry is ordinarily very slow to accept change. Choppers have the advantage of being relatively lossless: They inject very little heat into the system. They also provide continuous speed control, rather than just discrete steps corresponding to the resistors in the cam controller. Terry D. Sanders, supervisor of solid-state train control at Westinghouse, notes:

"In addition the chopper can make braking regenerative. Normally we effect dynamic braking by using a chopper to control the energy to a bank of resistors in series with the field winding of the motor. Instead of dumping the power into fixed resistors and producing heat, the system can be regenerative and can feed the power back into the rail system to power other trains."

Linear motors headed for wider use

Although dc rotating motors are still favored, the future would seem to lie with linear motors. Linear-induction motors appear destined for use in high speed, inter-city vehicles, and linear-synchronous motors in low and medium-speed intra-city vehicles.

Most linear motors proposed today have their active part—the stator—on the vehicle. But for high-density systems, it may be practical to place the stator on the guideway. A linear motor is the same in its method of operation as a rotating motor; it is merely the same motor cut open and stretched out.

Garrett-AiResearch Corp. in Torrance, Calif., has built the only linear-induction motor in this country that is designed to drive a train. Others have been built in Europe. A 2500-hp motor has been installed by Garrett on a research vehicle, and the company is building an 8000-hp version that is to drive a Grumman tracked air-cushion research vehicle, soon to be tested in Pueblo, Colo. The motor will provide 8000 hp on a continuous basis, and 12,000 hp for three minutes. The vehicle will travel at speeds of over 250 mph.

Keith Chirgwin, chief engineer for ground transportation at Garrett, points out that some potential problems remain:

"One problem is that the 5/8-inch-thick reaction rail [rotor] can overheat and warp. The air gap between the coils and the reaction rail must also be kept fairly constant. On our research vehicle the gap from coil to reaction rail is about 0.45 inch for designed thrust."

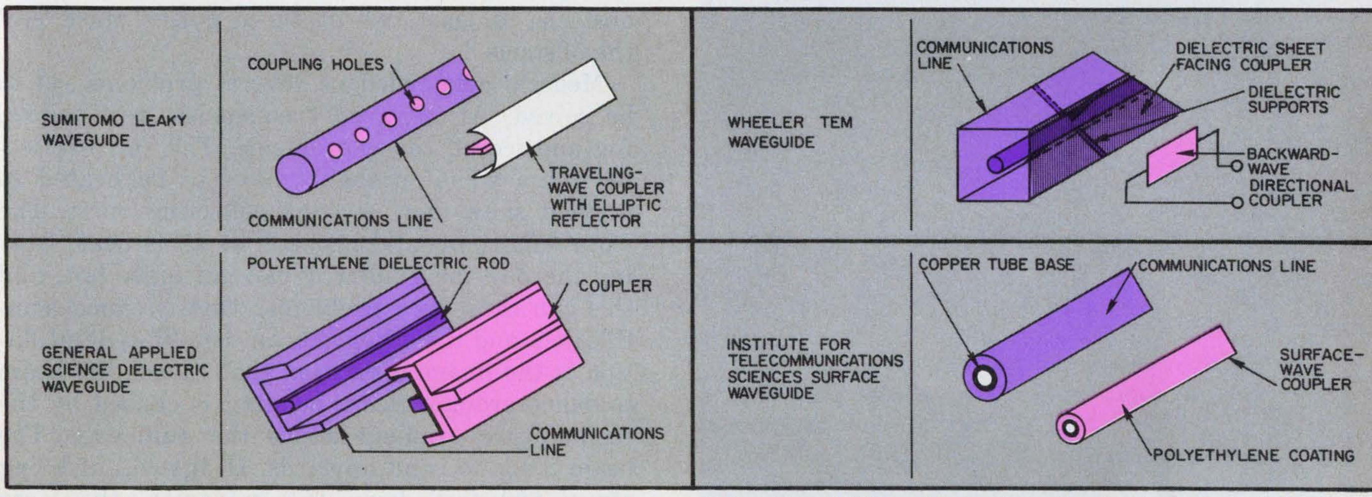
Dr. Richard A. Uher, senior engineer in the Westinghouse Transportation Div., notes some other problems:

"We feel that the reaction rail on a linear-induction motor will cause serious problems. At guideway and a passive vehicle."

Potentially better than tracked air-cushion vehicles for high-speed transit are electromagnetically suspended vehicles. Dr. James R. Powell, a nuclear engineer at the Brookhaven National Laboratory in Upton, N.Y., describes his proposed system this way:

"The train would have three sets of superconducting loops. They would be: one on either side for both suspension and propulsion, and one set on the bottom for lateral stability. The suspension, or lift, loops would sit between two passive loops on the guideway. The lift loops would balance halfway between the two guideway loops, due to field balancing. Thus the train could easily ride about six inches above the guideway and not have the small obstacle problems of a tracked air-cushion vehicle.

"Propulsion loops could be laminated together with the lift loops. Only that portion of the pro-



Future high-speed trains will carry communications systems with bandwidths on the order of 100 MHz to 1 GHz. Possibilities for such guided microwave links include these four broadband concepts.

high speeds a 5/8-inch reaction rail, such as Garrett is using, might crimp and distort due to the guidance forces. In addition long-term maintenance is very difficult on an extremely closely toleranced system."

Uher also cautions: "At speeds below 100 mph the efficiencies of a linear-induction motor drops to around 20%. At speeds of 150 mph or faster, efficiencies rise to at least 60%. At low speeds a linear-synchronous motor is practical. Efficiencies of 60% to 70% might be achievable at 20 to 30 mph."

At TRW Systems in Redondo Beach, Calif., Kenneth K. Tang, a member of the technical staff, reports: "Disney is experimenting with a linear-synchronous motor for a system that would be installed in Disney World in Florida. The initial development of the motor was done by North American Rockwell. This motor uses an active

pulsion loop that is normal to the direction of train motion provides thrust. A 100,000-pound train would require about 4000 pounds of thrust. That could be provided with about 4 MW of power. The levitation loops would carry about 300,000 to 400,000 amps, with essentially no i^2R losses at all."

Dr. Gordon T. Danby, a physicist at Brookhaven, explains: "For levitation, the train is active and the guideway is passive. For propulsion, the train is passive and the guideway is active. Propulsion would be linear synchronous, and sections of the tract could be switched so that only portions of the guideway are active at any point in time."

Coils are considered active when drive current is passed through them and passive when voltage is induced across them.

Consider the problem of providing 17 MW of power to a vehicle suspended in the air and moving at a speed of 250 mph.

Chirgwin of Garrett discusses the problem: Three phase, 60 Hz, 7500 V is the power to be distributed to the Grumman tracked air-cushion vehicle. We are proposing a group of three sliding carbon brushes on rails. The specs call out 99% contact with the rail, with no power interruption of more than 30 ms. The Grumman vehicle requires 12 MW continuous and 17 MW for three minutes. That means that up to about 2300 amps must pass from the rails to the vehicle. We propose to split that into two cables to ease the current-carrying requirement."

Dr. Uher at Westinghouse says: "We proposed a lightweight, sensitive, rugged sliding-contact system for power pickup—not unlike a phonograph tone arm."

Tang at TRW sounds this warning: "RF interference generated by sparking in the power pickup system might be a serious problem. The whole problem would, of course, be eliminated if it were the guideway that were active rather than the vehicle."

EIA panel considers transit

The Electronic Industries Association has established a mass-transportation panel that meets frequently throughout the year to discuss transportation problems. The panel is made up of top-level industry executives and is intended to serve as an interface between industry and the U. S. Dept. of Transportation. Chairman of the EIA panel is W. Earl Trantham Jr., manager of transportation control systems at General Telephone & Electronics Information Systems, Inc. Information about the panel can be obtained from Mr. Jean A. Caffiaux, EIA Headquarters, 2001 Eye St. NW, Washington, D. C. Tel. (202) 659-2200.

What if vehicle hits a stone?

Since tracked air-cushion vehicles are designed to go 250 mph at an altitude of 3/4 inch, and hitting anything at 250 mph would severely damage not only the vehicle but also the people riding inside, it's necessary to sense obstacles measuring an inch or more on the guideway far enough in advance so a vehicle can start braking at least two miles away. Two methods are proposed.

One is a laser system developed by General Applied Science Laboratories. According to Hector Medecki, senior research scientist:

"We use a moving mirror to provide a scan, and a series of laser transceivers strung out along the length of the guideway. The laser beam is reflected back off a continuous fence of corner reflectors. A corner reflector sends the reflected beam back at precisely the same angle as that of the incident beam. With a center-beam, raised, reaction rail guideway, we would deploy our retro-reflector fences on either side of the support base of the reaction rail.

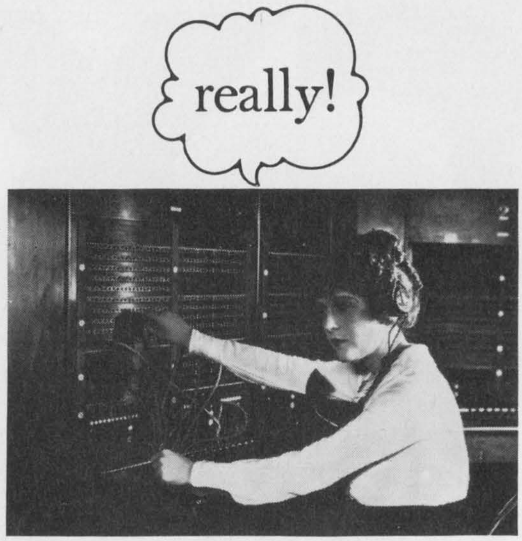
"We determine the presence of an object in the following way: We pulse the laser with a pulse width of about 1/10th of a microsecond. We then gate the receiver, so that the receiver is off when the pulse is transmitted and is only turned on when the pulse is expected to return from the nearest retro-reflector.

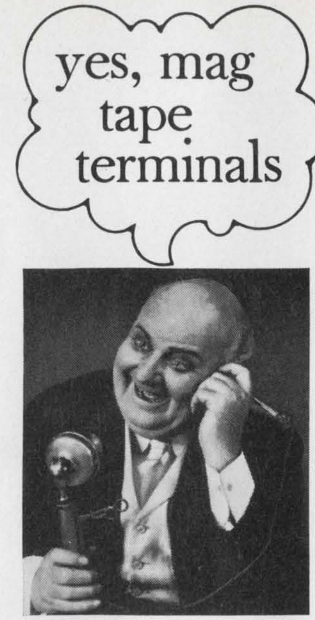
"The gating system allows us to receive a return only from the retro-reflector fence. If an object is in the way, the signal will not return. Our beamwidth is about 3/4 inch. During a scan the beam moves about 1/8 inch per laser pulse. Therefore, for an object of at least one inch in size, the receiver must receive at least three or four pulses. Before the detector will confirm an obstacle, at least two of three pulses must 'see' the obstacle."

Medecki acknowledges several problems yet to be solved. At infrared frequencies, rain, snow, fog and ice all cause problems. The retro-reflector fence would probably have to be heated to prevent snow and ice from collecting on it. The worst environmental problem of all is heat. During the day the guideway can get quite hot, and this can cause two problems: One is called scintillation, and the other is beam bending. Scintillation is the image distortion that causes the beam to dance around. Beam bending is caused by the temperature gradient above the guideway. The beam tends to bend upwards. If, instead of being aimed 600 feet down the guideway, the laser is only aimed for 300 feet, many of these problems are not as severe.

A similar system is currently being investigated by Applied Metro Technology in Barrington, N.J. This system uses light-emitting diodes in a nonlasing mode. According to Dr. Matthew J. Campanella, vice president of engineering, a typical installation would have transmitter-receiver pairs spaced every 70 feet along the guideway. Each transmitter would be aimed at a reflector up to 1000 feet down the guideway and mounted at the base of the reaction rail. Due to the broad beamwidths, any object would be hit by several overlapping beams without mechanical scanning. Interruptions in the beams would be detected by the receivers. The broad beamwidths would also serve to eliminate the beam-bending problem.

Other areas of surface mass transportation where electronics will play a part include automatic ticketing and station controlling, passenger conveniences and comfort, and security. ■■



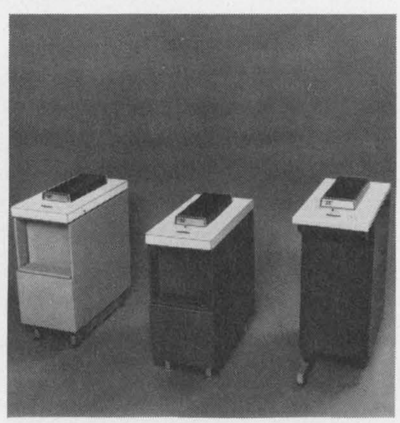


It's true.

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.



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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.

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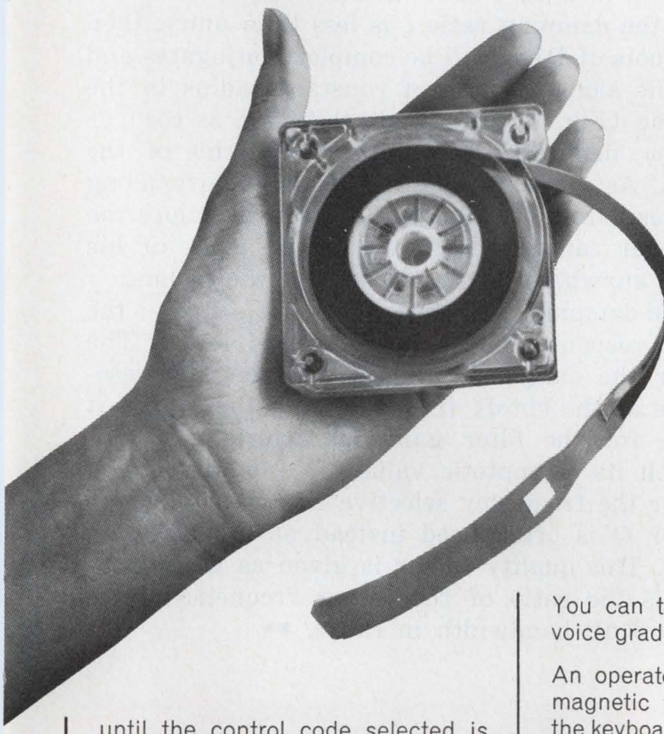
The units have a "fast access" switch which will move tape forward or reverse at a speed of 33 inches per second. A digit counter provides a reference point to help locate vari-ous areas of the tape.

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.

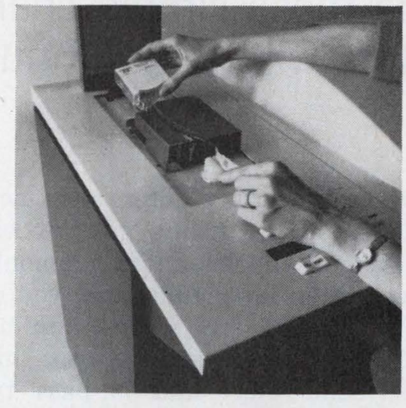
Also magnetic tape adds high speed on-line capability to low speed data terminals.

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.

machines that make data move

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INFORMATION RETRIEVAL NUMBER 52

Design active filters with less effort

Use these simple charts to design any of the five most common filters with a small number of components.

Designing active filters does not have to be a tedious job. By using only the essential design criteria for the five most commonly used second-order active-filter functions, you can design any one of these filters with a minimum of effort.

The five filters are low-pass, high-pass, band-pass, band-reject and all-pass types. Each of these filters uses resistors and capacitors as the passive elements and a high-quality op amp in a positive, fixed-gain configuration as the active element. There are other methods for generating these transfer functions, but the ones presented offer a simplified means for realizing these functions with a small number of components.

To fully characterize each of the five types of filters, the following information is needed:

- Voltage transfer function, H(s).
- Circuit configuration.
- Cutoff or center frequency, ω_o.
- Damping ratio ζ or quality factory Q.
- Stability functions.
- Passive component values.

Both the center (or cutoff) frequency and damping ratio (or quality factor) are selected to meet the over-all filter requirements. With these two pieces of information determined, the component values can be calculated.

The stability functions provide a measure of the sensitivity of the circuit to changes in component values. If components with tight tolerances are used, the filter performance will be very close to the initial specification. For the sake of economy, of course, component tolerances should be no tighter than the over-all filter performance requirements dictate.

A brief description of the denominator of the transfer function provides some insight into the characteristics of the five filters described.

All have the same denominator

All of the transfer functions of the filters shown have one thing in common—the denominator is second order. The transfer functions can all be written

$$H(s) = \frac{N(s)}{D(s)}$$

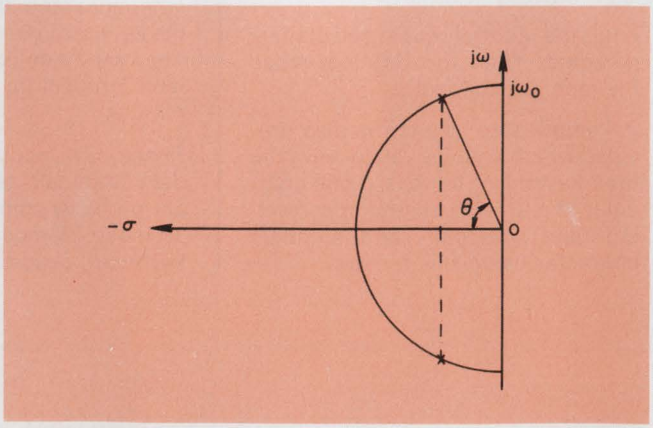
where

$$D(s) = s^2 + 2\,\zeta\omega_o s + \omega_o^2.$$

If the damping ratio ζ is less than unity, then the roots of D(s) will be complex conjugates and will lie along a circle of constant radius in the s-plane (Fig. 1). The angle Θ (given as $\cos^{-1}\zeta$) and ω_o determine the polar coordinates of the roots. As ζ varies, these roots will move along the semicircle. By choosing component values the designer can arbitrarily place the poles of his filter anywhere in the left half of the s-plane.

The damping ratio determines the shape of the filter response in the neighborhood of ω_o. The lower the damping ratio the greater the resonance at the cutoff frequency and the longer it takes for the filter gain characteristic to approach its asymptotic value of −40 dB/decade.

For the frequency selective filters, the quality factor Q is often used instead of the damping ratio. This quality factor is given as $Q = 1/2\zeta$ and is the ratio of the center frequency ω_o to the −3 dB bandwidth in rad/s. ■■



1. **The poles of the filter can be arbitrarily placed** anywhere in the s-plane in order to achieve the desired value of damping. The angle Θ is given as $\cos^{-1}\zeta$, where ζ is determined by the relative values of the passive components chosen for the particular active filter.

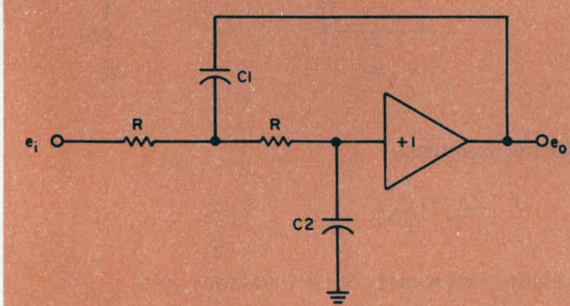
Howard T. Russell, Applications Engineer, Components Group, Texas Instruments, Inc., Dallas, Tex. 75222.

Low-pass

1. Transfer function:

$$H(s) = \frac{\omega_o^2}{s^2 + 2\zeta\omega_o s + \omega_o^2}$$

2. Circuit configuration:



3. Cutoff frequency:

$$\omega_o = \frac{1}{R\sqrt{C_1 C_2}}$$

4. Damping factor:

$$\zeta = \sqrt{\frac{C_2}{C_1}}$$

5. Stability functions:

(a) $$\frac{\Delta\omega_o}{\omega_o} = -\left[\frac{\Delta R}{R} + \frac{1}{2}\frac{\Delta C_1}{C_1} + \frac{1}{2}\frac{\Delta C_2}{C_2}\right]$$

(b) $$\frac{\Delta\zeta}{\zeta} = \frac{1}{2}\left[\frac{\Delta C_2}{C_2} - \frac{\Delta C_1}{C_1}\right]$$

6. Component values:

$$R = \left[\frac{\zeta}{\omega_o}\right]\frac{1}{C_2}$$

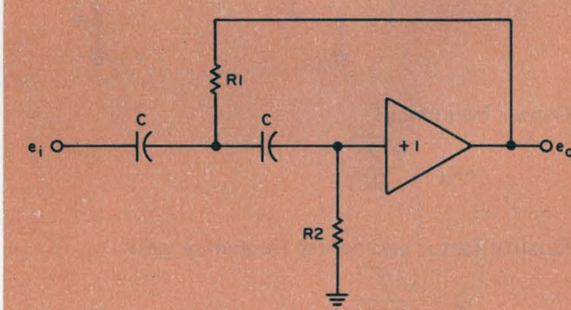
$$C_1 = \left[\frac{1}{\zeta^2}\right]\frac{1}{C_2}$$

High-pass

1. Transfer function:

$$H(s) = \frac{s^2}{s^2 + 2\zeta\omega_o s + \omega_o^2}$$

2. Circuit configuration:



3. Cutoff frequency:

$$\omega_o = \frac{1}{C\sqrt{R_1 R_2}}$$

4. Damping factor:

$$\zeta = \sqrt{\frac{R_1}{R_2}}$$

5. Stability functions:

(a) $$\frac{\Delta\omega_o}{\omega_o} = -\left[\frac{\Delta C}{C} + \frac{1}{2}\frac{\Delta R_1}{R_1} + \frac{1}{2}\frac{\Delta R_2}{R_2}\right]$$

(b) $$\frac{\Delta\zeta}{\zeta} = \frac{1}{2}\left[\frac{\Delta R_1}{R_1} - \frac{\Delta R_2}{R_2}\right]$$

6. Component values:

$$C = \left[\frac{\zeta}{\omega_o}\right]\frac{1}{R_1}$$

$$R_2 = \left[\frac{1}{\zeta^2}\right]\frac{1}{R_1}$$

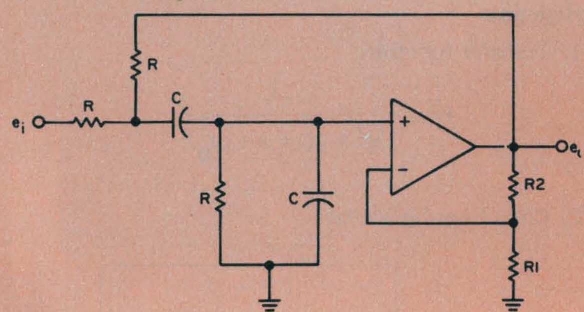
(continued on page 84)

Bandpass A

1. Transfer function:

$$H(s) = \frac{K_o(\omega_o/Q)s}{s^2 + (\omega_o/Q)s + \omega_o^2}$$

2. Circuit configuration:



3. Center frequency:

$$\omega_o = \frac{\sqrt{2}}{RC}$$

4. Quality factor and center frequency gain:

$$Q = \frac{\sqrt{2}}{5\text{-}K}$$

$$K_o = \frac{K}{5\text{-}K}$$

where $K = 1 + \frac{R_2}{R_1}$

5. Stability functions:

(a) $\frac{\Delta\omega_o}{\omega_o} = -\sqrt{2}\left[\frac{\Delta R}{R} + \frac{\Delta C}{C}\right]$

(b) $\frac{\Delta Q}{Q} = (2\sqrt{2}\ Q\text{-}1)\left[\frac{\Delta R_2}{R_2} - \frac{\Delta R_1}{R_1}\right]$

(c) $\frac{\Delta K_o}{K_o} = (3.54Q)\left[\frac{2.84Q-1}{3.54Q-1}\right]\left[\frac{\Delta R_2}{R_2} - \frac{\Delta R_1}{R_1}\right]$

6. Component values:

$$R = \frac{\sqrt{2}}{\omega_o C}$$

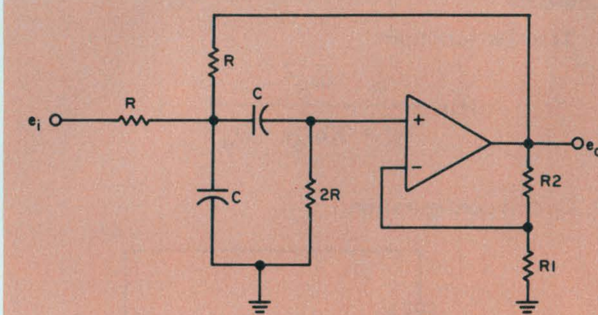
$$R_2 = \left[4 - \frac{\sqrt{2}}{Q}\right] R_1 = (K\text{-}1)\ R_1$$

Bandpass B

1. Transfer function:

$$H(s) = \frac{K_o(\omega_o/Q)s}{s^2 + (\omega_o/Q)s + \omega_o^2}$$

2. Circuit configuration:



3. Center frequency:

$$\omega_o = \frac{1}{RC}$$

4. Quality factor and center frequency gain:

$$Q = \frac{1}{3\text{-}K}$$

$$K_o = \frac{K}{3\text{-}K}$$

where $K = 1 + \frac{R_2}{R_1}$

5. Stability functions:

(a) $\frac{\Delta\omega_o}{\omega_o} = -\left[\frac{\Delta R}{R} + \frac{\Delta C}{C}\right]$

(b) $\frac{\Delta Q}{Q} = (2Q\text{-}1)\left[\frac{\Delta R_2}{R_2} - \frac{\Delta R_1}{R_1}\right]$

(c) $\frac{\Delta K_o}{K_o} = 3Q\left[\frac{2Q\text{-}1}{3Q\text{-}1}\right]\left[\frac{\Delta R_2}{R_2} - \frac{\Delta R_1}{R_1}\right]$

6. Component values:

$$R = \frac{1}{\omega_o C}$$

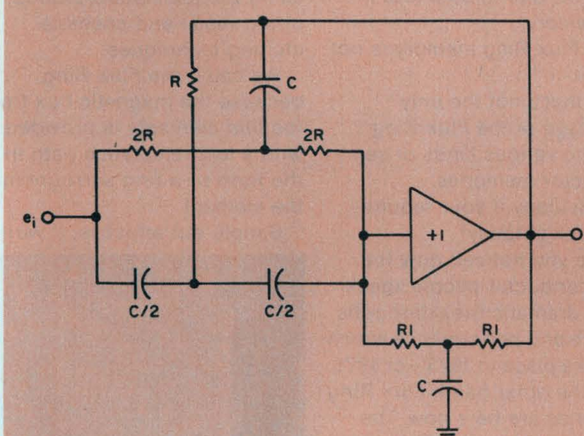
$$R_2 = \left[2 - \frac{1}{Q}\right] R_1 = (K\text{-}1)\ R_1$$

Band-reject

1. Transfer function:

$$H(s) = \frac{s^2 + \omega_o^2}{s^2 + (\omega_o/Q)s + \omega_o^2}$$

2. Circuit configuration:



3. Center frequency:

$$\omega_o = \frac{1}{RC}$$

4. Quality factor:

$$Q = \frac{R_1}{4R}$$

5. Stability functions:

(a) $$\frac{\Delta\omega_o}{\omega_o} = -\left[\frac{\Delta R}{R} + \frac{\Delta C}{C}\right]$$

(b) $$\frac{\Delta Q}{Q} = \left[\frac{\Delta R_1}{R_1} - \frac{\Delta R}{R}\right]$$

6. Component values:

$$R = \frac{1}{\omega_o C}$$

$$R_1 = \left[\frac{4Q}{\omega_o}\right]\frac{1}{C}$$

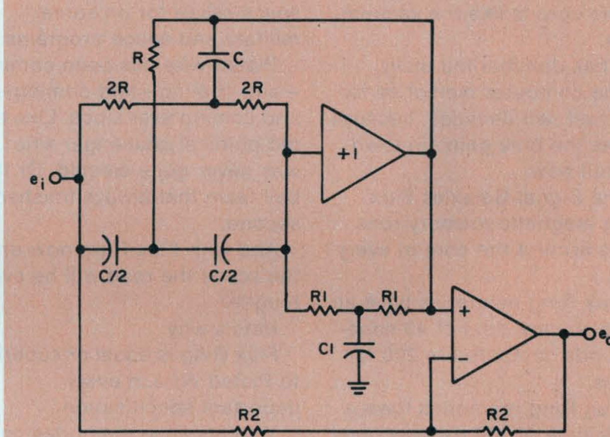
$$C_1 = \left[\frac{1}{2Q}\right]C$$

All-pass (360°)

1. Transfer function:

$$H(s) = \frac{s^2 - (\omega_o/Q)s + \omega_o^2}{s^2 + (\omega_o/Q)s + \omega_o^2}$$

2. Circuit configuration:



3. Center frequency:

$$\omega_o = \frac{1}{RC}$$

4. Quality factor:

$$Q = \frac{R_1}{4R}$$

5. Stability functions:

(a) $$\frac{\Delta\omega_o}{\omega_o} = -\left[\frac{\Delta R}{R} + \frac{\Delta C}{C}\right]$$

(b) $$\frac{\Delta Q}{Q} = \left[\frac{\Delta R_1}{R_1} - \frac{\Delta R}{R}\right]$$

6. Component values:

$$R = \frac{1}{\omega_o C}$$

$$R_1 = \left[\frac{4Q}{\omega_o}\right]\frac{1}{C}$$

$$C_1 = \left[\frac{1}{2Q}\right]C$$

THE FLUX RING MEMORY. HERE'S WHAT IT ISN'T.

IT ISN'T SLOW AND BULKY LIKE THE CORE.
Remember the vacuum tube?

It was the dominant component of all things electronic just a few short years ago.

The core is like the vacuum tube.

It has dominanted main frame computer memories for the past two decades, because it was the only game in town.

Until now.

The Signal Galaxies Flux Ring magnetic memory runs rings around the core in every way.

Flux Ring memories have an initial access time of 40 nanoseconds compared to 200 for cores.

Flux Ring memories have a cycle time of 100 nanoseconds compared to 600 for cores.

Flux Ring memories have a complementary bit structure which cancels common mode noise.

Flux Ring memories have a Mean Time Between Failure several times better than the best core memory you can buy.

You can buy an 8,192 bit Flux Ring array for less than a penny a bit. Or a 65,536 bit Flux Ring stack for under 0.8¢ a bit.

Can you think of any reason for specifying a core memory rather than a Flux Ring memory?

IT ISN'T EXPENSIVELY COMPLEX LIKE PLATED WIRE.
Plated wire memories came along during the mid-'60s because cores just couldn't hack the tough environmental specs asked for on some military and space programs.

Plated wire has been coming — and coming — and coming — and coming ever since. Like the old political challenger who was never quite elected. Or the ball team that always finished second.

And with Flux Ring now on the scene the road will be even tougher.

Here's why.

Flux Ring is equal or superior to Plated Wire in every important specification.

Yet Flux Ring memories cost less than half as much on a bit for bit basis.

Check the Flux Ring specs we covered in column one. Compare them to the best Plated Wire specs available anywhere.

You'll find the Flux Ring memory is about twice as fast. It requires less complex electronics. Operates on about one-half the drive current. Has a much better Mean Time Between Failures. And, being batch processed, costs a lot less.

Can you think of any reason for specifying Plated Wire instead of Flux Ring?

IT ISN'T VOLATILE LIKE A SEMI.
Non-volatility is very important in military, and many commercial applications where loss of power could cause critical problems due to data loss in the memory.

The Flux Ring memory is not volatile.

But that's not the only advantage of the Flux Ring over the various kinds of semiconductor memories.

Particularly if your requirements exist today!

Have you noticed how the semi-conductor people speak of the dramatic breakthroughs in price and performance which will take place in 1973 — or 1975.

On the other hand, Flux Ring memories are here now. The yields are high.

When you look at the fine print you'll find Flux Ring memories are faster than ICs. And when all of the costs are added up you'll find them to be less expensive too.

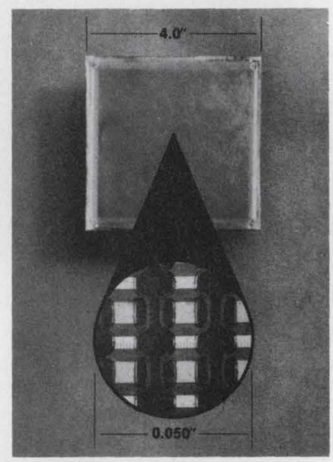
Should you specify a semiconductor memory without at least looking at an equivalent Flux Ring?

FLUX RING. IT IS THE BEST OF ALL THE ISN'TS.
What is a Flux Ring?

It's a batch fabricated planar array of magnetic thick-film elements manufactured by using unique electro-plating, photo-resist and chemical etching techniques.

We call it the Flux Ring because the magnetic flux from the film elements is provided with a low reluctance path in the form of a ring surrounding the element.

Simple but effective. It works.



THE $80 ARRAY. HOORAY.
Here is a flux ring array. Just 4 by 4 inches square and .075 inches thick. This one contains 8,192 bits (64 by 128). By the time the ink dries on this ad we will be offering 3 times the packing density. You can buy this array for just $80 in 100 lots.

We also have 64,000 bit stacks and complete memory modules too.

So don't specify ANY memory until you carefully compare price and performance to the Flux Ring.

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INFORMATION RETRIEVAL NUMBER 53

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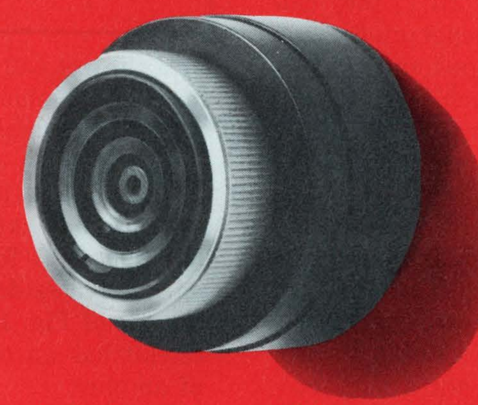

Actual size

You'll get it from our 1¼-ounce Sonalert® electronic audible signal.

With as little as 6 VDC and 3 ma., Sonalert produces a piercing sound that's hard to ignore. Yet it weighs only a couple of ounces because it's all solid state. Even the transducer is a crystal. This makes Sonalert reliable, efficient and long lasting. And because it's solid state, there's nc danger of arcing, no RFI or EMI noise, important considerations in computer and other control signal applications.

Standard units vibrate at a fixed frequency of 2900 ± 500 Hz or 4500 ± 500 Hz depending on model. In addition, pulsing, warbling and AC models are available. The penetrating sound covers a wider area than alarm lights and demands instant action. This makes Sonalert ideal where ignoring warnings would be hazardous or cause damage. Examples: aircraft fuel warning, electrical overload, computer error, automobile door ajar or headlights-on warning. Other applications include communications, shipboard, missile and medical electronics alarms.

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INFORMATION RETRIEVAL NUMBER 54

Boost op-amp power in ac circuits

by adding a split-load output stage. It's economical in parts and power.

The versatility of packaged operational amplifiers makes them useful as building blocks for a wide variety of circuits. Their versatility can be improved, however, if their output power is boosted to handle electro-mechanical loads such as servo motors, solenoids and mechanical choppers.

One good way to get more power out of an op amp is to hang a complementary emitter-follower stage onto its output (Fig. 1).

In a typical system, the power-supply buses are about ±25 V or more while most op amps are designed to work at ±15 V or less. Since the op amps require only about 10 mA at 15 V, they can be operated from a 25-V line if zener diodes are used to limit the voltage. The output emitter followers, however, must provide much larger peak-current swings (about 100 mA for a 0.5-W, 10-V, pk output) and thus should be supplied directly from the 25-V buses.

Since the high-current pulses in each of the emitter-follower collector circuits can be accompanied by a 15 to 20-V voltage swing—25-V supply minus 5 to 10-V peak emitter swing—the power dissipation in both collectors will exceed the power delivered to the load—not a very economical way to operate. The 0.5-W circuit of Fig. 1, for example, has an output-circuit efficiency of about only 33%.

Split-load circuit increases efficiency

If a transformer, having three equal windings (two primaries and a secondary), is connected as shown in Fig. 2, the power developed in the collector circuits can be usefully coupled to the load instead of being dissipated in the transistors. This split-load configuration reduces the collector dissipation by a factor of three in this case since the peak collector-to-emitter voltage can now be reduced to 5 V or less, as compared with its previous value of 15 to 20 V.

An efficiency of about 67% can be realized (out of a theoretically possible 78%) while the power output is doubled to about 1 W. This power output is obtainable with transistors having betas of 50 or more, at currents of 100 mA.

Comparison of Parameters

Parameter	Ordinary emitter follower	Split-load stage
Turns ratio (N)	0	$(V_{cc}/e_{in}) - 1$
Output impedance	$R_g/(\beta+1)$	$R_g/(\beta+1)\ (N+1)$
Input impedance	$R_L(\beta+1)$	$R_L(\beta+1)\ (N+1)$
Efficiency	$(\pi/4)\ (e_{in}/V_{cc})$	Approaches $\pi/4$ or 78%

The output impedance of the split-load configuration is extremely low. It was measured to be about 3 Ω for the 1-W circuit when used as an oscillator-driver (following the feedback scheme of Fig. 1). When used as an amplifier, the circuit has an output impedance of a few tenths of an ohm.

The output-power capability is limited by two factors: the output-current capacity of the op amp and the betas of the output transistors. The peak output current capability of the circuit is equal to the product of these two factors.

Since the output-voltage swing is limited to 20 V, peak-to-peak, the current limits the output power. Typically, an IC op amp has a peak output current rating of 2 mA; hence the circuit's output current is limited to $\pm 2\beta$ mA.

The output is capacitively coupled to the transformer winding to allow an effective dc feedback path. When the circuit is used as an oscillator-driver, this capacitive coupling renders the circuit almost immune to destruction by output short circuits. With the output shorted, the npn transistor delivers only enough current for the wiper of pot R_a to exceed about 0.75 V—the voltage required to make D_1 conduct.

The circuit of Fig. 2 is a special case of the

Sergio Bernstein, President, Berne Electronics, Inc., 28 Havilands Lane, White Plains, N. Y. 10605.

general configuration shown in Fig. 3. To see how the scheme works, let windings e-f and g-h be used as reference with a unity turns ratio between them. Then, ignoring base-emitter drops and assuming that the saturation resistances of the transistors can be neglected, we can write

$$e_{out}/1 = e_{in}/1 = (V_{cc} - e_{in})/N_1 \quad (1)$$

where N_1 is the turns ratio between the collector windings (a-b and c-d) and the reference windings.

To maximize output power and efficiency, therefore, N_1 should be selected so that

$$N_1 = (V_{cc}/e_{in}) - 1. \quad (2)$$

It should be emphasized that e_{in} is the peak value of the input signal.

In the example of Fig. 2, the turns ratio was chosen as unity. Since $e_{in} = 10$ V pk, there is 10 V pk at the emitters of Q_1 and Q_2. With $N_1 = 1$, there is a 10-V drop between V_{cc} and each collector. This leaves 5 V for V_{cc} across each transistor, permitting linear operation.

The load current has two components

Note that the load current, I_L, is not equal to the emitter current I_e, but is comprised of two components. One is equal to I_e as expected from the unity transformation ratio between the emitter and output windings. However, an additional component is coupled to the output winding from the collector circuits. The component is equal to N_1I_c, or approximately N_1I_e. It is this second component which increases the efficiency of the split-load circuit.

The load current, I_L, is therefore given by

$$I_L = I_e + N_1I_c \cong I_e(N_1 + 1) \quad (3)$$

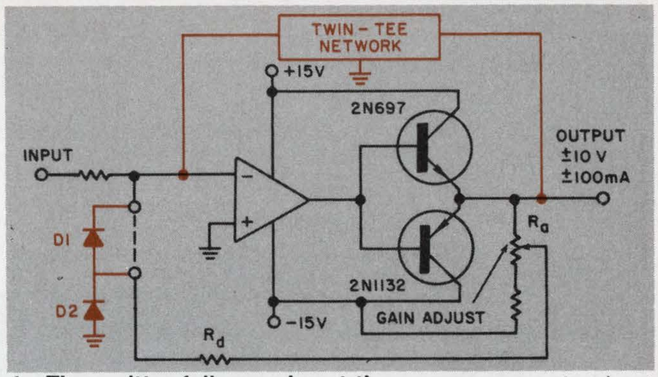
The above relationship holds true, even if the load R_L is connected directly at the emitter, and not through an output winding; provided of course, that winding e-f is in the circuit, as shown. This, indeed, is the situation in Fig. 2.

From Eq. 3 it is seen that the emitter current is less than the load current by a factor $1/(N_1 + 1)$. This allows lower power transistors to be used for a given load. The base drive requirement is lowered, the input impedance is increased, and the output impedance is decreased as well.

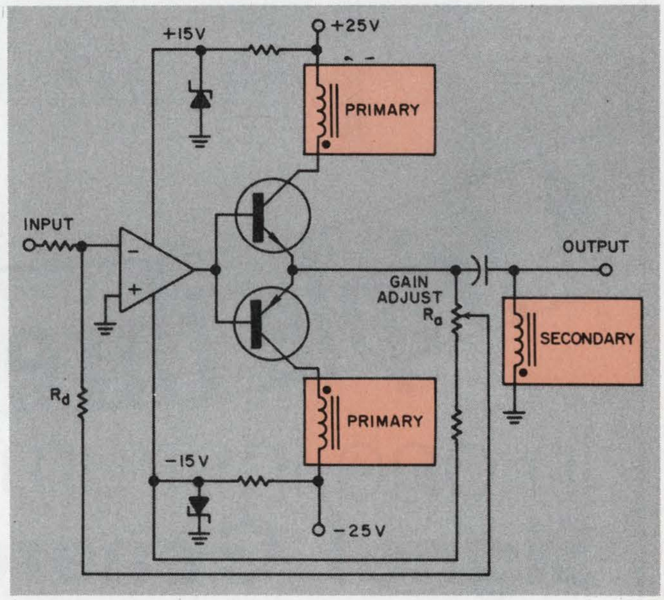
A summary of the superior parameters obtained with a split-load stage is given in the table. It should be noted that the formulas for the input impedance, output impedance and efficiency of the emitter-follower circuit are special cases of the formulas for the split-load stage, with $N = 0$. In particular, $N = 0$ implies that $e_{in} = V_{cc}$ and the efficiency of the emitter follower becomes $\pi/4$. ■■

Acknowledgment

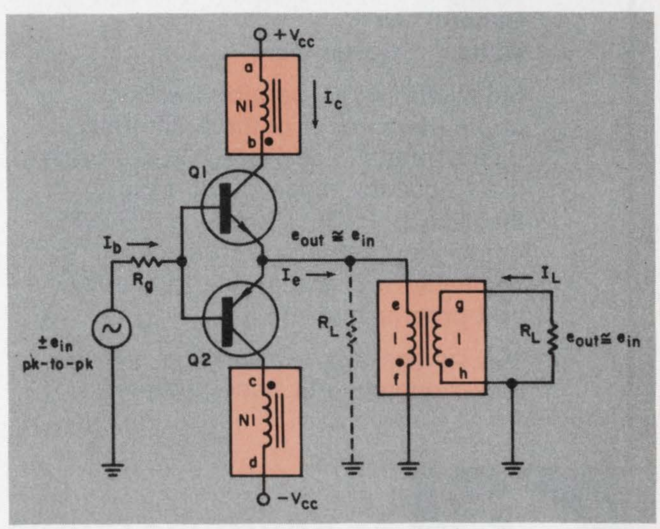
This work was done while the author was with the Perkin-Elmer Corp., Norwalk, Conn.



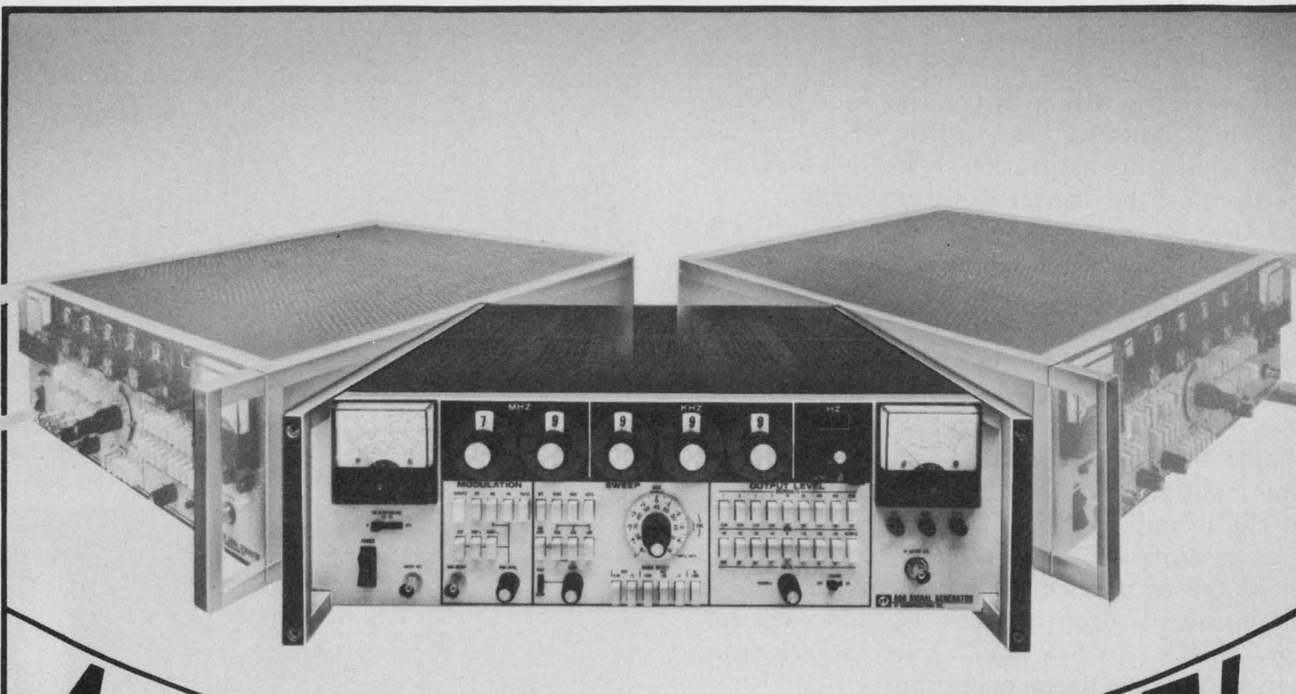
1. **The emitter followers boost the op-amp power** to about 0.5 W. With the dashed line connected and the colored components omitted, the circuit is a linear amplifier. The reverse case yields an oscillator-driver.



2. **The transformer doubles the power and efficiency** of the output stage by coupling the power developed in the collector circuits into the load. The output can now provide ±10 V at currents up to ±200 mA. This circuit can also be used as an oscillator-driver by employing the feedback scheme illustrated in Fig. 1.



3. **The generalized split-load output stage** has an N_1:1 turns ratio between the collector windings and the output windings. In the analysis in the text it is assumed that β is high enough to consider $I_e = I_c$.


MHZ
KHZ
HZ
MODULATION
SWEEP
OUTPUT LEVEL

Custom compensate your op amp. You can extend the closed-loop frequency response and get higher slew rates and lower gain-error.

If you're interested only in "average" performance with the new generation of monolithic operational amplifiers, follow the manufacturer's recommendations and link the unit to the capacitor that the spec sheet calls for. But if you want super performance with your super-gain op amp, substitute an RC network designed especially for your application.

The new op amps, such as Fairchild's μA748 and Amelco's 841, leave the shaping of the open-loop frequency characteristics entirely to the user. Although the manufacturers recommend connecting a single external capacitor to the device between pin numbers 1 and 8 (Fig. 1a), with a little understanding of the basic transistor electronics involved and a little determination, the circuit designer can greatly extend the open-loop gain for a given frequency domain. At the same time he can maintain the stability and phase margin.

Increase the open-loop gain

The main purpose for improving the open-loop gain at a higher frequency of operation is to reduce the op amp's closed-loop gain error, which is defined as the difference between the ideal closed-loop gain and the practical closed-loop gain. Expressed mathematically,

$$\left\{-\frac{R_F}{R_{IN}}\right\} - \left\{\frac{R_F}{R_{IN}}\left[1 - \frac{1}{A_V}\left(1 + \frac{R_F}{R_{IN}}\right)\right]\right\} = \frac{1}{A_V}\left(1 + \frac{R_F}{R_{IN}}\right) \quad (1)$$

where A_V is the finite ac open-loop gain of the amplifier at the frequency of operation, and R_{IN} and R_F are the input source and feedback resistances, respectively.

For example, for a unity-gain amplifier to have an accuracy of 0.01%, A_V must be greater than 20,000 V per volt at the frequency of interest. The manufacturer's recommendation would limit the user to a 0-to-60-Hz bandwidth. But with custom compensation techniques, the user can extend the 0.01% gain accuracy bandwidth to greater than 400 Hz. Another beneficial byproduct of this approach is the increase in the slew-rate for the unity-gain mode to approximately 1.0 V/μs.

A practical illustration of the kind of frequency response (Bode plot) that one might like to see, which promises extra gain-error reduction, is shown in Fig. 2. Control theory stipulates that, for optimum stability, the slope of the Bode plot at the crossover (unity-gain) frequency be not much greater than 20 dB per decade for an acceptable phase margin. The custom compensation technique uses two capacitors and a resistor, connected as indicated in Fig. 1b.

The first step to complete understanding of this technique requires thorough familiarity with the simplified schematic of the op amp's internal electronics (Fig. 3), which at the same time serves as an excellent conceptual model.[1] Clearly recognized is a cascaded arrangement of three distinct transistor amplifier stages: a differential amplifier; a high-gain, double feedback common-emitter transistor amplifier, and a unity-gain transistor buffer.

It is the second stage, with the behavior of its loading characteristics as well as its capacitive feedback contributions to the output of the first stage, which commands most attention. These are the two key factors that decisively locate the breakpoint frequencies of the poles and zeros in the over-all Bode plot.

Consider first the components R_2 and C_2 connected in series between pin numbers 7 and 8 in the redrawn second stage (Fig. 4a). The two diodes serve merely to reduce the zero crossover distortion of the ac signal that may be present at the output of the device, and they need not be accounted for analytically. This common-emitter configuration can be generalized into the network described in Fig. 4b, where the impedance Z_E acts as a resistive series-current degenerative feedback, Z_F provides the capacitive-

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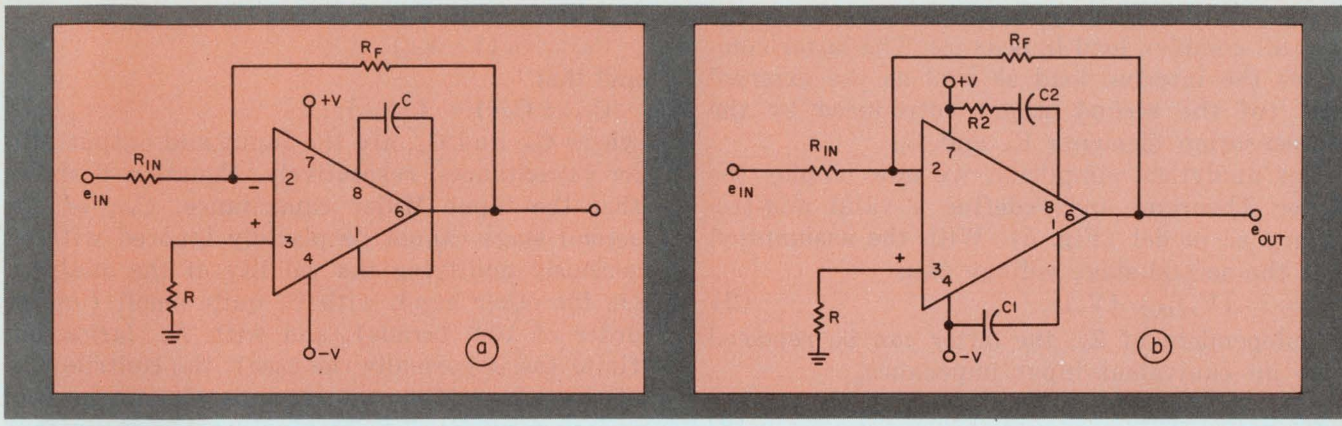
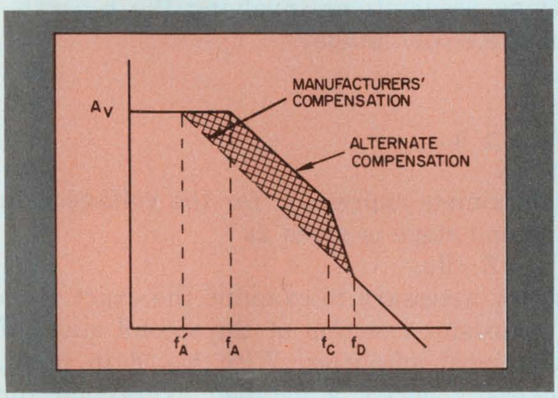
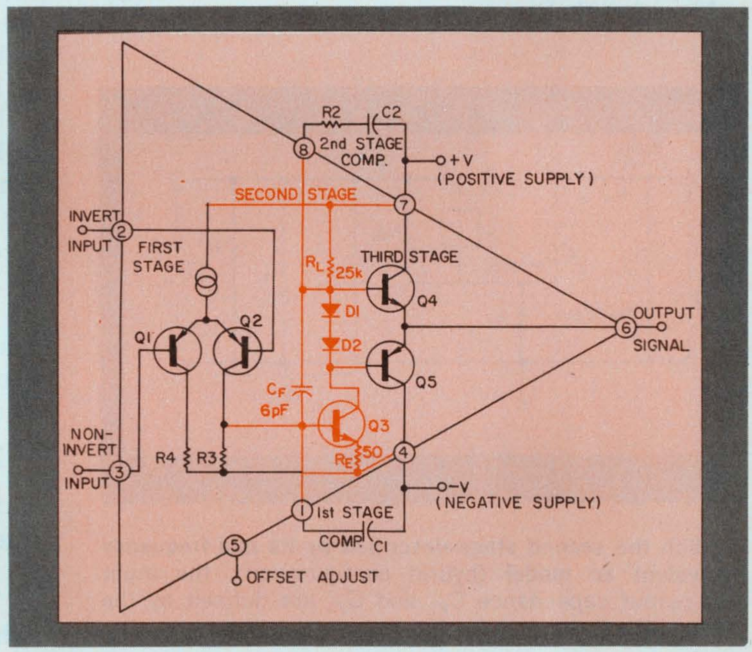


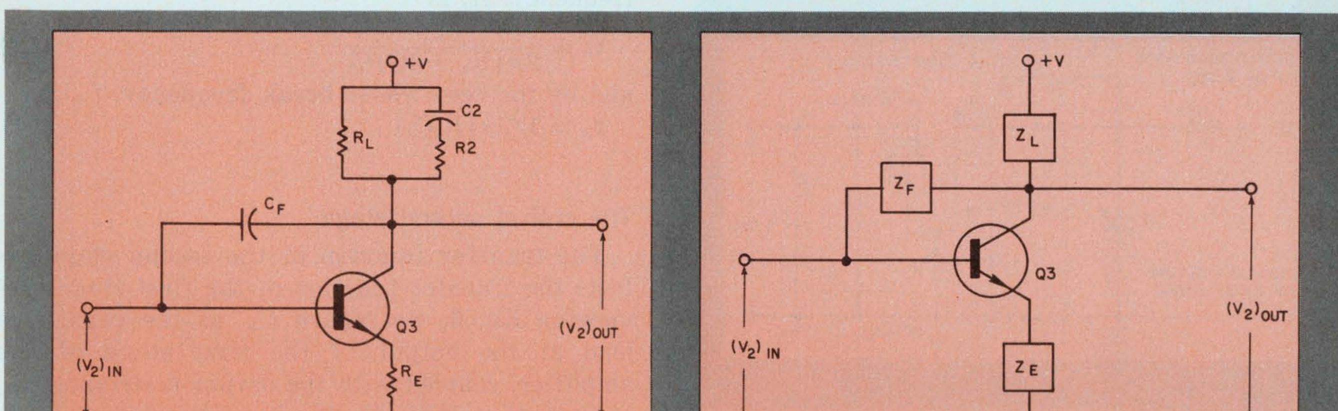
1. **The recommended compensation specified by the manufacturer** employs a single capacitor that introduces a simple 20-dB roll-off at low frequency and stabilizes the device against temperature variations and parts replacement. High-gain flexibility accompanied by low gain-error reduction at the frequency of interest is provided by this alternate hook-up (b) of external components (resistor R2 and capacitor C2).



2. **Bode plots of both compensation techniques** are compared by graphical superposition to illustrate the increased gain for the extended frequency domain. Note the addition of another pole and zero to the Bode plot.

3. **Simplified schematic shows the internal electronics** of each of the three amplifier stages and their relation to the external components.





4. **The device's second stage is redrawn (a) for analytical simplicity.** Internal as well as compensation (external) feedback elements are recognized. The second stage can be visualized as a general common-emitter configuration (b), with the basic impedance elements defined as shown.

shunt negative voltage feedback, and Z_L is the over-all complex load impedance. The latter comprises the internal load as well as the external load (of the second stage) introduced by the compensation elements R_2 and C_2.

For analytical simplicity, we now employ the Miller Theorem[2] and redefine a valid mid-frequency ac model (Fig. 5). With the assumption that the second-stage voltage gain

$$A_{V2} = (V_2)_{OUT}/(V_2)_{IN} \quad (2)$$

is independent of Z_F, the latter can be replaced with an equivalent input impedance,

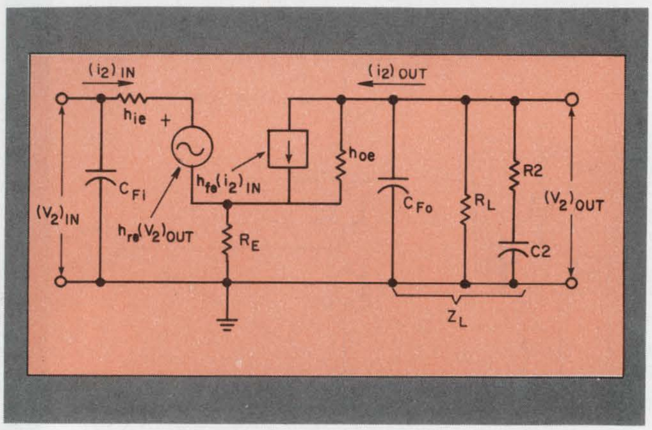
$$Z_{F1} = \frac{Z_F}{1 + A_{V2}} \quad (3)$$

and also with an equivalent output impedance,

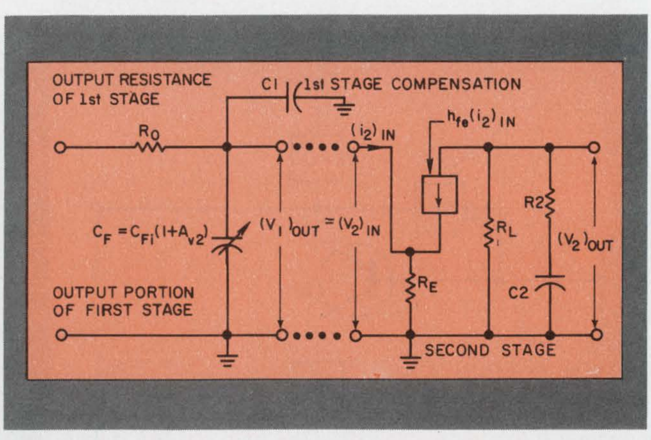
$$Z_{Fo} = \frac{Z_F}{1 + (1/A_{V2})} . \quad (4)$$

Since

$$Z_F = 1/sC_F , \quad (5)$$



5. **With the second stage described by its mid-frequency equivalent ac model** (hybrid configuration), the input and output capacitance C_{Fi} and C_{Fo} are defined by the Miller Effect.



6. **Valid ac model of combined first and second stages** of the device, with $C_{Fo} = 0$ and with the effect of h-parameters reduced for analytical simplicity. Note that C_{Fi} is a function of the second-stage gain, A_{V2}, the impedance of which decreases with an increase in frequency; this variation in C_{Fi} is compensated by C_1 connected in parallel.

it follows from Eqs. 3 and 4 that

$$C_{Fi} = C_F(1+A_{V2}) \quad (6)$$

and that

$$C_{Fo} = C_F(1 + 1/A_{V2}) , \quad (7)$$

where C_{Fi} and C_{Fo} are the input and output Miller capacitances, respectively. Equation 6 shows that the input Miller capacitance, C_{Fi}, of the second stage cannot be placidly ignored without seriously nullifying the validity of the analysis. On the other hand, with C_F quite small (on the order of 10^{-12} farads), and with A_{V2} large, but finite (as is normally the case), the contribution of the output Miller capacitance, C_{Fo}, to the load is seen from Eq. 7 to be considerably diminished in importance, and hence negligible:

$$C_{Fo} \simeq 0. \quad (8)$$

Replacing the common-emitter transistor with its hybrid model, we then enumerate the usual simplifying assumptions involving the h-parameters of the second stage:

$$h_{re} \simeq 0. \quad (9a)$$
$$h_{oe} \simeq 0. \quad (9b)$$
$$h_{fe} R_E >> h_{ie}. \quad (9c)$$
$$h_{fe} >> 1. \quad (9d)$$

The approximate expression for the voltage gain of the second stage is given as[3]

$$A_{V2} = -Z_L/R_E. \quad (10)$$

It is now necessary to examine the exact form of the transistor function of the second stage of the operational amplifier. With Eq. 8 in mind, we can easily derive a detailed expression for the load impedance, Z_L (Fig. 6):

$$Z_L = R_L \left[\frac{1+SR_2C_2}{1+S(R_L+R_2)C_2}\right] . \quad (11)$$

Substituting Eq. 11 into Eq. 10, we find that the gain of the second stage is

$$A_{V2} = K_2 \left[\frac{1+SR_2C_2}{1+S(R_L+R_2)C_2}\right] , \quad (12)$$

where $K_2 = -R_L/R_E$. Evidently the frequency response is governed by the pole whose break frequency, f_B, is

$$f_B = \frac{1}{2\pi(R_L + R_2)C_2} \quad (13)$$

and by the zero whose break frequency, f_D, is

$$f_D = 1/2\pi(R_2C_2) . \quad (14)$$

The critical second stage

The transfer function of the second stage affects the transfer function of the first stage. Reviewing Eq. 6, we regard C_{Fi} as the capacitive load at the output of the first stage of the amplifier, coupled with the output resistance, R_o, of that stage (Fig. 6). We immediately recognize a low-pass configuration, where the voltage gain, A_{V1} of the first stage can be written as

$$A_{V1} = \frac{(V_1)_{OUT}}{(V_1)_{IN}} = K_1 \left[\frac{1}{1 + SR_oC_{Fi}}\right] , \quad (15)$$

where K_1 is the fixed dc gain of the first amplifier stage. If A_{V2} is assumed to be much greater than unity, Eq. 6 can be reduced to

$$C_{Fi} = C_F A_{V2} , \quad (16)$$

and Eq. 15 becomes

$$A_{V1} = K_1 \{1/1 + SR_oC_F[A_{V2}]\} . \quad (17)$$

Substituting Eq. 12 into Eq. 17, we get, after simplification,

$$A_{V1} = K_1 \left\{ \frac{S[(R_L+R_2)C_2] + 1}{S^2[K_2R_oC_FR_2C_2] + S[(R_L+R_2)C_2 + K_2R_oC_F] + 1} \right\}, \quad (18)$$

whose zero is governed by f_B (Eq. 13) and whose poles occur at the frequencies labeled f_A and f_C, which, in turn, are derived from the roots of the quadratic in the denominator of Eq. 18.

While, compared with the manufacturers' recommendation, this second-stage compensation approach has shifted the initial pole, f'_A, to a somewhat higher frequency, f_A. This is not quite satisfactory from a stability viewpoint because of greater variation in gain with device substitution and temperature change. To remedy this situation, the second pole, f_C, of the second stage must be less than the zero, f_D, of the first stage.

Shift the pole

One solution is to shift that pole further leftward to a lower frequency region and we can do this by decreasing the value of f_C. This is easily done by placing an additional capacitor of an appropriately chosen value in parallel to C_{Fi}, as shown in Fig. 6. The compensation capacitor at the first stage—C_1, connected between pin numbers 1 and 4—is the one to use, and Eq. 16 is then modified to

$$C_{Fi} = C_F A_{V2} + C_1 . \quad (19)$$

Reviewing the procedure for obtaining Eq. 18, we can, in an analogous fashion, derive the expression for the transfer function when $C_i \neq 0$. The final form is given as follows:

$$A_{V1} = K_1 \left\{ \frac{S[(R_L + R_2)C_2] + 1}{Y_1S^2 + Y_2S + 1} \right\} , \quad (20)$$

where

$$Y_1 = K_2R_oC_FR_2C_2 + R_oC_1(R_L+R_2)C_2$$
$$Y_2 = (R_L+R_2)C_2 + K_2R_oC_F + R_oC_1$$

Remembering that,

$$f_D > f_C > f_B > f_A , \quad (21)$$

we find for $C_1 \neq 0$ that f_B vanishes completely since the second-stage pole cancels the first-stage zero.

The third stage is a unity-gain amplifier with no contribution of poles or zeros to the frequency region of interest. Additional poles may exist at frequencies that occur well beyond the megahertz range; for most applications in which the closed-loop gain is generally greater than unity, this possibility is not critical and may safely be overlooked. The minimum requirement for the external load resistance (or impedance) to the device is slightly greater with this compensation technique than with the single-capacitor technique specified by manufacturers.

Using the technique

The custom compensation for the op amp is determined by the over-all open-loop transfer function, described as follows:

$$A_V(s) = \frac{V_{OUT}}{V_{IN}} = A_{V1} \times A_{V2} \times A_{V3} , \quad (22)$$

where A_{V1}, A_{V2}, A_{V3} are the individual transfer function for each amplifier stage. With A_{V3} equal to unity, the resulting equation is:

$$A_V(s) = K_1 \cdot K_2 \left[\frac{SR_2C_2 + 1}{Y_1S^2 + Y_2S + 1} \right] , \quad (23)$$

where

$$Y_1 = K_2R_oC_FR_2C_2 + R_oC_1(R_L+R_2)C_2 .$$
$$Y_2 = (R_L+R_2)C_2 + K_2R_oC_F + R_oC_1 .$$

Before the compensation components C_1, R_2 and C_2 can be specified, certain internal parameters that are intrinsic to the device must first be empirically determined. These parameters include K_2, the second-stage dc gain, R_o, the first-stage output impedance, C_F, the second-stage internal capacitance, and R_L, the second-stage load resistance. All of these vitally affect the poles of $A_V(s)$.

For the Amelco 841 operational amplifier, in particular, the second-stage dc gain, K_2, of the uncompensated device is easily deduced by direct measurement of the voltage difference betwen pins 1 and 6, and is found to be 500. The output impedance of the first stage, R_o, is 2.7 MΩ and is calculated by noting the value of the corner frequency for a selected capacitor connected between pins 1 and 8, as specified in the manufacturer's data sheet. Repeating this procedure with the value of R_o already established, and without the connection of a compensation capacitor, we then determine the internal capacitance, C_F, from the modified corner frequency and find it is 6 pf. The second-stage load resistance, R_L, also determined by measurement, is 25 kΩ.

It is possible to boost the op amp's open-loop gain to a minimum of 80 dB at 400 Hz. To achieve this result, both compensation capacitors were conveniently assigned the same value of 1200 pF. A resistance of 5 kΩ was then chosen for the compensation resistor. ■■

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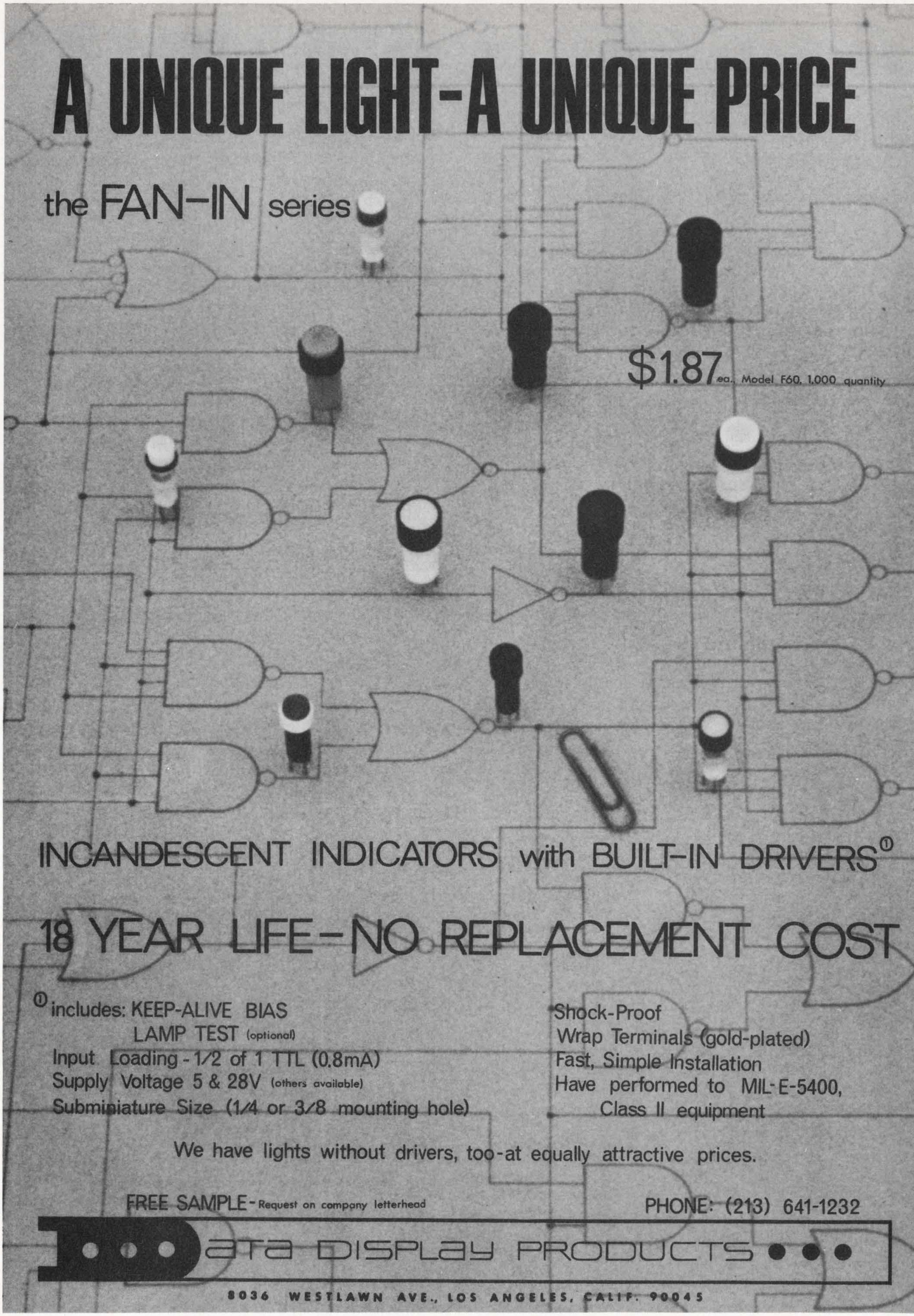

INFORMATION RETRIEVAL NUMBER 57

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Applications Logic levels can be accurately tested in virtually any (DTL, TTL, RTL) IC system including desk calculators, business machines, N/C devices, computers or telephone systems. Power is derived from the unit under test allowing use in the field or in the lab.

Specifications
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*Patent #3,525,939 applies, others pending.

INFORMATION RETRIEVAL NUMBER 58

Use a technical Rx for management ills,

says this company president, who prescribes engineering principles for solving a supervisor's problems.

Richard L. Turmail, Management Editor

There is no law that says an engineer must become a manager. However, many electronics designers prefer to swap design decisions for management ones. The problem is that often they find themselves unprepared to handle supervisory decisions.

The question, then, is how can an engineering manager or would-be manager better prepare himself for the responsibilities of his position?

If you're a designer-turned-manager, chances are you'll be encouraged by Frank H. Roby, president of Sola Basic Industries, because he uses the engineering principles you were teethed on to solve management problems. By appraising Roby's method, you may discover new ways to apply your own technical knowledge to a job you have not been formally trained to do.

Where the principles apply

In the broadest sense, engineering is the application of scientific principles to practical ends, such as the design, construction or operation of efficient and economical structures, equipment and systems. Roby reminds managers and engineers alike that an equally appropriate definition for an engineer is one who skillfully or shrewdly manages an enterprise.

Roby's success with Sola Basic has largely been the result of his "bump principle," in which company acquisitions must be closely related to the firm's business of making electrical and electronic equipment for the distribution, control and use of electrical power. Each newly acquired firm can help one or more of the other established divisions by means of technical expertise and/or supply.

"Our 10 divisions complement one another," Roby says, "like 10 grapes in a bunch, instead of like 5 grapes and 5 coconuts."

"My management effectiveness," he says, "is often dependent on my ability to combine efficiency as an engineer with whatever skill I possess as an entrepreneur."

Although the front-line manager may not need the skills of an entrepreneur, he can, according to Roby, by the effective use of engineering principles, solve management problems when they involve:

- Motivating people.
- Digesting data.
- Technical orientation.

People who need people . . .

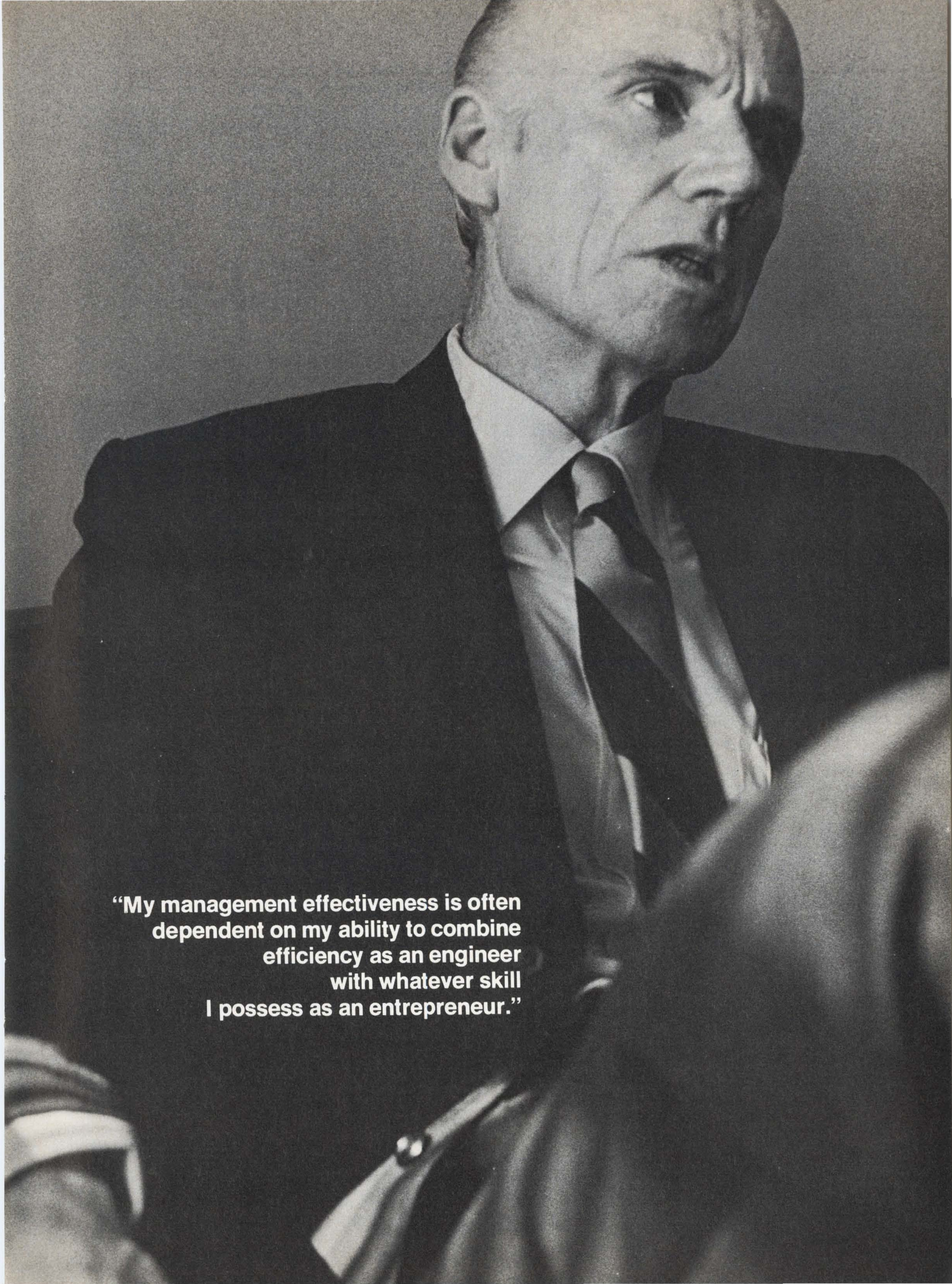
"The biggest over-all management problem has always been the motivation of people," says Roby. He offers the company profit plan as an illustration of the point.

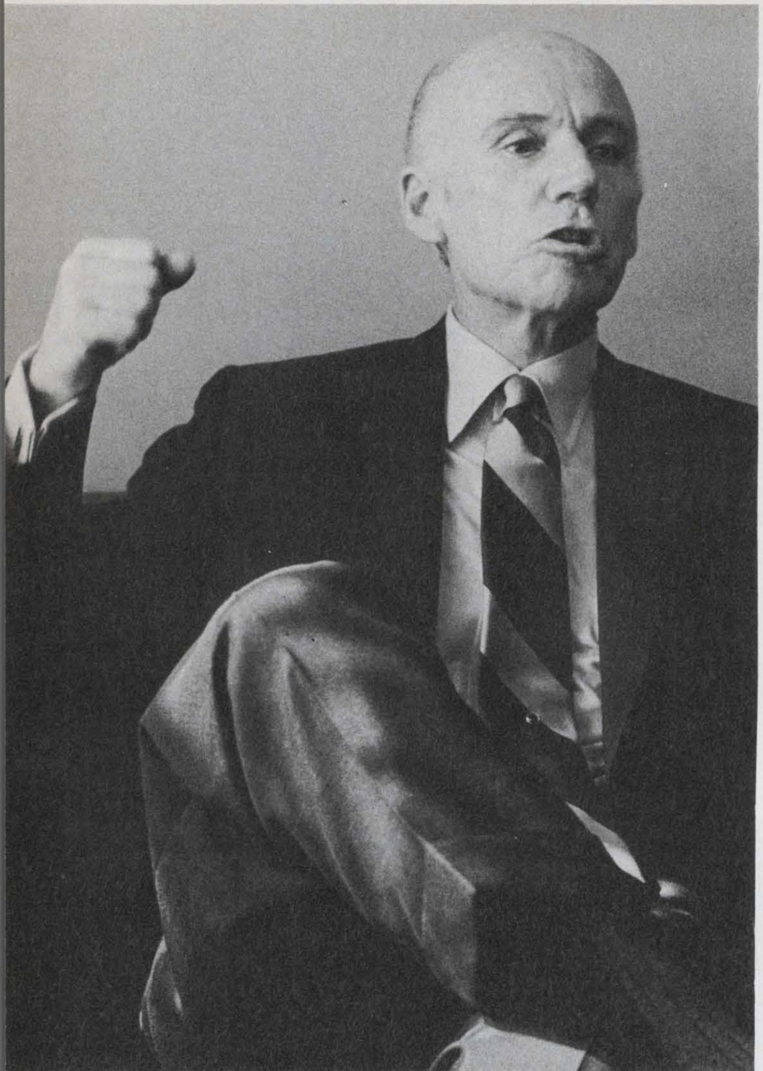
Roby believes that all serious management problems extend from the bottom line (profit) of the financial report, and that if a company is making a suitable profit, there are few problems. He says that a company must have a profit plan, that the plan is the canvas on which the manager paints the picture, and that he must get his subordinates to bring that picture to life.

If the manager stays with the same approach to planning, according to Roby, people start to see what those profit figures mean. Eventually, after he has painted the picture half a dozen times, they see how they can make the plan work. Here, "repetition" is as effective a tool as it is in engineering.

"But remember," Roby says, "no one ever listens until you've said it six times. People can help you," he says, "but only if you're predictable. The equivalent engineering principle is 'logical sequence.' My secretary, for instance, has told a client on occasion that it was all right to change my schedule to meet his needs. She knows my behavior pattern, because, for one reason, I never throw away a piece of paper, I mark it 'destroy,' instead. That way she learns as much from what I don't keep as from what I do. It's the same with engineering: you learn as much from a failure as you do from a success, sometimes more."

To motivate his employees, Roby says that he treats them as equals, which elevates them, and he tries to be consistent in his actions so they'll always know where he stands. He says that his


"My management effectiveness is often dependent on my ability to combine efficiency as an engineer with whatever skill I possess as an entrepreneur."



"No one ever listens until you've said it six times."

management method works best at all management levels when the chief executive is willing to spend considerable time at frequent intervals with his various operating units instead of merely overseeing operations from a headquarters office.

He adds that he doesn't always see the boss when he visits one of the company's operations. He makes a point of seeing the first-line managers and paints the profit picture for them, personally.

Data digestion depends on the diet

The second area of management concern where engineering principles can apply is the digestion of data. It involves three stages of operation:

1. Digging out relevant information.
2. Collating and interpreting it.
3. Acting effectively and decisively on the resulting intelligence.

In explaining how engineering principles can be applied to solve the problems that crop up, Roby says that engineering teaches you, in gathering and sharing information, to take a look at random elements and "paint" a practical picture that has meaning. For example, both engineers and accountants have mathematical ability. While an accountant records history, Roby says that an engineer will take the same figures and rearrange them into an organized pattern that has meaning. Thus, the accountant records; the engineer reasons.

"The poorest-managed businesses," Roby says, "are the ones managed emotionally by someone carried away with ideas, rather than with facts that have meaning."

As an illustration of effective action taken after data has been interpreted, Roby cites his "corporate identity program."

He had learned that most businesses fail through not being able to sell their products. Companies, he says, like General Electric have an advantage because when a purchasing agent doesn't have time to check out an unknown brand, no one is going to criticize him for buying a well-known one like GE.

Further interpretation of the data, however, led Roby to the conclusion that this particular fact of business life could be turned to his firm's advantage if he acted effectively. He reasoned that there were disadvantages to being a GE, because people are funny about names. For example, according to Roby, GE has never been able to successfully compete in the electronics component market because they are their own competitors. He says that many buyers feel that business ought to be conducted in its natural elements, and they therefore prefer to buy electronic components from a company that produces them exclusively.

Roby decided to combine the advantages of a name that has customer recognition value with that of small exclusive producers. He adopted a "corporate identity program" for each of his firm's acquisitions, using a logo that displayed each division's name along with the "SB" of Sola Basic.

Because Roby wanted each of the ten division presidents to be autonomous—which enhances the division's image as a separate producer—he gave up his right to order. And he proved his point logically with the following six-step program by:

1. Publishing a book on corporate identity and distributing it company-wide.
2. Placing the logo on stationery, business cards, invoices, etc.
3. Pointing out that since the firm's equipment goes everywhere, each division would stand to profit if the name plate was that of one company.
4. Instituting uniformity of packaging to further encourage customer recognition.

5. Sending corporate people (after five years) to the divisions to help them with publications, advertising and sales promotions on a parent company basis.

6. Placing a flyer in every product package that describes all divisions of Sola Basic.

Roby says that the plan has worked, and the company is beginning to reap the profits that instant recognition often stimulates.

Where technical knowledge is vital

Those management problems that require a particularly high degree of technical orientation include:

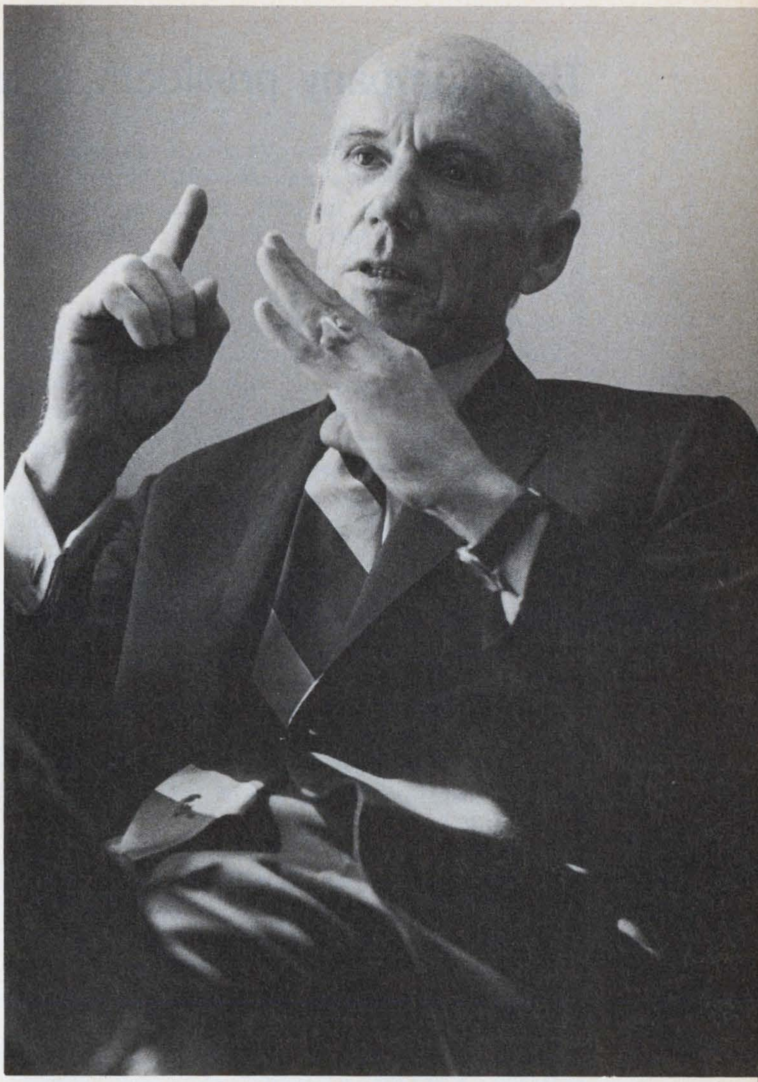
- Sales volume—a problem almost certain to exist after all others have been solved.
- New product development—essential for rapid company growth.
- Manufacturing methods—the key to profitability.
- Operating controls—necessary to measure progress.

Sales volume. Roby says that you've got to be certain you have a good product, because only then can you use the engineering principle of logical sequence to remove the last doubt in the prospective buyer's mind. He adds that it is important for the salesman to be technically oriented, not only to know the product but the buyer as well. Since it's necessary for the salesman to put himself in the buyer's shoes in order to determine his needs, it usually takes someone with a strong enough technical background to come back to his own point of view.

"I'll bet 85% of all salesmen now, even in the insurance field, are technically oriented," Roby says, "because they can paint a logical picture and not get sidetracked by a creative, but illogical argument."

New product development. Roby says that it's important to place your engineers in the right department. As he sees it, there are two kinds of engineers: the efficient engineer who puts in long hours in making the effort, but who is never overly concerned about the results of his work; and the entrepreneur engineer who conceives ideas to satisfy his intellectual curiosity. Since the engineer with both qualities is rare, a good manager tries to split his department or project into two distinct areas of operation—product development and engineering—thus using the two kinds of engineers to advantage. It's important, too, that the manager himself be an engineer so that he can more actively participate in the development of a product.

"When I was a salesman," Roby says, "my engineering background helped me immensely. I was able to patent over 20 product ideas, because I didn't always have the product the customer



"People can help you, but only if you're predictable."

wanted. If I hadn't been an engineer, my sales would have been more limited.

"I think technical training is priceless," Roby adds.

"Nearly all our company managers are engineers, and nine out of ten of our division presidents are engineers."

Manufacturing methods. Managers of technical discipline are vital in the manufacturing operation of his company. At Sola Basic, Roby says that an industrial engineer is in charge of plant equipment and standard costs, a job that entails cost accounting and quality control. The man in charge of production control has a computer background and is responsible for both the kind of material required and its flow. The materials manager, who is responsible for the shipping department, storeroom inventory, and purchasing, must have a good technical knowledge of materials so he'll know, for example, if he can substitute aluminum for copper. The factory superintendent (called the production manager at many companies) manages everything in the

This company president is a 'chief' among engineers

Engineering has been Frank H. Roby's way of life ever since he graduated with honors from Purdue University in 1933. He says: "I don't like to read instructions or maps; I'd rather reason out the problem." He has lived by the principles of engineering, and he has guided Sola Basic by applying these same rules.

During the past five years Roby has presided over the third phase of Sola Basic founded in Milwaukee, Wis., as the Froedtert Grain & Malting Co. in 1867. At the start of its second phase in 1951, the firm became a conglomerate holding company of diversified activities under the name of Basic Products Corp. When Roby took the corporate reins in 1965, he changed both the company's name and its business by getting rid of its profitless subsidiaries and concentrating on building a fully integrated operating company making electrical and electronic equipment for the distribution, control and use of electrical power.

Roby believes that the electrical industry is, and will continue to be, one of the most rapidly expanding in the world.

Through the course of Roby's tenure as president and chairman, the company's sales have increased from \$51-million to \$103-million, and earnings have increased from \$1.7-million to \$3.5-million—about 15% per year. Sola Basic Industries now has more than 4,000 employees in 20 plants in the United States and 11 plants in Canada, Mexico, Colombia, England, Japan, Australia, and the Netherlands.

In 37 years of business life, Roby rose from a salesman with Square D Co. to that firm's vice president of marketing. He later served as the executive vice president of Federal Pacific Electric Co., and was elected president of that company a year before he went to Sola Basic Industries.

For much of his 25 years with Square D, he served as spokesman for both the Industrial Control and Low-Voltage Distribution Equipment Industry. Typical of this type of activity were his successful dealings with WPB and OPA in Washington in which the industry received blanket priorities on materials and price rollbacks were avoided.

A past vice president and president, and a present director of the American Standards Association, he recently received the Howard Coonley Gold Medal for personal contributions to the Voluntary National Standards movement.

Both academic and business communities have recognized Roby's contributions to his industry. In 1967 he was awarded an honorary Doctorate Degree in Engineering by Purdue, and last year he received the James H. McGraw Medal for Cooperation in the electrical industry. He was cited for his outstanding personal initiative, creativity and leadership in developing and promoting standardization in electrical products to the broad benefit of the industry as a whole and the public it serves. His efforts included involving the active cooperation of all branches of the electrical industry to achieve the desired objectives.

Roby says simply about his success that he's an "introverted activist. Because of my logical approach, though, my wife has said if I'd been born a woman, I'd probably lay all my hairpins in a row."

factory but the money.

"He must be an engineer," Roby says, "because when the product and the assembly process don't go together, he must apply his technical knowledge fast."

Operating controls. Most company controls center around money. Since financial controls are essential, Roby says that it is necessary to set up a guide for his firm's accountants to follow.

"I indicate the form in which I want to see the numbers," Roby says, "because accountants are inclined to tell me what the figures are on a month-to-month basis, when I want to know what the change is since the first of the year."

Still receptive to ideas

With all this weighted evidence in favor of an engineering background, Roby's answer to the question of whether or not his background and training had ever got in his way on his climb to the top, was surprising.

"It proved to be a problem," he said, "when I found that I was reasoning things out and marrying the idea, to the exclusion of any other idea.

"You reach the point where you think you know it all," he said, "and if you're the boss you can be wrong, but you're still the boss. Now I've learned to like it when someone changes my mind because it proves that I'm still receptive to the ideas of others."

Of his management experience, Roby says that he's found that the decisions of "what to do" are academic. "When to do" is more important and takes experience and maturity. He says his engineering background has made it possible for him to know what and when to do it most of the time. ■■

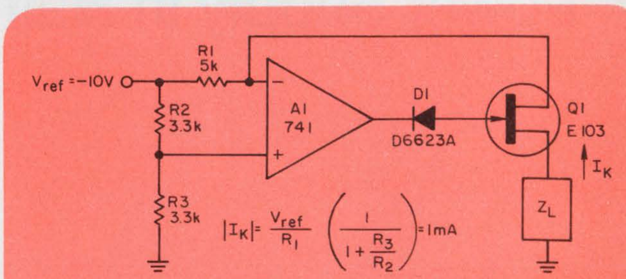
ideas for design

Current-source polarity is reversible at will

A constant-current circuit can supply either polarity of reference current with appropriate circuit modifications (see diagram) to a grounded load. The voltage reference may be derived from any point in a circuit and the input impedance of the circuit is constant.

The potential established at the noninverting input of an op amp by R_2 and R_3 keeps the FET, Q_1, biased in the pinchoff region. The op-amp output adjusts the gate voltage of Q_1 so that the drain current is constant and independent of FET parameter variations. Since gate current is many orders of magnitude less than drain current, little error is introduced by assuming that drain and source current are the same. Diode D_1 is included to prevent the possibility of forward biasing the gate.

This circuit has several advantages over other constant-current configurations. It is simple and errors are not a function of the load, so that outstanding dynamic characteristics result. Only a single precision resistor, R_1, and a precision ratio match, R_2/R_3, are required. The reference voltage with respect to ground allows the load to be grounded, and active loads can be accommodated as long as the drain-source voltage of Q_1 is maintained greater than its pinchoff voltage.



Precisely controlled load current flows only through the FET, Q_1. To reverse current flow, V_{ref} should be positive, Q_1 should be a p-channel FET and D_1 should be reversed.

Leonard Accardi, Electrical Engineer, Advanced Development, LOC B-3, Kollsman Instrument, 80-08 45th Ave., Elmhurst, N. Y. 11373.

VOTE FOR 311

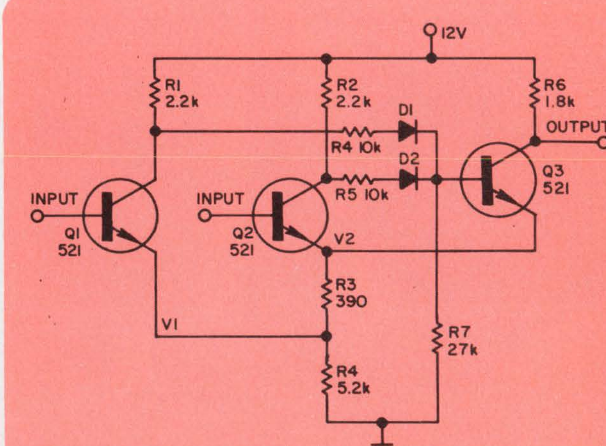
Dual Schmitt trigger matches diodes

The circuit shown functions as two Schmitt triggers. It triggers as a function of the inputs to Q_1 and Q_2, and these inputs do not have to be of the same voltage level. The circuit can be used to match diodes or, with a simple modification, will also act as a normal Schmitt with very low hysteresis.

Initially Q_3 is biased so that when Q_1 and Q_2 are cut off Q_3 is in saturation. R_6 and the combination of R_3 and R_4 determine the base voltages V_1 and V_2. When either Q_1 or Q_2 starts to conduct, Q_3 is cut off. As shown, Q_1 triggers at 8.7 V and Q_2 triggers at 9.5 V.

The circuit can be used as a Schmitt trigger with very low hysteresis by connecting the bases of Q_1 and Q_2 and adjusting the bias so that $V_2 - V_1$ equals the hysteresis voltage of Q_2.

It can also be used in a test fixture to match diodes. When the two diodes are matched within tolerance, the circuit triggers. A bulb can be used as the indicator.

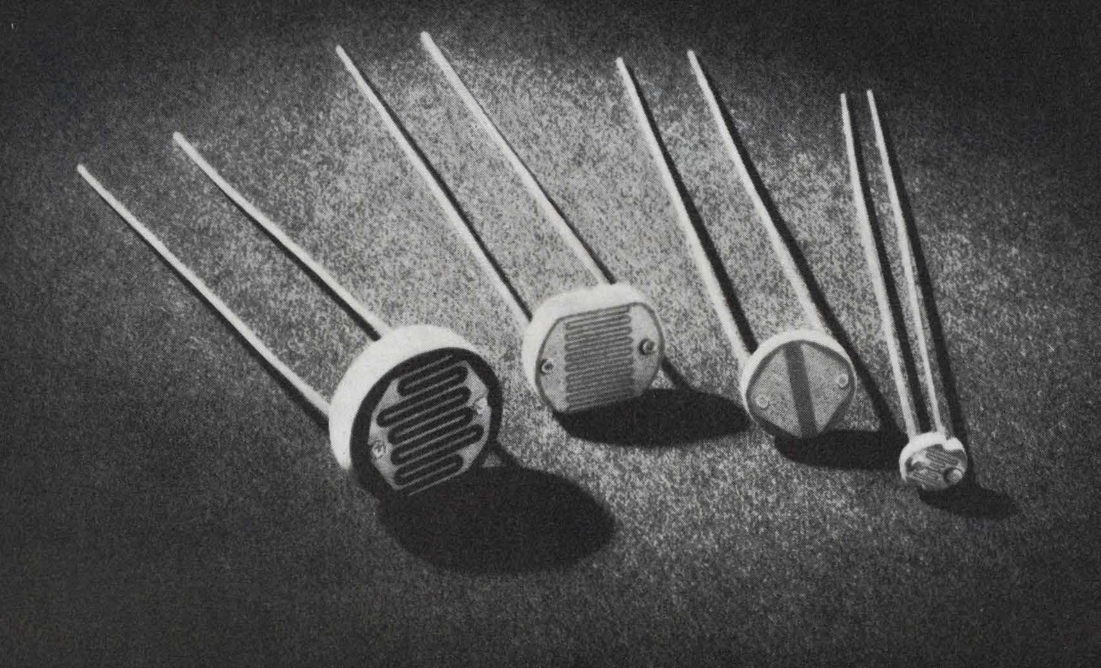


Different input voltage levels to Q_1 and Q_2 will trigger this circuit. The circuit can be used to match diodes. Connecting the bases of Q_1 and Q_2 produces a Schmitt trigger with low hysteresis.

Augustine Kuruvilla, 84, Dacosta Square, St. Mary's Town, Bangalore, 5, India.

VOTE FOR 312

Photocells ~~are~~ were too expensive for my application



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Symmetrical counter can handle any odd modulus

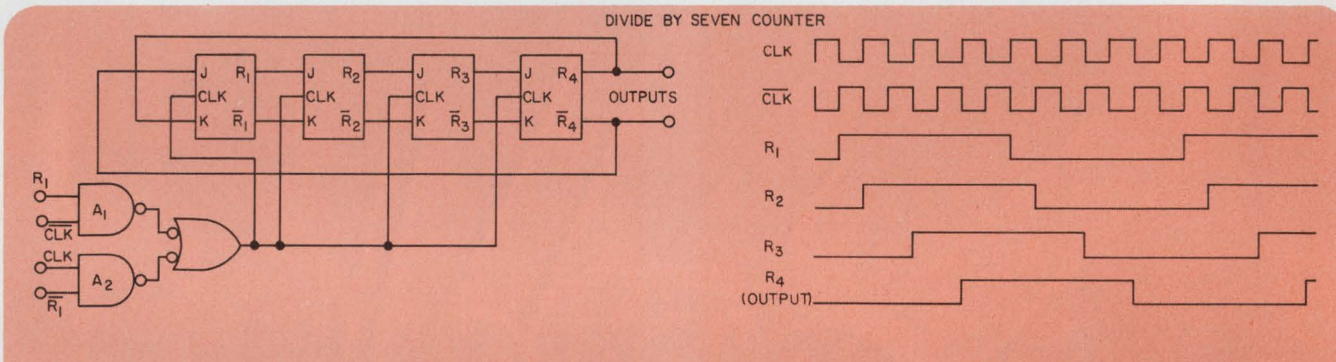
A counter whose modulus is controlled by the number of flip-flop stages used has a symmetrical output, little delay, and an adaptable design. Four stages, as shown in the diagram, can count to seven; three stages would count to five; n stages would count to 2n-1.

The operation of the counter is relatively simple. A shift counter is made by folding the nth-stage outputs back on the steering inputs of the first stage. The first stage is used to control the clocking phase by means of gates A_1 and A_2. This allows a half of a clock period to be counted. The counter shown is a divide-by-seven configuration in which each output period is made to cover seven clock periods.

All outputs are symmetrical, providing the clock is symmetrical. Also, all stages are clock-edge synchronous, therefore eliminating needless delays due to propagation through the counter.

David Mundie, Project Engineer, SCI Electronics, Inc., P. O. Box 4208, Huntsville, Ala. 35802

VOTE FOR 313



A divide-by-seven counter uses four flip-flop stages and three gates. The timing diagram demonstrates the symmetry of the output if the clock itself is symmetrical. Over-all delay is minimal.

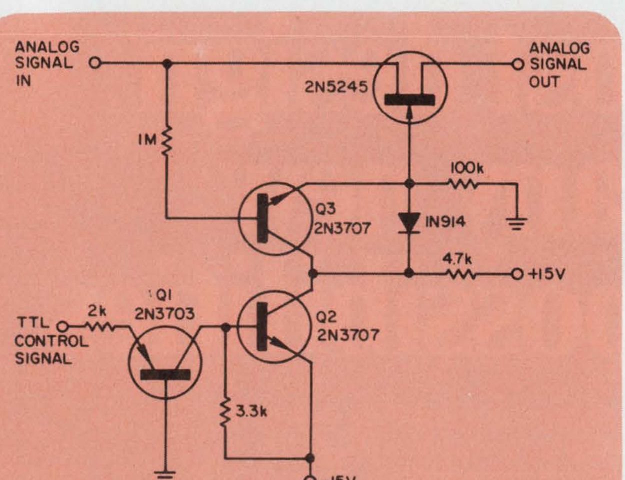
TTL-compatible analog gate for only $2 in parts

This low-cost TTL-compatible analog gate is ideal for a myriad of instrumentation and telemetry applications. It is based on the analog-gate circuit described in another Idea for Design,[1] with transistors Q_1 and Q_2 added to make the circuit compatible with TTL logic levels.

Transistor Q_3 is an emitter follower. By allowing the FET's gate to follow the input signal, it keeps the channel resistance low over a wide range of input voltages.

The added transistors operate as follows: A logical ONE at the input of Q_1 causes both Q_1 and Q_2 to conduct heavily, making the gate of the FET negative and thus cutting it off. A logical ZERO input applies a positive voltage to the collector of the emitter follower, opening the analog gate.

Using the components shown, the total cost of the gate is approximately $2.



This analog gate can handle large signals because emitter follower Q_3 allows the FET's gate to follow the analog signal input, keeping the channel resistance low over a wide voltage range.

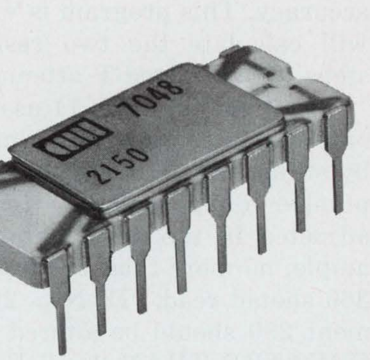
Reference

1. G. Colla, K. Roffi, and G. Sinigaglia, "High-Level Analog Gate Uses an Inexpensive J-FET," *Electronic Design*, Sept. 26, 1968, p. 71.

Steven E. Holzman, Technical Staff Member, E. S. L., Inc., Sunnyvale, Calif.

VOTE FOR 314

Computer Microtechnology has RAMS,



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2 It's bipolar. TTL and DTL compatible. And, as we said, *fast:* 74 nsec typ. access, (including the decoding time which is not part of the spec on some other RAMS).

3 It has three chip selects: 2 active high, one active low. You can expand your memory up to 2048 words (of whatever length your system understands) without adding a single decoder; outputs are OR-tieable. And even if you add inverters, buffers, or decoders in your chip select lines, any delay of up to 40 nsec will not slow down your address time. You can pre-address any of the bits in your chosen word and get all your data out in 74 nsec. *There's no speed penalty in building a big random store.*

4 BONUS 1: The CM 2150 has a fan-in of ½ TTL unit load. Any standard buffer or inverter can drive twice as many 2150's, happily reducing your system package count. BONUS 2: Less power supply current is needed; our spec is only 1.8 mW/bit.

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Computer Microtechnology Inc.,
P. O. Box 7050, Sunnyvale, Calif. 94086

INFORMATION RETRIEVAL NUMBER 61

Program to design a bridged-T attenuator is BASIC

The design of a variable attenuator is often tedious, especially if the number of attenuator steps is large. The use of a time-shared computer can relieve the burden and provide speed and accuracy. This program is written in BASIC, and will calculate the two resistor values between steps of a bridged-T attenuator section.

The program (Fig. 1) assumes equal input and output impedances. Error messages are returned by statements 170, 250, and 330 if required. The number of permitted attenuator steps can be adjusted in the limit statement 360. If, for example, no more than 20 steps are permitted, then 360 should read, "IF N > 20 THEN 330." Statement 290 should be altered also, to read "(NOT GREATER THAN 20)." For a fixed attenuator, of course, N = 1.

The first R_1 computed in the program is the smallest value of R_1 in the attenuator from input. The final R_2 computed is the smallest value of R_2 in the attenuator to common.

```
110 PRINT "BRIDGED T ATTENUATOR, Z IN = Z OUT"
130 PRINT "WHAT IS THE IMPEDANCE IN OHMS";
140 INPUT RO
150 IF RO > 0 THEN 210
170 PRINT "IMPEDANCE NOT GREATER THAN ZERO!"
190 GO TO 130
210 PRINT "WHAT IS THE LOSS PER STEP IN DB";
220 INPUT L
230 IF L > 0 THEN 290
250 PRINT "LOSS PER STEP NOT GREATER THAN ZERO!"
270 GO TO 210
290 PRINT "HOW MANY STEPS (NOT GREATER THAN 99)";
300 INPUT N
310 IF N > 0 THEN 350
330 PRINT "INCORRECT NUMBER OF STEPS!"
340 GO TO 290
350 IF N - INT(N) > 0 THEN 330
360 IF N > 99 THEN 330
380 PRINT "FIXED RESISTORS ARE BOTH EQUAL TO"RO" OHMS."
390 PRINT "R1 IS THE SERIES RESISTOR BETWEEN STEPS."
400 PRINT "R2 IS THE SHUNT RESISTOR BETWEEN STEPS."
410 PRINT "K IS THE RATIO OF INPUT CURRENT TO LOAD CURRENT."
420 PRINT "Z IN = Z OUT ="RO" OHMS."
430 PRINT "THE FIRST R1 IS CONNECTED FROM INPUT TO THE FIRST STEP."
440 PRINT "THE LAST R2 IS CONNECTED FROM THE LAST STEP TO COMMON."
480 PRINT "LOSS,DB          R1,OHMS          R2,OHMS          K"
490 FOR S = L TO N*L STEP L
500 LET K = EXP(S*(LOG(10))/20)
510 LET R1 = RO*(K-1)
520 LET R2 = RO/(K-1)
530 IF S = L THEN 570
550 PRINT "               "(R1 - P1), (P2 - R2)
560 GO TO 600
570 PRINT "               "R1
580 LET T2 = R2
590 REM  P1 IS THE R1 FOR THE PRIOR STEP.
600 LET P1 = R1
610 REM  P2 IS THE R2 FOR THE PRIOR STEP.
620 LET P2 = R2
630 IF S >= 10 THEN 680
650 PRINT "  "S," "," ",K
660 GO TO 690
680 PRINT " "S," "," ",K
690 NEXT S
700 LET T1 = R1
720 PRINT "                              "R2
740 PRINT "TOTAL SERIES RESISTANCE EQUALS"T1" OHMS."
750 PRINT "TOTAL SHUNT RESISTANCE EQUALS"T2" OHMS."
760 LET A = 0
790 PRINT "IF FINISHED INPUT 0; IF NOT INPUT 1.";
800 INPUT A
820 IF A = 1 THEN 130
830 END
```

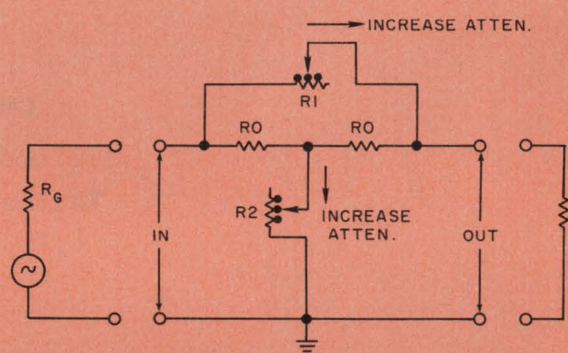
1. **Bridged-T attenuator is designed by this BASIC program** with interactive control by the programmer. Lines 110-300 provide for input of data.

An elective escape is provided by the statement in line 790 in Fig. 1. If 1 is the input, the program will go back to statement 130 and calculate another attenuator. If 0 is the input, the program will halt.

The program has been designed to run under any BASIC compiler and does not contain any convention or syntax peculiar to a particular compiler or computer.

Bert Solomon, Xerox Data Systems, 701 S. Aviation Blvd., El Segundo, Calif. 90245.

VOTE FOR 315

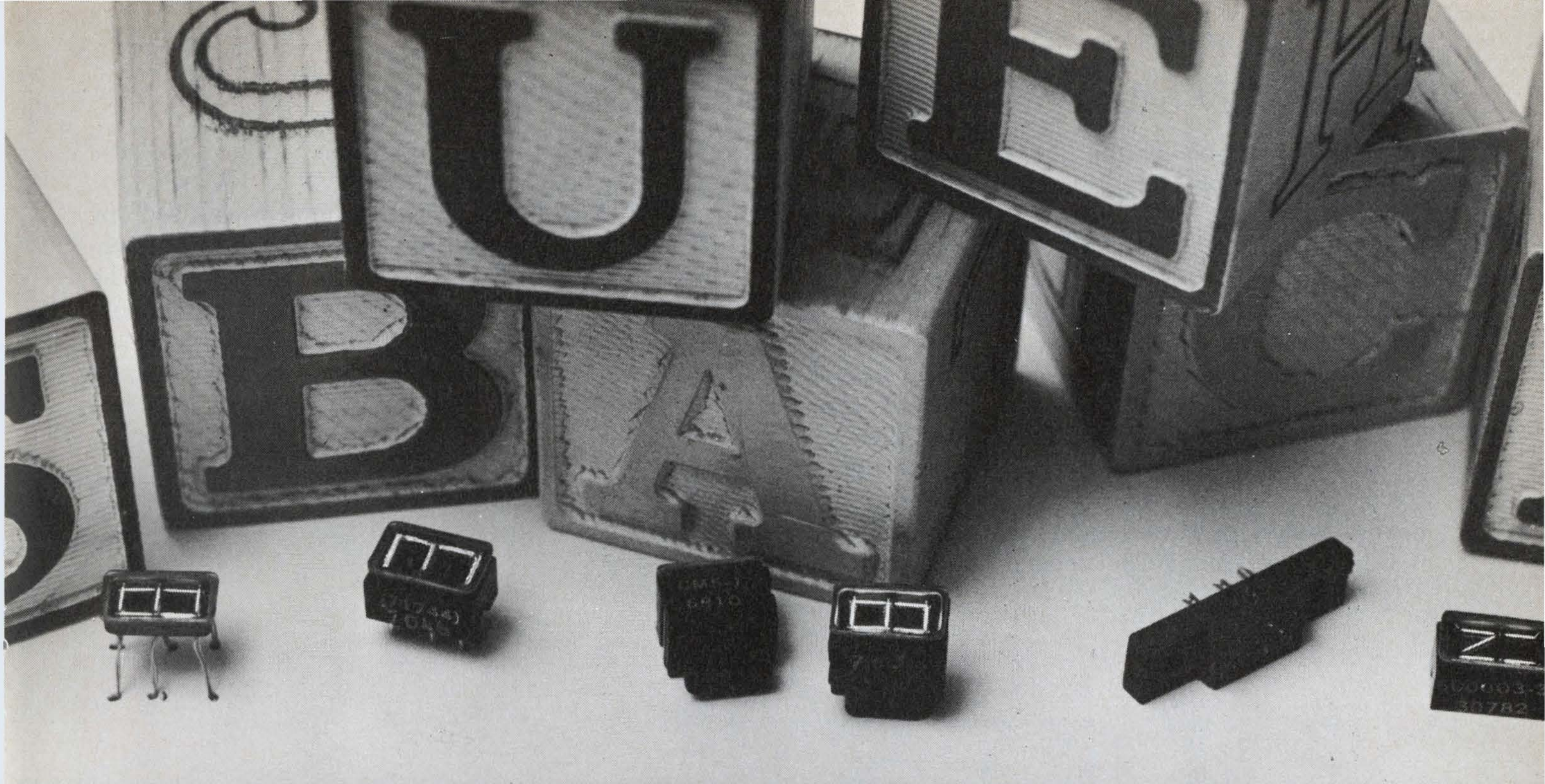


$R_G = Z_{in}$ $R_L = Z_{out}$ $Z_{in} = Z_{out} = RO$ $(RI)(R2) = RO^2$

2. **The attenuation of the constant-impedance bridged-T network** depends on the values of R_1 and R_2. The exact attenuation for given settings can be computed in advance by the program of Fig. 1.

```
>RUN
BRIDGED T ATTENUATOR, Z IN = Z OUT
WHAT IS THE IMPEDANCE IN OHMS: 600
WHAT IS THE LOSS PER STEP IN DB: 2.5
HOW MANY STEPS (NOT GREATER THAN 99): 8
FIXED RESISTORS ARE BOTH EQUAL TO 600  OHMS.
R1 IS THE SERIES RESISTOR BETWEEN STEPS.
R2 IS THE SHUNT RESISTOR BETWEEN STEPS.
K IS THE RATIO OF INPUT CURRENT TO LOAD CURRENT.
Z IN = Z OUT = 600    OHMS.
THE FIRST R1 IS CONNECTED FROM INPUT TO THE FIRST STEP.
THE LAST R2 IS CONNECTED FROM THE LAST STEP TO COMMON.
LOSS,DB       R1,OHMS       R2,OHMS        K
              200.11285
  2.5                                      1.3335214
              266.85478     1028.0534
  5                                        1.7782794
              355.85657     333.41385
  7.5                                      2.3713737
              474.54237     160.03232
 10                                        3.1622776
              632.81242     90.97398
 12.5                                      4.216965
              843.86893     56.736944
 15                                        5.6234132
              1125.3173     37.451534
 17.5                                      7.498942
              1500.6347     25.656051
 20                                        10
                            66.666666
TOTAL SERIES RESISTANCE EQUALS 5400     OHMS.
TOTAL SHUNT RESISTANCE EQUALS 1798.9848    OHMS.
IF FINISHED INPUT 0; IF NOT INPUT 1.: 1
```

3. **A typical solution printout lists loss and circuit values** as computed by the program. Answering the question in the last line with "1" allows the program to be reentered. A "0" stops the program.



ICs simplify a two-phase bidirectional motor drive

A simple low-power method of obtaining a bidirectional two-phase motor drive is shown in the figure.

Flip-flop 1 (FF1) supplies a 50% duty cycle square wave to FF2 and FF3. The Q and $\overline{Q}$ outputs of FF2 supply one phase to the motor-drive bridge circuit (not shown).

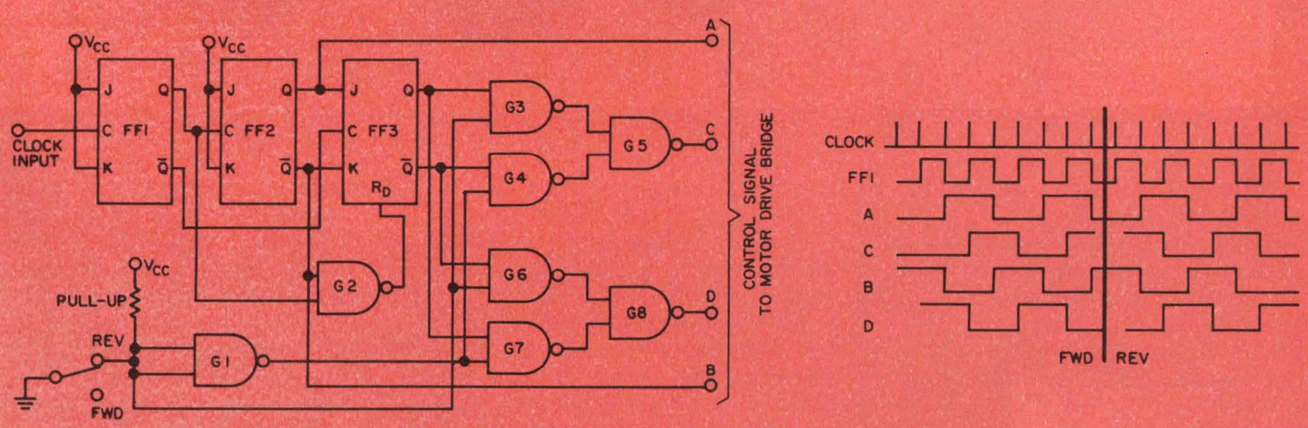
FF3 shifts the outputs of FF2 by 90 degrees, using the $\overline{Q}$ output of FF1 as the clock input. The Q and $\overline{Q}$ outputs of FF3 supply the other phase to the motor-drive circuit. G3 through G8 form an "exclusive OR" function, selecting the proper phase for reverse and forward commands.

G2 insures that FF3 keeps the same relationship to FF2, even with noise spikes and the power turned on or off.

Two TI7473 dual J-K flip-flops were used for FF1, FF2, and FF3, and two TI7400 quad two-input AND gates were used for the gating. The total power dissipation is approximately 240 mW. If low-power IC packages of the same type are used, the power required may be dropped to approximately 23 mW.

Ron Kostenbauer, Electronics Engineer, Odetics, Inc., 1845 S. Manchester Ave., Anaheim, Calif. 92802.

VOTE FOR 316

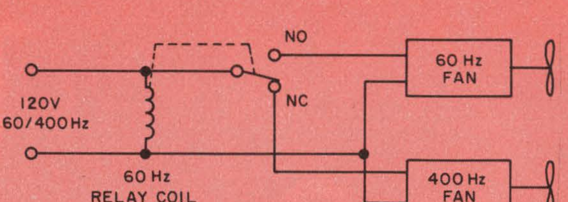


Only four ICs are required to build this two-phase motor control. Two 7400 quad two-input AND gates and two 7473 dual J-K flip-flops were used. Total power dissipation is approximately 240 mW.

60-Hz relay senses frequency for fan control

Dual-frequency power supplies (60 or 400 Hz) normally require no adjustment when changing the input frequency. However, if cooling fans are used in the supply cabinet, switching in the correct fan is necessary to avoid possible equipment damage if the frequency is changed.

A good solution to this problem is to use a frequency-sensitive relay to do the switching. A standard 120-V, ac, 60-Hz relay is quite effective. When 60-Hz power is used, the relay pulls in and connects the input power to the 60-Hz fan terminals. When 400-Hz power is used, the higher coil reactance prevents relay pull-in. The input is then connected to the 400-Hz fan terminals.



A 60-Hz relay can be energized only when connected to a 60-Hz supply. If it is connected to a 400-Hz supply, the higher inductive reactance of the coil limits current to less than pull-in value.

Peter Yanczer, President, Marcon Engineering Co., Inc., 9526 Manchester Rd., St. Louis, Mo. 63119.

VOTE FOR 317

Gunn-diode modulator covers 0 to 10 MHz

Gunn-diode oscillators can be modulated by adding a modulation voltage, V_m, to the dc-bias supply voltage, V_{in} to obtain a modulated bias voltage V_{out}. This modulator subtracts V_m from V_{in} directly: The collector current of Q_1 is given by

$$(V_{in} - V_m - V_{be1})/R_1,$$

where V_{be1} is the base-emitter voltage of Q_1. Through emitter follower Q_2, the collector potential of Q_1 controls the collector current of Q_3 in the same way as V_{in} controls the collector current of Q_1.

If we choose $R_1 = R_2$ and $R_3 = R_4$, and if we assume that $V_{be1} = V_{be2}$, then the collector potential of Q_3 is given by

$$V_{c3} = V_{in} - V_m + V_{cc-} - V_{cc+} + V_{bc3}.$$

To prevent bias oscillations of the Gunn diode, which behaves as a negative differential conductance (dynatron characteristic), the output resistance of the modulator should be low. Toward this end, the potential V_{c3} is applied to one input (base of Q_4) of a differential amplifier (Q_4 through Q_8) while V_{out} is applied to the other input (base of Q_5). At equilibrium, the voltages must be equal—that is, $V_{out} = V_{c3}$.

Under this condition, the output current needed by the load is controlled by both Q_7 and Q_8. Since the output voltage is not dependent on the load, the differential output resistance is very low.

The collector-to-emitter voltage of Q_8, V_{ce8}, which is given by

$$V_{ce8} = (V_{in} - V_m) - V_{out},$$

is controlled by both V_{cc-} and V_{cc+}. It is adjusted to about 2 V, which provides low power dissipation and modulation voltages up to 3 V, pk-pk.

Neither coupling capacitors nor transformers are used in the design, so the modulator has a rather broad bandwidth. It covers dc through 10 MHz.

The modulator's specifications are as follows:

$V_{cc-} = -15$ V $\quad$ $V_{cc+} = +18$ V

$V_{in} = -2$ to -15 V $\quad$ $V_{out} = 0$ to -13 V

Input resistance seen by $V_m = 50\Omega$.

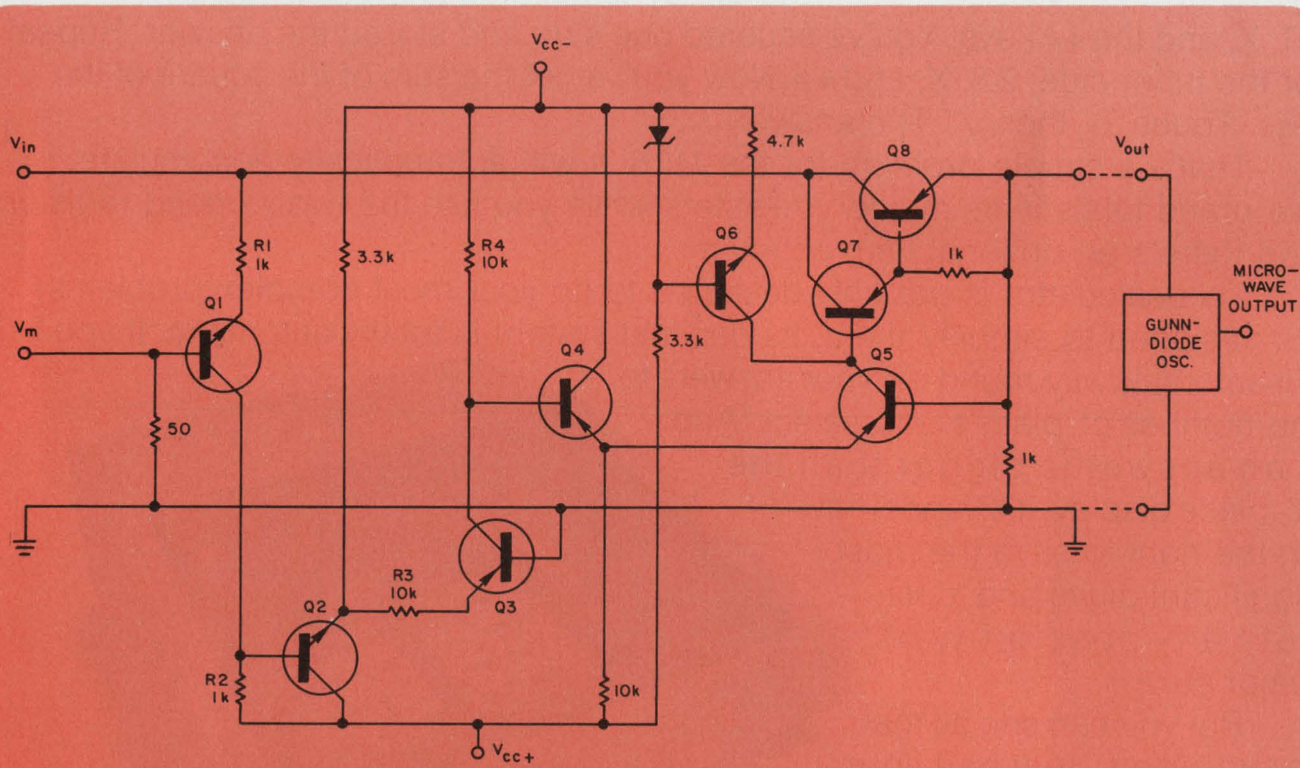
Ouput resistance $= 0.1\Omega$.

Modulation signal gain $= 1.0$.

Modulation frequency range $= 0$ to 10 MHz.

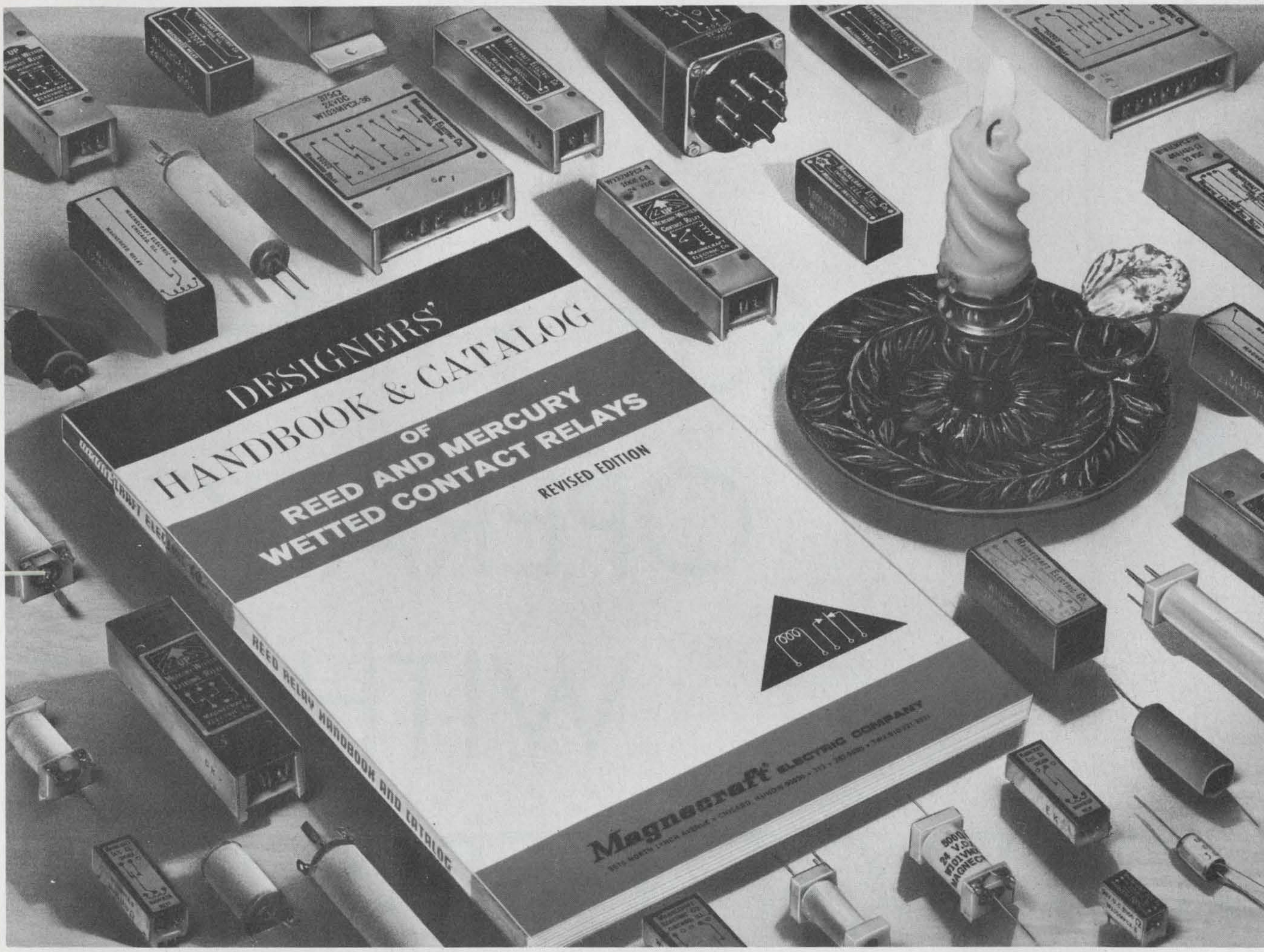
Dipl. Ing. Peter Albrecht, Institut für Technische Electronic Technical University, 8 Munich 2, Arcisstr. 21, W. Germany.

VOTE FOR 318



This modulator for X-band Gunn diodes supplies 100 to 300 mA at 7 to 12 V dc. Its output resistance is extremely low, to prevent bias oscillations of the diode. Transistors Q_1, Q_2 and Q_6 are ITT types BC 172 C; these have $\beta > 500$ and transit frequencies of 300 MHz. Q_3, Q_4, Q_5 and Q_7 are 2N5139s and Q_8 is a 2N2905; both types are made by National Semiconductor.

"WHEN IT COMES TO REED RELAYS,



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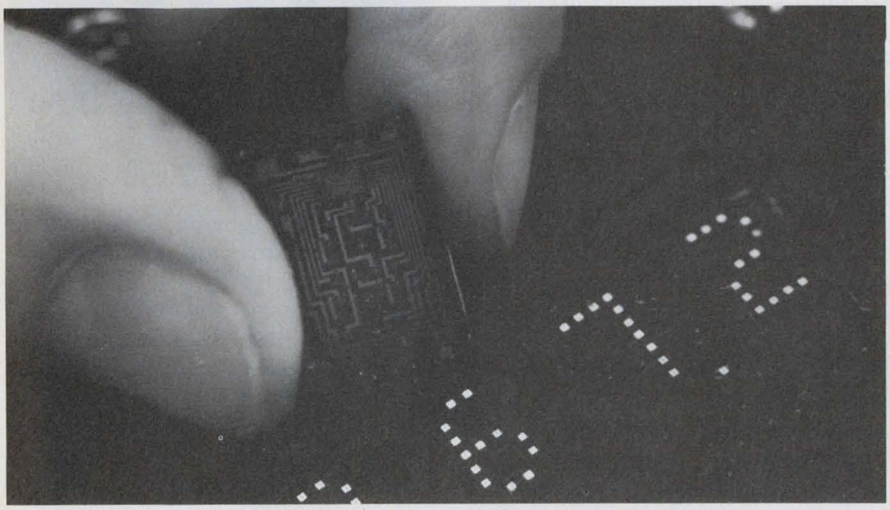
INFORMATION RETRIEVAL NUMBER 64

LED DIP display for $10 has decoder/driver and memory



Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 326-7000. P&A: $16.50 (1-99), $14 (100-499), $12 (500 to 999), $10 (1000); 2 wks.

For a price of only $10 (1000-piece quantities), the new 5082-7300 solid-state LED numeric display comes complete with a decoder/driver IC on the same substrate, a memory and a red filter.

The new display's 4-by-7 dot matrix generates digits that are not boxy in appearance and are pleasing and easy to read. In addition, the use of dot arrays insures against ambiguous reading if one dot fails.

Characters on the new solid-state display are 0.29-in. high and 0.19-in. wide and packaging is in a standard 0.6 by 0.4-in. dual-in-line configuration that can be mounted in standard, readily available hardware or directly on a printed-circuit board.

The 5082-7300 unit is fully compatible with DTL and TTL circuitry and requires only a 5-V dc supply for operation. Its current drain is only 75 mA (typical) and 120 mA (maximum). Power dissipation is a maximum of 660 mW.

Other attractive characteristics of this low-cost display are rugged and reliable construction insuring a long operating life that is estimated at 100,000 hours when operated at half-brightness levels.

A user can address the display with four-line BCD positive-logic information in one of two ways: Parallel character input and sequential character input.

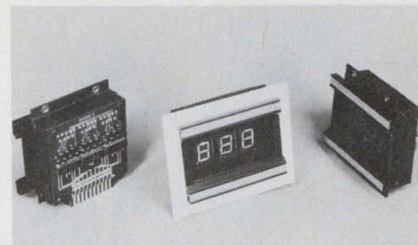
To address each display with character information in parallel, all memory enable input lines are permanently connected to ground. This allows the display to continuously read and show the character information presented to the four-line BCD input.

To address several displays with a common set of four-line BCD inputs, the memory enable line for each display is wired for sequential activation of the memory. This can be accomplished by connecting each display memory enable line to a counter that is clocked to the input information.

The new solid-state LED display costs $12 each, when purchased in quantities of 500 to 999 units. Other prices include $14 each for 100 to 499 units and a price of just $16.50 for 1 to 99 units.

CIRCLE NO. 250

Decoder/driver displays are only 1.2-in. deep

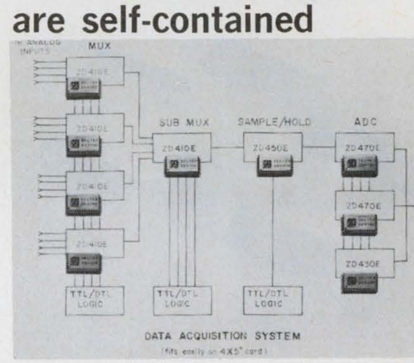


Display General, Inc., 241 Crescent St., Waltham, Mass. Phone: (617) 899-2700. Price: $90.75.

Incorporating a 140-degree viewing angle, the series D-4000 7-segment numerical decoder/driver displays feature a behind-the-panel depth of only 1.2 in. The displays use fluorescent tubes and interface directly with four-line BCD. Standard displays contain three, four and five decades. Bezels are available in various sizes and options are also available.

CIRCLE NO. 251

Conversion modules are self-contained

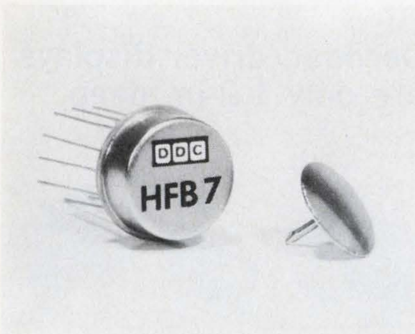


Zeltex, Inc., 1000 Chalomar Rd., Concord, Calif. Phone: (415) 686-6660. P&A: $40, $29, $70, $50, $75; stock.

A new line of 14-pin DIP hybrid conversion products features self-contained operation requiring only external power supplies. The line consists of the ZD410 four-channel MOSFET analog multiplexer, the ZD430 8-bit d/a converter and the ZD450 sample-hold module. It also includes the ZD470 staircase and ZD471 successive-approximation 8-bit a/d converters.

CIRCLE NO. 252

Unity-gain amplifier slews at 1 kV/μs

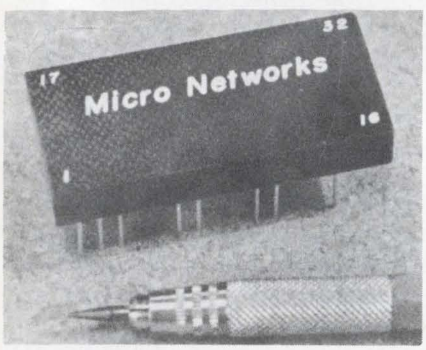


DDC, 100 Tec St., Hicksville, N. Y. Phone: (516) 433-5330. P&A: $75; stock to 3 wks.

Featuring a −3-dB bandwidth of 100 MHz and a full-output frequency of 15 MHz, the HFB-7 FET hybrid unity-gain amplifier slews at a rate of 1000 V/μs with an output of ±10 V at 30 mA. Its input impedance is 10^{11} Ω, input current is 200 pA and input capacitance is 4 pF. Offset voltage and voltage drift are determined by an optional external correction circuit.

CIRCLE NO. 253

D/a 10-bit converter uses 1.5 in.^{2} of space

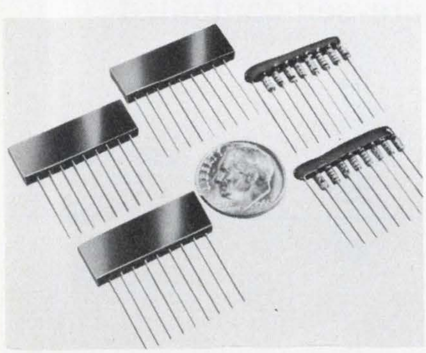


Micro Networks Corp., 5 Barbara Lane, Worcester, Mass. Phone: (617) 756-4635. P&A: $235; 1 wk.

The model MN410 10 bit ac-reference d/a converter takes up less than 1.5 in.^{2} of PC-board space with dimensions of only 0.875 by 1.7 in. It accepts digital inputs that are TTL/DTL compatible and analog inputs of ±12.5 V ac or dc. The unit is made of hermetically sealed flatpack circuits mounted in a molded shell. It meets the requirements of MIL-STD-883.

CIRCLE NO. 254

Nine-lead modules hold eight diodes

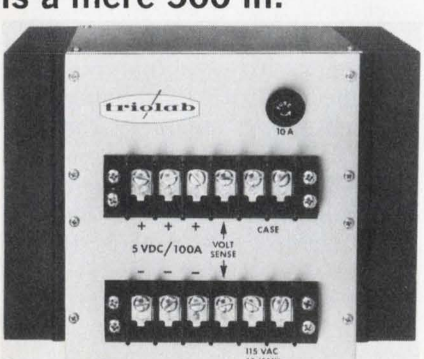


California Microcircuits, Inc., Div. of Teller Industries, Inc., 111 Main St., El Segundo, Calif. Phone: (213) 772-2161. Availability: stock.

Two diode package modules contain either eight 1N914/1N4148 diodes, or eight FD600 diodes, with either common anodes or with common cathodes. The nine-lead packages are single-in-line units with pin spacings of 0.1 in. Each diode package module is available in either molded or in unpackaged configurations.

CIRCLE NO. 255

5-V 100-A power supply is a mere 500 in.^{3}

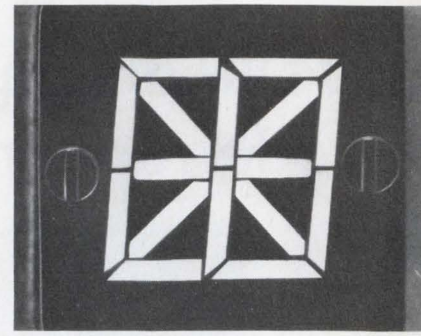


Trio Laboratories, 80 Dupont St., Plainview, N. Y. Phone: (516) 681-0400. P&A: $695; stock.

The new model 630 power supply provides an output of 5 V dc at 100 A from a package measuring only 8-1/2 by 6-3/4 by 8-1/2 in. Its efficiency is 65% for all load conditions and it operates without the need for forced-air or external cooling with full-rated output to +55°C. The model 630 power supply operates from 115 V ac at 47 to 100 Hz.

CIRCLE NO. 256

16-segment readout shows tiny characters

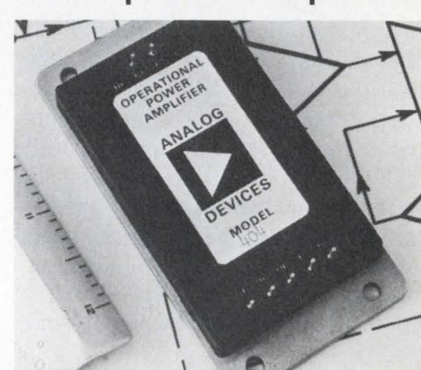


Oppenheimer, Inc., 2475 Wyandotte Rd., Willow Grove, Pa. Phone: (215) OL9-6000.

A new 16-segment alphanumeric readout features miniature character size of 0.4 by 0.4 in. The Opcalite readout is front relampable, has a non-glare high-contrast face and produces a brightness of 500 foot-lamberts at 5 V dc. It can be mounted on 0.675-in. centers and is available in single or stacked units with a choice of colors and filters.

CIRCLE NO. 257

Low-cost power amps develop 60-W outputs



Analog Devices, Inc., 221 Fifth St., Cambridge, Mass. Phone: (617) 492-6000. P&A: $85, $98; stock.

A wide selection of new power operational amplifiers develop outputs of ±20 V at 3 A or ±12 V at 5 A at low prices. Models 402, 403 and 404 retail at $85 and models 406 and 407 at $98. All five operational amplifiers are rated for 80 W of internal power dissipation and have open-loop dc gains of 3000 and 60,000 for the $85 and $98 units, respectively.

CIRCLE NO. 258

One-in.-high supply delivers 40 watts

Arnold Magnetics Corp., 11264 Playa Court, Culver City, Calif. Phone: (213) 870-7014. P&A: $200; 2 to 4 wks.

A new 1-in.-high power supply delivers 40 W of power or 5 A of current to a load from a 5-by-5.3-in. package. As a special version of the earlier PHU power supply, it operates from 115 V ac over 47 to 500 Hz and has output voltages from 3 through 2000 V dc which can be specified. Crowbar overvoltage protection is available as an option.

CIRCLE NO. 259

Modular power supplies program currents

Kepco, Inc., 131-38 Sanford Ave., Flushing, N.Y. Phone: (212) 461-7000. P&A: $150; stock.

A new line of modular current-stabilized power supplies offer programmable current with adjustable voltage limiting. Designated as CCP, they feature fast-recovery circuits that allow the output to stabilize in as little as 2 μs/V of compliance. CCP modules measure 3-3/8 by 6-3/8 by 4-15/16 in. and provide terminal-strip access to all functions.

CIRCLE NO. 260

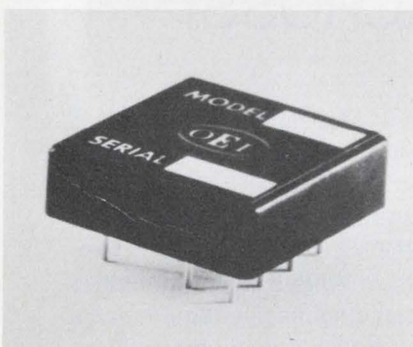
Counters with memories use plug-in-card logic

Instrument Displays, Inc., 18 Granite St., Haverhill, Mass. Phone: (617) 374-0311. P&A: $110 (4 decades); stock.

A new line of counter displays with memories features all logic functions on plug-in cards. Only one connector is required for each card regardless of the number of decades used. In a single bezel and housing, anywhere from 2 to 8 decades can be provided. Individual logic cards mount directly behind the display tubes.

CIRCLE NO. 261

High-gain op amp boasts f_T of 1 GHz



Optical Electronics, Inc., P. O. Box 11140, Tucson, Ariz. Phone: (602) 624-8358. P&A: $60; stock.

The model 9491A operational amplifier provides a guaranteed 6-dB/octave roll-off rate, beginning typically at 1.5 MHz and crossing unity gain at 1 GHz minimum. The unit makes possible closed-loop bandwidth in excess of dc to 300 MHz by just employing a feedback resistor and an input resistor. The device also offers a minimum open-loop gain of 60 dB.

CIRCLE NO. 262

Miniature module socks out 5 V at 1 A

Computer Products, Inc., 1400 Gateway Dr., Ft. Lauderdale, Fla. Phone: (305) 933-5561. P&A: $63.95; 1 to 5 days.

The PM532 is a fully encapsulated PC-mounting power supply module that provides 5 W of power in a package measuring only 3.5 by 2.5 by 1.25 in. Voltage and current output are 5 V dc at 1 A. It operates from 115 ±10 V ac at 50 to 400 Hz. Ripple and noise are less than 1 mV and line regulation is ±0.05%.

CIRCLE NO. 263

D/a converter for $49 handles 10 bits to 0.1%

Varadyne Systems, div. of Varadyne, Inc., 1020 Turnpike St., Canton, Mass. Phone: (617) 828-6395. P&A: $49; stock.

Featuring externally programmed selection of either a unipolar or bipolar output, a new 0.1% 10-bit d/a converter sells for only $49 in single-unit quantities. In its 1.6-cubic-inch plastic case, model DAC-49 contains input buffer logic, electronic switches, ladder network, voltage reference source and output buffer amplifier.

CIRCLE NO. 264

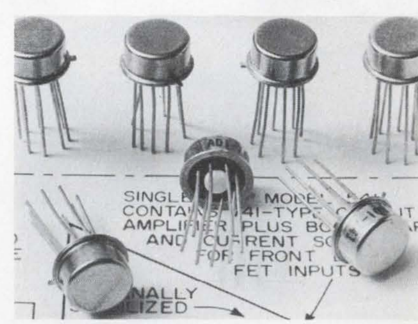
D/a converter resolves 14 bits

Teledyne Philbrick Nexus, Allied Dr. at Route 128, Dedham, Mass. Phone: (617) 239-1600. P&A: $895; stock.

Model 4001 is a high-speed self-contained d/a converter offering 14-bit resolution. Built-in features include a reference, switching networks, an output amplifier and gain and offset adjustments. Overshoot and controlled monolithic transition between digital levels is ±5 mV. Settling time is 20 μs ± the least significant bit. Operation is from ±15-V power supplies.

CIRCLE NO. 265

FET-input op amps offer zero trimming



Analog Devices, Inc., 221 Fifth St., Cambridge, Mass. Phone: (617) 492-6000. P&A: $22 or $33; stock.

Two new FET-input IC operational amplifiers can be trimmed for zero (cancelling initial offsets), without introducing serious additional voltage drift problems. Respective features for models AD503J and AD503K include: an offset voltage of 20 or 8 mV, a bias current of 15 or 5 pA, a voltage drift of 30 or 15 μV/°C, a common-mode rejection ratio of 80 dB and an open-loop gain of 50,000.

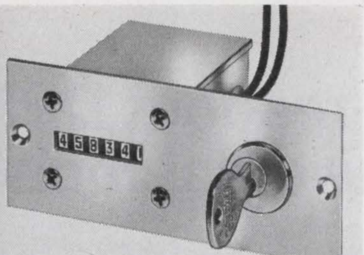
CIRCLE NO. 266

SERIES P

THE

MOST COMPLETE LINE OF

PANEL MOUNTED COUNTERS



Model P-4A

Key resettable counter. U.L. listed. Lock on counter permits reset by key only for security measures. 115 V., 60 Hz. std.

ENM now offers the most complete line of panel mounted counters manufactured by a single source in the U.S.A.

Seven separate and distinct panel mounted models encompassing both resettable and non-resettable counters, key lock types and elapse time indicator with 9999.9 time scale.

All units feature six digits with a standard counting speed of 500 cpm. Higher speeds and various voltages available. Specials on request.

Write for 4-page full line panel mounted counter brochure.

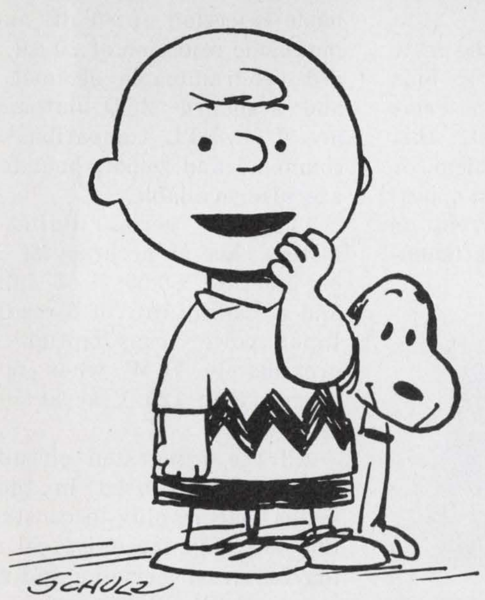
ENM COMPANY

5340 N. Northwest Highway
Chicago, Illinois 60630
Phone: (312) 775-8400

INFORMATION RETRIEVAL NUMBER 68

"IT'S GOOD BUSINESS TO HIRE THE HANDICAPPED."

ISN'T THAT A GREAT IDEA, SNOOPY?



THE PRESIDENT'S COMMITTEE ON EMPLOYMENT OF THE HANDICAPPED, WASHINGTON, D. C.

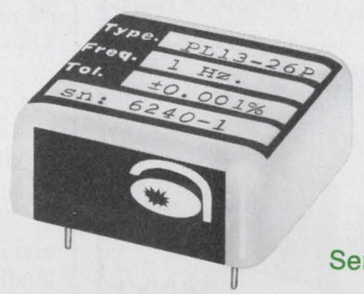
OSCILLATORS

1 Hz to 250 MHz

LOW CURRENT DRAIN / 800 MICRO-AMPS AT 1 Hz

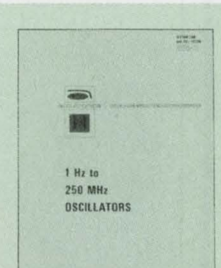
YES, THAT'S RIGHT . . . less than 1 ma current drain at the frequency of 1 Hz! If your new KLOOGE can't stand a high current drain oscillator, our new Series 162 is probably the answer. Not only is the Series 162 easy on the current drain and budget, it only requires an area of 1.5 x 1.5 x .62 inches . . . much smaller than a clock plus countdown.

INTERESTING? Call Wayne Benson, (area) 312 - 232-2600, and he will be glad to fill you in on all the details and send you our new catalog.



Series 162

FREQUENCY: 1 Hz to 1 MHz
FREQUENCY TOLERANCE: ±0.001%
TEMPERATURE RANGE: 0°C. to 60°C. typical
SUPPLY VOLTAGE: −20V DC, or +6V DC, or +12V DC
OUTPUT VOLTAGE: Compatible with MOS, TTL logic, Sinewave also available.
SIZE: 1.5" x 1.5" x 0.62" PC board mount, Chassis mount also available.



FREE:

NEW 1971 CATALOG

Our new catalog covers various types of oscillators: VCXO, LCVCO, RCVCO, high stability, computer clocks, high output power, Navy standard hardware modules and low current drain oscillators from 1 Hz to 250 MHz. We'll even send you three neat conversion charts (3) to hang on your wall and impress your friends.

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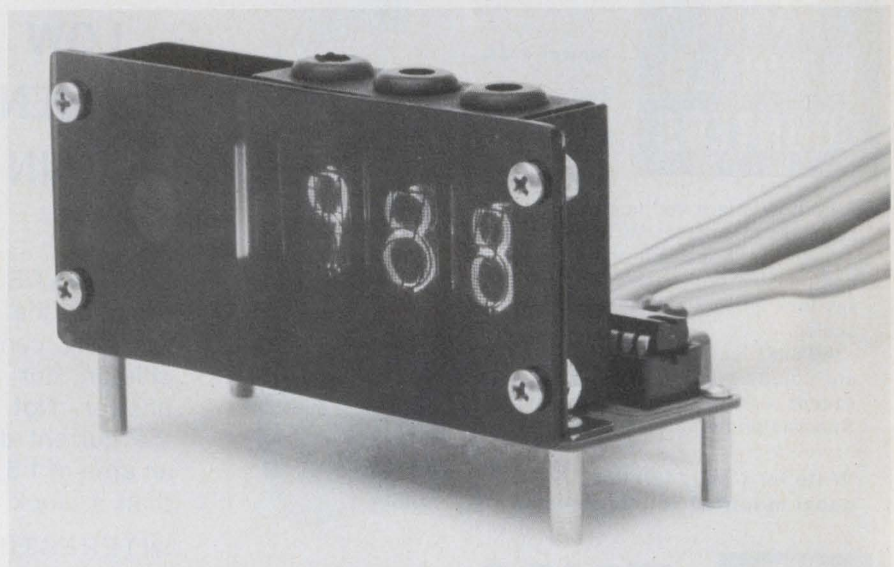
INFORMATION RETRIEVAL NUMBER 69

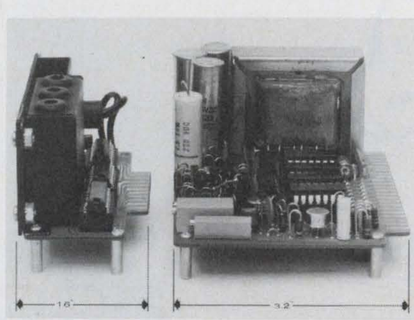
Remote-readout DPMs allow universal mounting



Data Technology Corp., 1050 E. Meadow Circle, Palo Alto, Calif. Phone: (415) 321-0551. P&A: $150 (3-1/2-digit unipolar), $157 (3-1/2-digit bipolar); December 1970/January 1971.

Allowing universal mounting capability limited only by the user's imagination, the new 3800 series of 2-1/2 and 3-1/2 digit unipolar and bipolar panel meters are available with separate a/d converters and separate remote readouts that require a mere 1.6 in. of behind-the-panel depth.

Equally important is the new meters' low input offset or bias current of just 100 pA. In terms of performance and cost, this minimizes the user's problem of either having to generate an opposing input cancellation current or to lower the meter's input attenuator impedance thereby increasing circuit loading.



Separate display and a/d converter plug-in modules can mount together or remotely through a cable.

The separate a/d converters come with power supplies on the same 4.5 by 3.2-in. cards. Each converter card can be plugged directly into the readout module to give a total behind-the-panel depth of just 3.5 in. If the user desires, the converter can be remotely (up to 3 feet) hooked up to the readout through a cable.

Characteristics include an input impedance of 1000 MΩ, common-mode rejection of 80 dB and normal-mode rejection of 20 dB, standard programmable decimal points and standard BCD outputs that are TTL/DTL compatible. Print-command and remote-hold features are also available.

The 3800 series digital panel meters have an accuracy of ±0.1% of reading ±0.05% of full scale and a reading rate of 6 readings/s. Input power consumption is approximately 7 W when operated from 105 to 125 V ac at 50 to 60 Hz.

All the integrated circuits and readout tubes used in the 3800 series feature plug-in construction. Coupled with the universal mounting features, servicing and replacement of the 3800 series digital panel meters becomes a simple and inexpensive task.

CIRCLE NO. 267

Four-digit multimeter retails for $495

Dixson Instruments, Inc., Box 1449, Grand Junction, Colo. Phone: (303) 242-8863. P&A: $495; stock.

The mn124 four-digit multimeter with 17 ranges of measurement and accuracies that range from 0.001% to 0.01% costs only $495. It measures dc voltages from 200 mV to 1 kV in 5 ranges, ac voltages from 200 mV to 500 V in 5 ranges and resistances from 200 Ω to 2 MΩ in 5 ranges. It also measures ac and dc currents. Other features include automatic zero and polarity and built-in calibration.

CIRCLE NO. 268

Automatic IC tester sells for $1400

Electrodata Concepts, Inc., 69 Connecticut Ave., Norwalk, Conn. Phone: (203) 853-2792. Price: $1400.

A new automatic IC tester tests TTL, DTL and RTL (including Nixie drivers) in DIP, flatpack or TO-5 packages up to 16 pins for a price of only $1400. The model 7000 automatically tests for truth-table verification, outputs, inputs, input thresholds, shorts and overcurrents. Test results are displayed on a test set panel by means of pass/fail lights and four fault-analysis lights which pinpoint faults.

CIRCLE NO. 269

Double-pulse generator produces 5 MHz for $395

Lyons Instruments Ltd., Hoddesdon, Herts, England. P&A: $395; January, 1971.

The PG-71 half-rack pulse generator spans a pulse repetition frequency of 1 Hz to 5 MHz, in single or double-pulse outputs, with 7 decade ranges that include a logging vernier, for only $395. Pulse delay and width range from 50 ns to 1 s and output amplitude covers 0.5 to +10 V. External triggering is from dc to 1 MHz. Rise and fall times are under 10 ns for both channels.

CIRCLE NO. 270

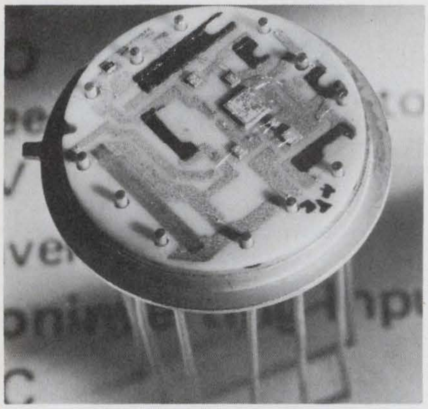
Scope time-base plug-in shows 1-ns/cm sweep

Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 326-7000. P&A: $1150; 8 wks.

A new oscilloscope time-base plug-in has a delayed sweep that gives a sweep time of 1 ns/cm to make it possible to measure pulse widths and short time intervals with sub-nanosecond resolution. The 1841A also makes it possible to view complicated waveforms or pulse trains. Designed for use with the 183 series oscilloscopes, it has 21 sweep times ranging from 10 ns/cm to 0.1 s/cm.

CIRCLE NO. 271

Hybrid 1-A regulator needs no compensation



Texas Instruments, Inc., 13500 N. Central Expressway, Dallas, Tex. Phone: (214) 238-2011. P&A: $17.10 (100 to 999); stock.

Featuring adjustable output voltage from 2 to 37.5 V, a new hybrid positive-voltage regulator includes regulated output current up to 1 A without the need for an external pass transistor or for any external compensation techniques.

The new HIC106 positive-voltage regulator can be operated either in series or in shunt modes and requires only a single external adjustable resistor. An optional output is available with internal current limiting.

Excellent temperature stability of ±0.02% characterizes the HIC-106 over an operating temperature range of −55 to +125°C when operating at an output voltage of 25 V and at an output current of 1 A.

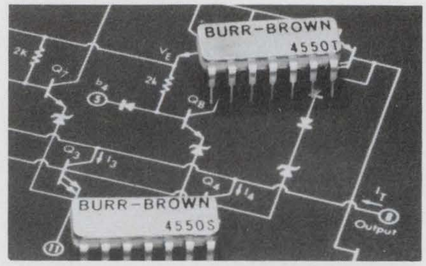
Other characteristics include line regulation of 0.15% for an input voltage swing of 20 to 40 V and an output voltage of 15 V. Load regulation is given as 0.2% for an input voltage of 40 V and an output voltage of 35 V when operating within the output current range of 1 to 300 mA.

Internal power dissipation is 5 W at a case temperature of 25°C. Ripple rejection characteristics range over 74 to 86 dB.

In addition to the HIC106, a negative-voltage version (the HIC-107) is available. Except for its 0 to −37.5-V output, it has the same characteristics and ratings as the HIC106.

CIRCLE NO. 272

12-bit d/a converter drifts but 1 ppm/°C

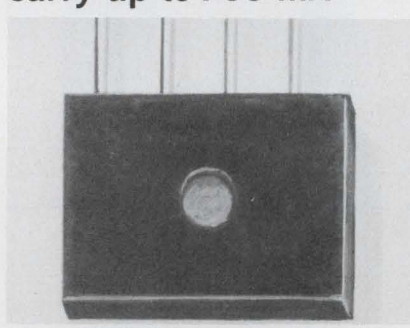


Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. Phone: (602) 294-1431. P&A: $10 to $28; stock to 4 wks.

The model 4550 monolithic d/a converter features 12-bit accuracy ±1/2 the least significant bit, a switching time of 200 ns for settling to within ±0.01% and a temperature coefficient as low as ±1 ppm/°C. It offers a choice of two temperature ranges: 0 to +70°C and −55 to +125°C. Input logic is DTL/TTL compatible. The 4550 operates from −15 V.

CIRCLE NO. 273

600-V bridge rectifiers carry up to 750 mA

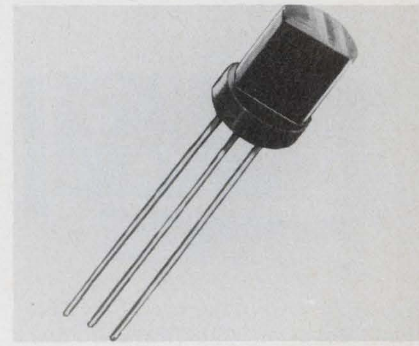


General Instrument Corp., 65 Governeur St., Newark, N. J. Phone: (201) 485-2100. Price: 42¢, 37¢, 32¢.

A line of new low-cost single-phase silicon bridge rectifiers is rated for 250, 500, 750 mA of current at a voltage range of 50 to 600 V PRV. The bridges measure 0.69 by 0.25 by 0.52 in. and have in-line leads for printed-circuit board insertion. Types 7BP02, 50BP02 and 25BP002 are plastic-molded units which are priced as low as 32¢ each for 1000-piece quantities.

CIRCLE NO. 274

Transistor complements drop noise to 0.5 dB

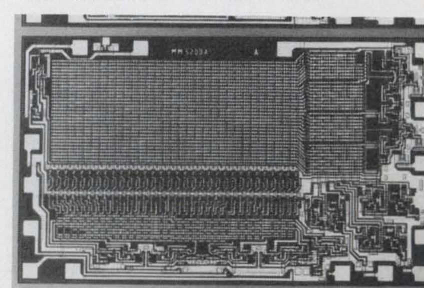


General Electric Co., Semiconductor Products Dept., 1 River Rd., Schenectady, N. Y. Phone: (315) 456-2298. P&A: from 23¢ (10,000 quantities); stock.

New pnp/npn complementary signal transistors encapsulated in epoxy TO-98 packages feature a specified noise figure of 1.5 dB maximum and 0.5 dB typical. Transistor numbers 2N5998, 2N5999, 2N6008 and 2N6009 offer a dc common-emitter forward-current gain hold-up range of 10 μA to 300 mA. Leakage is 10 nA.

CIRCLE NO. 275

1024-bit bipolar ROM accesses in 30 ns

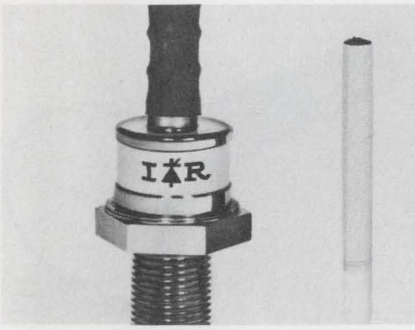


Monolithic Memories, Inc., 1165 E. Arques Ave., Sunnyvale, Calif. Phone: (408) 739-3535. P&A: $70; 3 wks.

A new 1024-bit bipolar read-only memory organized as 256 words by 4-bits accesses in just 30 ns. The MM5200 also has low power dissipation of 0.35 mW/bit. The new memory has full address decoding on the chip and is DTL/TTL compatible. It also has two enable inputs and an open collector output which allow for easy expansion.

CIRCLE NO. 276

Inverter-type SCRs take 150 A at 600 V

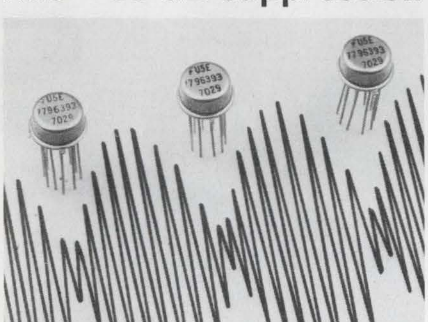


International Rectifier Semiconductor Div., 233 Kansas St., El Segundo, Calif. Phone: (213) 678-6281. Price: $35.30.

A new series of fast-switching inverter-type SCRs can handle average currents of 150 A at voltages ranging from 50 to 600 V. The units offer a current differential of 300 A/μs and a voltage differential of 200 V/μs. Their turn-off time is only 20 μs. Series 151RF units are supplied in JEDEC TO-93 cases.

CIRCLE NO. 277

Modulator/demodulator has −65-dB suppression

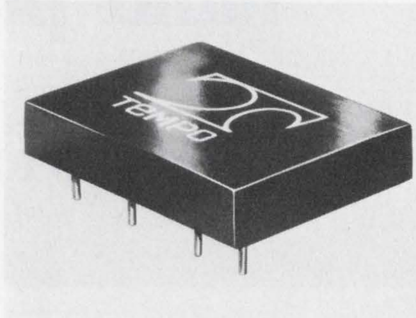


Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. Phone: (415) 962-3563. Price: $7.20.

A new monolithic double balanced modulator/demodulator features carrier suppression of −65 dB at 0.5 MHz and −50 dB at 10 MHz. The μA796 linear IC has precisely matched transistor components at its inputs and outputs. It operates with an input offset current of 0.7 μA and limits drift to 2 nA/°C. It provides a differential output swing of 8 V pk-pk.

CIRCLE NO. 278

Time-delay relays cover 25 ms to 500 s



Tempo Instrument Div. of Allen Electric and Equipment Co., East Bethpage Rd., Plainview, N. Y. Phone: (516) 694-4400.

Two new series of miniature solid-state time-delay relays, LPT1 and LPT5, provide fixed time delays from 25 ms up to 500 s and 200 s respectively. Both feature plastic-encapsulated flatpack configurations and are DIP compatible. The former operates over −55 to +170°C and the latter over −55 to +125°C.

CIRCLE NO. 279

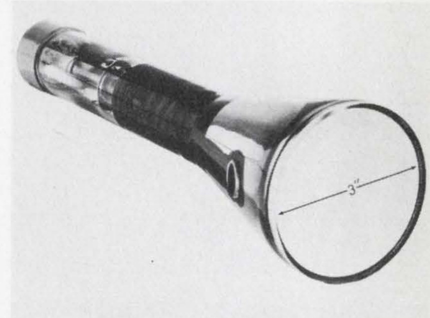
Small-transformer kit spans many impedances

Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y. Phone: (516) LO1-6050. P&A: $37.95; stock.

The model 500K Selector Kit contains nine transformers covering a center-tap impedance range of 600 to 50 kΩ. The transformers are open-frame types and range in sizes from 1/4 by 3/8 by 3/8 in. to 3/4 by 3/4 by 1 in. The kit is furnished with outline drawings, a nomograph for class A & B transistor amplifiers, a power-vs-dBm chart and a MIL-T-27 guide.

CIRCLE NO. 280

High-resolution CRT costs just $45

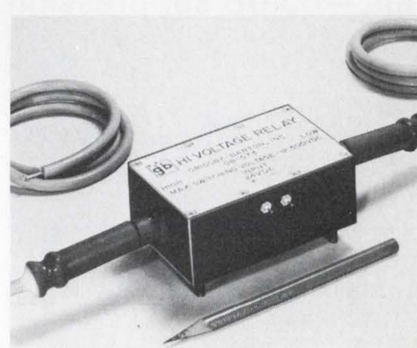


Thomas Electronics, Inc., 100 Riverview Dr., Wayne, N. J. Phone: (201) 696-5200. Price: $45.

Incorporating a 3-in. dia and line resolutions that range from 0.002 to 0.004 in., a new compact CRT costs less than $45, in production quantities. It uses magnetic deflection and either electrostatic or magnetic focusing. It is designed for applications in computer output terminal systems and as a flying-spot scanner in electronic video recorder systems.

CIRCLE NO. 281

High-voltage relay switches to 12.5 kV

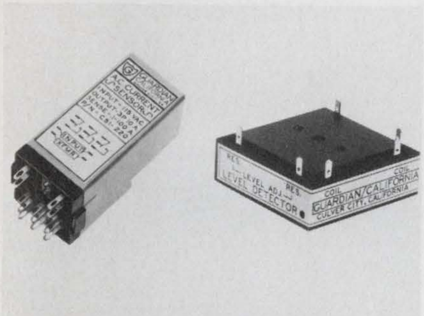


Grigsby-Barton, Inc., 3800 Industrial Dr., Rolling Meadows, Ill. Phone: (312) 392-5900.

A new compact high-voltage relay for use with floating power supplies can switch 12.5 kV at 1 mA and is capable of standing off 15 kV across its contacts and over 40 kV from contacts to coil or to case. It is available in 6, 12, 24 and 48-V models. The case is of cast-aluminum and comes with high-voltage cable connectors. Case dimensions are 4-1/8 by 2-5/8 by 1-5/8 in.

CIRCLE NO. 282

Solid-state detectors sense power lines



Guardian Electric Manufacturing Co. of California, Inc., 5755 Camille Ave., Culver City, Calif. Phone: (213) 870-4642.

A new line of solid-state protective sensors detect under-voltage and phase-loss conditions and either sound an alert or shut down operating equipment. They are available as three-phase voltage or four-wire phase-sequence sensors, as 204-V-ac three-wire sensors, and as adjustable frequency and ac current sensors.

CIRCLE NO. 283

Keyboard reed switch can be pre-adjusted

Amphenol Switch Div., The Bunker-Ramo Corp., 2855 S. 25 Ave., Broadview, Ill. Phone: (312) 261-2000.

The new 601 single-reed keyboard switch permits switch adjustment to a specified operating point at the factory. Electrical characteristics include initial contact resistance of 0.2 Ω, contact power-handling capacity of 10 W and breakdown of 300 V ac at 60 Hz. All contacts are single-pole normally open. The total switch height, in a mounted position, is 1.593 in.

CIRCLE NO. 284

Chip capacitors cover 10 pF to 1 μF

Allen-Bradley Co., 1201 S. Second St., Milwaukee, Wis. Phone: (414) 671-2000.

New multilayer chip capacitors range in values from 10 pF to 1 μF. MB capacitors are available in four proposed standard EIA sizes and in standard capacitance values. Their operating temperature range is −55 to +125°C. Standard voltage ratings available are 50, 100 and 200 V/dc. Available capacitance tolerances are ±5%, ±10% and ±20%. The new monolithic chip capacitors come in NPO, stable, semi-stable and Hi-K materials.

CIRCLE NO. 285

0.00019-in.^{3} inductor has 1-mH inductance

Nytronics, Inc., Inductor Div., Orange St., Darlington, S. C. Phone: (803) 393-5421. Price: $2.38 to $3.64.

The Pee Dee Ductor is an axial-lead inductor that packs inductance values of 0.1 μH to 1 mH in a device 0.075 in. in dia and 0.14-in. long. It has minimum Q values of 21 to 55 at rf frequencies with standard inductance tolerances of ±10%. It handles currents from 30 to 600 mA and operates from −55 to +125°C.

CIRCLE NO. 286

Tiny power-line filter is a mere 0.115-in. long

Potter Co., 500 W. Florence Ave., Inglewood, Calif. Phone: (213) 678-2651. P&A: $4 to $14; 6 wks.

A new hermetically sealed filter for ac and dc power lines measures only 0.115-in. long and weighs as little as 2.5 grams. Specifications include a dc resistance of 0.01 Ω, a dc current rating of 10 A, dielectric strength of 100 V dc and insulation resistance of 100 MΩ. Voltage ratings are 50 and 28 Vdcw at +85 and +125°C, respectively. Operating temperatures range from −55 to +125°C.

CIRCLE NO. 287

Optical reader terminal reads bar codes

Ferranti-Packard Ltd., Electronics Div., 121 Industry St., Toronto 15, Canada. Phone: (416) 762-3661. Price: $3000.

The Datatriever on-line optical reader terminal reads printer-generated bar code on any transmitted document. An integrated keyboard, a numeric display and a 20-column printer provide communication with remote terminals. Transmission is asynchronous in serial ASCII at bit rates up to 50 kilobaud over full or half duplex lines.

CIRCLE NO. 288

Keyboard-display is self-contained

UniComp, Inc., 18219 Parthenia St., Northridge, Calif. Phone: (213) 886-7722.

A new totally self-contained keyboard-display contains a keyboard, CRT display, memory, power supply and communications interface, all in one package. The 522 stand-alone unit can be used in place of Teletype equipment and features selectable transmission rates of 110, 150, 300, 600 or 1200 baud, as well as 9600 bits/s. A split screen displays 1998 characters in full or half-duplex operation.

CIRCLE NO. 289

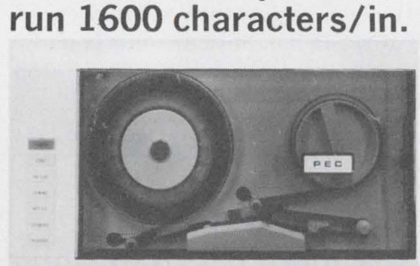
Twin-display terminal controlled by one link

Communitype Corp., 767 5th Ave., New York, N.Y. Phone: (212) 758-4230. P&A: $4150; 30 days.

The model 2000 CRT display terminal features two independent 9-in. display units that are controlled and selected by a single data communications link and keyboard. Each screen has a display capacity of 20 lines with 40 character positions to a line. A display screen selector provides the capability of selecting either display or both displays simultaneously.

CIRCLE NO. 290

Encoded transports run 1600 characters/in.

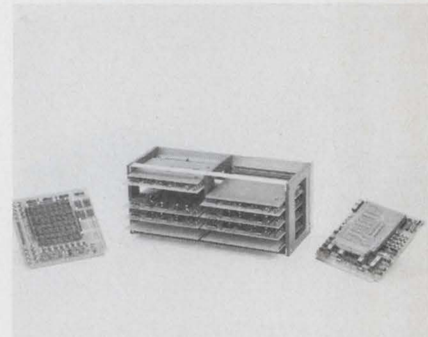


Peripheral Equipment Corp., 9600 Irondale Ave., Chatsworth, Calif. Phone: (213) 882-0030. Price: $2920.

The 7000 series of magnetic tape transports includes phase-encoded models with 7-in. reels that work at 1600 characters/in. They are available in read-after-write and write-read configurations and offer 9-track and 12.5-in./s operation. Data transfer rates are up to 20,000 characters/s. The new transports require only 9-3/4-in. of space.

CIRCLE NO. 291

4k by 8-bit memory mixes RAMs and ROMs

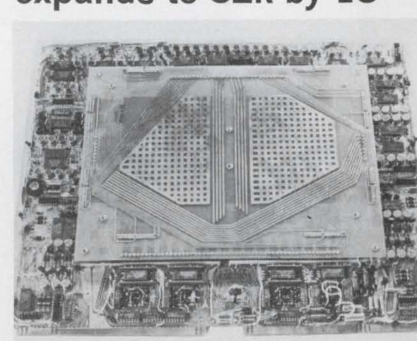


Unicom, Inc., 1275 Bloomfield Ave., Fairfield, N.J. Phone: (201) 228-1696. P&A: $2490; 30 days.

A new 4k by 8-bit memory system allows the mixing of 1k by 8-bit segments of read-only and read-write memories. It features TTL compatibility, is non-volatile and has ac on/off protection and sensing. The new memory system is field alterable and comes completely packaged in a 19-in. rack-mountable frame. Power supplies for the memory can also be supplied.

CIRCLE NO. 292

1.5-μs core memory expands to 32k by 18

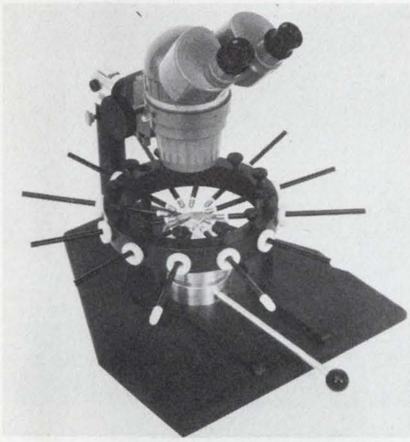


Information Control Corp., 9610 Bellanca Ave., Los Angeles, Calif. Phone: (213) 641-8520. P&A: $1388; 30 days.

A new inexpensive random-access core memory system can be expanded up to 32k by 18 bits by the addition of eight 4k increments. The Comrac 50 utilizes DTL/TTL and can read/restore and clear/write in a full cycle in 1.5 μs. Read/modify/write mode is a split cycle requiring 1.8 μs and access time is 0.45 μs. The basic memory uses two boards.

CIRCLE NO. 293

Microprobe station mounts 12 test probes

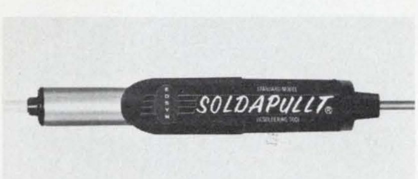


Adcotech Corp., 887 Maude Ave., Mountain View, Calif. Phone: (415) CA9-4040. Price: $285.

A new microcircuit probe station can mount and rapidly position as many as 12 removable test probes. Designated as the Model 610, the new prober is manually operated and uses a restrained sphere as the mechanism for mounting each probe arm to a fixed-ring assembly. The sphere mechanism serves as a bearing, slide, support and locking fixture for the arms for universal probe-tip motion.

CIRCLE NO. 294

Handy solder puller facilitates rework

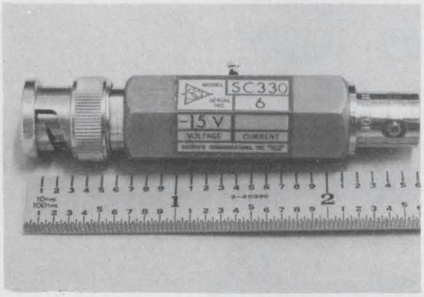


Edsyn, Inc., 15954 Arminta St., Van Nuys, Calif. Phone: (213) 989-2324. P&A: $5.95; stock.

The Soldapullt desoldering tool facilitates component rework through rapid removal of unwanted solder from solder joints. Molten solder is drawn into the chamber with a high-impulse vacuum stroke by thumb release of a spring-loaded piston. A plastic sleeve shields the exhaust ports from the user. The unit's low cost of $5.95 includes a 12-page solderability instruction manual.

CIRCLE NO. 295

0.3-GHz 23-dB amplifier drops noise to 4 dB

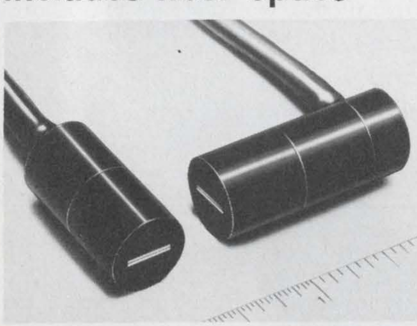


Scientific Communications, Inc., 2710 National Dr., Garland, Tex. Phone: (214) 271-3685. P&A: $145; stock to 1 wk.

The model SC330 broadband amplifier provides 23 dB of gain that is flat within 0.5 dB from 30 to 300 MHz with a maximum noise figure of 4 dB. It features high performance and hybrid construction. Several units can be readily cascaded for higher gain without sacrifice of gain flatness or noise figure. Other amplifiers are available for 1.3-GHz bandwidths.

CIRCLE NO. 296

Packaged photosensor includes fiber optics

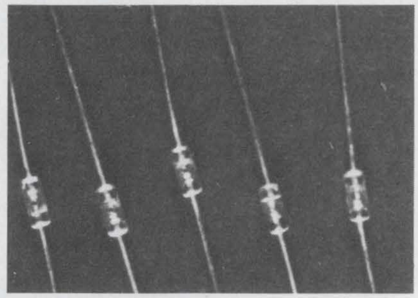


Welch Allyn, Skaneateles Falls, N. Y. Phone: (315) 685-5788.

A new reflective high-efficiency photosensor comes complete with lamp, fiber optics and phototransistor in one package. The sensor comes in two configurations and is adaptable for single-channel reflective-presence indicator applications. The fiber optics transmit and shape light into a rectangle 0.025 by 0.3 in. A similar fiber-optic bar transmits reflected light to a phototransmitter. Operating current is 0.115 A.

CIRCLE NO. 297

P-i-n switching diodes have breakdowns to 1 kV

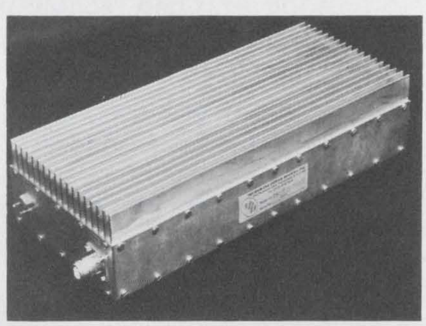


Microwave Diode Corp., 467 Merrimac St., Newburyport, Mass. Phone: (617) 462-7462. Availability: stock to 3 wks.

The MD431 series of microwave p-i-n switching diodes features breakdown voltages from 150 to over 1000 V. Typical series resistance varies from 8 $\times$ 10^4 Ω to 1 Ω as forward bias is applied. Capacitance varies from 1.7 to 0.7 pF. The diodes are available in pill, DO-7, and miniature glass packages. Applications include limiters and phase shifters.

CIRCLE NO. 298

1-GHz power amplifiers deliver 200 W cw

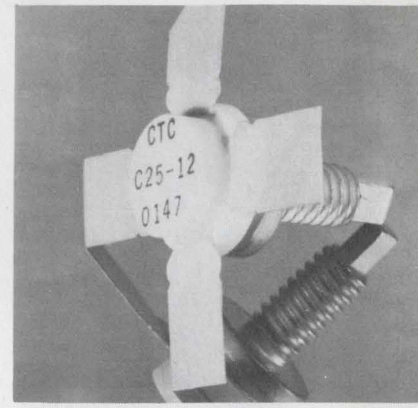


Microwave Power Devices, Inc., 556 Peninsula Blvd., Hempstead, N. Y. Phone: (516) 538-7520. Availability: 6 to 10 wks.

Covering a range of 100 through 1000 MHz, a new series of solid-state replaceable-module power amplifiers deliver output levels greater than 200 W cw. They employ a combination of lumped-stripline techniques and drive VSWR loads of 2:1 at any phase with no detuning. A typical unit is the PA-275-20-100-10 275-MHz amplifier with a 100-W output.

CIRCLE NO. 299

12-V 0.5 GHz transistors provide 25 W of power

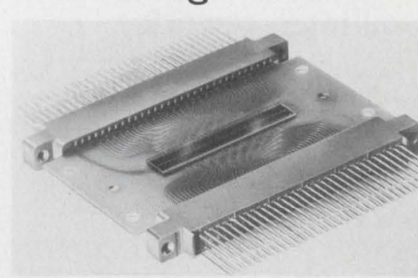


Communications Transistor Corp., 301 Industrial Way, San Carlos, Calif. Phone: (415) 591-8921. P&A: $84.30; 5 to 10 days.

Three new rf power transistors operate over the frequency range of 450 to 512 MHz and provide up to 25 W of output power from 12-V supplies. They exhibit infinite VSWR through all phase angles. The three are the C3-12, with a 4-W output, the C12-12 with a 12-W output and the C25-12 with a 25-W output.

CIRCLE NO. 300

Photodiode arrays hold leakage to 10^{-9} A

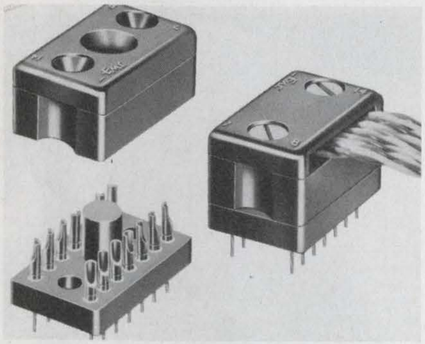


United Detector Technology, 1732 21 St., Santa Monica, Calif. Phone: (213) 393-3785.

A new series of silicon photodetector arrays contain Schottky-barrier and diffused photocells with exceptionally low leakage currents of 10^{-9} A. They feature response times of 5 $\times$ 10^{-9} s and linearity deviation of only 10%. The arrays offer center spacings from 0.008 to 0.05-in. and element densities from 50 to 256. Model PIN-DA has 100 elements in a 10-by-10 matrix.

CIRCLE NO. 301

Plug for PC boards interfaces input/outputs

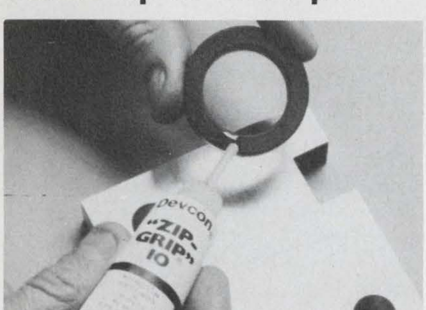


Electronic Molding Corp., 96 Mill St., Woonsocket, R. I. Phone: (401) 769-3800.

A new plug allows interfacing between input and output pins to basic patterns on printed-circuit boards or to an outside power source. The plug's solder-type terminals are made of phosphor bronze. A molded cover is screwed to the base and acts as a wire strain relief. Two models are offered: one with top entry and one with side entry, each in 14 and 16-pin versions.

CIRCLE NO. 302

Quick-acting adhesive bonds up to 5000 psi

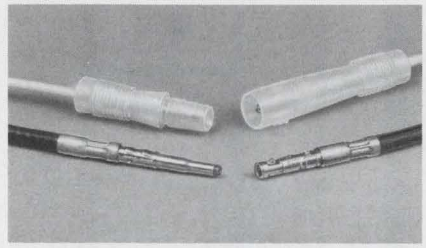


Devcon Corp., Endicott St., Danvers, Mass. Phone: (617) 774-1990. P&A: from $1.50; stock.

Zip-Grip 10 is a new adhesive that bonds almost anything to anything in seconds with a tensile strength up to 5000 psi. It bonds iron, steel, aluminum, bronze, brass, magnesium, copper, glass, all types of rubber and almost every plastic material to itself or to each other. No mixing, catalyst, heat or pressure is required.

CIRCLE NO. 303

Quick-disconnect splice joins power/coax cable

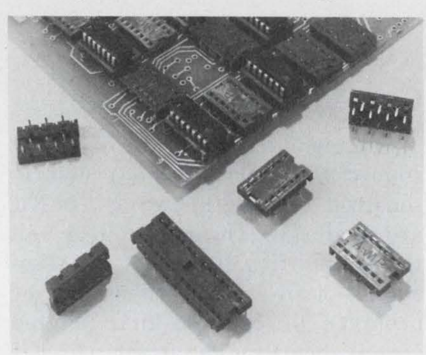


Burndy Corp., Richards Ave., Norwalk, Conn. Phone: (203) 838-4444.

A new quick-disconnect splice uses three types of contacts to join either power or subminiature coaxial cables. The Trim Trio splice uses AWG #16 formed or machined or subminiature coaxial contacts which are inserted into the shell halves by hand and removed with a simple hand tool. Wire size range is AWG #30 solid through #14 stranded for power leads. A wide variety of coaxial cables can be used.

CIRCLE NO. 304

Low-profile headers are just 0.15-in. high



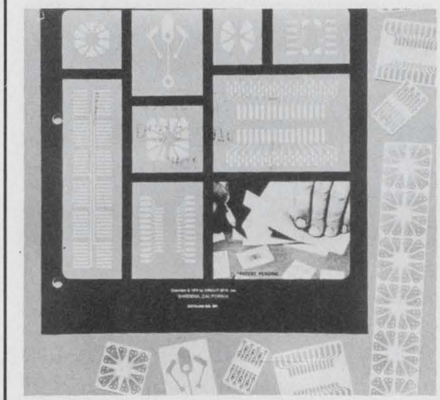
AMP, Inc., Harrisburg, Pa. Phone: (717) 564-0101.

Specially designed for wave or dip soldering to 0.125-in.-thick PC boards, new low-profile headers which accept 14 or 16-pin DIP packages measure only 0.15-in. high. Their one-piece glass-filled nylon housings provide wide and angular lead-in for easy insertion. Contact posts are available on in-line or staggered grid patterns and are self retaining in 0.031-in.-dia holes prior to soldering.

CIRCLE NO. 305

INFORMATION RETRIEVAL NUMBER 77

evaluation samples



Circuit elements

Free samples and a catalog of a complete family of circuit subelements and circuit materials designed as a packaging system are available. The system reduces design and drafting expenses and saves time that is normally lost to outside manufacturing services. Included are many types of circuit-element configurations that may be mixed and combined on the same board. Individual circuit boards can be assembled and tested from engineering sketches on the same day. Circuit-Stik, Inc.

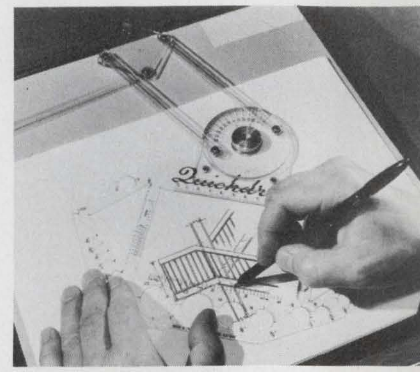
CIRCLE NO. 340

Copper foil tape

Samples and literature of a new copper foil tape with a pressure-sensitive backing known as Cir-Kit are available. The new copper foil tape simplifies the problems associated with the construction of protoype or one-of-a-kind printed circuit boards. To attach Cir-Kit tape to its insulated base, it is only necessary to peel off its protective paper backing and place it in position. It will immediately stick in place and its bond will improve with time. Soldering to Cir-Kit merely speeds up the aging process. It is flexible and will conform to any configuration desired. Strips of 1/16 and 1/8-in. widths and sheets measuring 6 by 12 in. are available. Cutting Cir-Kit is easily done with a knife or scissors. Cir-Kit.

CIRCLE NO. 341

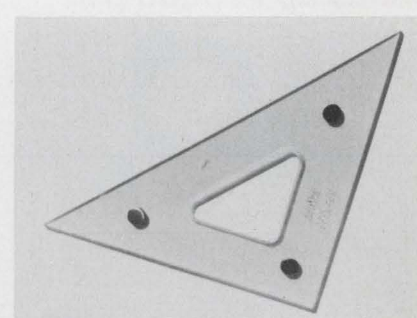
design aids



Drafting tool

The Quickdraw Mark II is a new drafting instrument with a special protractor head that allows its template to be set at any predetermined angle in increments of five degrees. It consists of a drawing board housed in a plastic-covered folder to which is mounted a double parallelogram with a template. Wherever it is positioned, the template maintains its horizontal and vertical axes, thus acting as a combined T-square and a triangle. The price of the Quickdraw Mark II is only $22.95. Jensen Tool and Alloys.

CIRCLE NO. 342



Drawing protectors

Smudge-Bans are thin pads which raise triangles and scales from contact with the drawing being made so that sliding drafting instruments do not smear pencil-lead, ink or dust onto the drawing. The pads are made of smooth stainless steel and are self adhesive. A set of 40 Smudge-Bans, which should be sufficient for most drawing applications, sells for only $1. Devonics, Inc.

CIRCLE NO. 343

application notes

GaAs optical isolators

The second volume of "GaAs-LITE Tips" is available. This volume describes in detail a variety of uses for optical isolators such as photo-coupled pairs, phototransistors, photo-diodes and SCR-coupled pairs. Circuit diagrams and sketches are used abundantly. Monsanto Co., Electronic Products & Controls Div.

CIRCLE NO. 344

High-power GaAs LEDs

The technology and uses of high-power GaAs light-emitting diodes are explained in a fifteen-page application report. The report details the theory of operation of gallium-arsenide emitters and provides a comparison between them and silicon and germanium light-emitting diodes. Texas Instruments, Inc.

CIRCLE NO. 345

Microwave capacitors

A discussion of base-emitter and broad-band impedance matching using porcelain microwave capacitors up to a frequency of 1 GHz is given in a technical note. American Technical Ceramics.

CIRCLE NO. 346

Fast-settling amps

The basic types of fast-settling amplifiers and their performances under various operating conditions are the subject of a new application note. Following a thorough investigation of settling-time measurement, the note progresses into such considerations as phase shift and amplitude error introduced by stray capacitances. Formulas, charts and tables assist in the discussions. A nomogram of full-power-output frequency versus slew rate is also included. DDC Div. of Solid State Scientific Devices Corp.

CIRCLE NO. 347

Phase-locked loops

The fundamentals of phase-locked loop circuits are described in a technical paper. The paper includes sections on the application of phase-locked loops in the circuit design of FM modulators, frequency-shift keyers, frequency multipliers and decoders. Signetics.

CIRCLE NO. 348

D/a converters

The conventional approach to building a d/a converter is presented in a 12-page set of application notes. A discussion of recent developments in hybrid technology which have made it possible to incorporate an entire converter in a singe hybrid IC package is also discussed. Beckman Instruments, Inc., Helipot Div.

CIRCLE NO. 349

Computing counter notes

Sixteen new application sheets have been added to the Hewlett-Packard Computing Counter Applications Library. The Library is a collection of measurements and computations made by the 5360A computing counter. Hewlett-Packard Co.

CIRCLE NO. 350

Multiplying converters

Basic concepts and applications of multiplying d/a converters are given in a new application note. The note shows how multiplying d/a converters work and gives a wide range of applications for their use. Many sketches and diagrams illustrate the principles covered. Applications given include digital attenuation, gain control, digital phase shifter, hybrid computation, automatic checkout, resolver/synchro interface, resolver-to-digital conversion and CRT character generation circuits. Analog Devices, Inc.

CIRCLE NO. 351

annual reports

Avnet, Inc. 767 Fifth Ave., New York, N.Y.

Manufacturing and marketing of CATV, CCTV and consumer parts and systems, automotive parts.

1969: net sales, $252,122,187; net income, $14,024,492.

1970: net sales, $286,602,213; net income, $7,003,976.

CIRCLE NO. 352

Barnes Corp., Landsowne, Pa.

Sockets, carriers, contactors, breadboards and test handlers for MOS, LSI, data processing and communications equipment.

1969: revenues, $3,621,201; net income, $300,992.

1970: revenues, $3,902,505; net income (loss), ($55,851).

CIRCLE NO. 353

Camin Laboratories, Inc., 505 Park Ave., New York, N.Y.

Metal fabrication by electroforming techniques, fiberglass, plastics and computer software.

1969: net sales, $5,971,304; net income, $421,959.

1970: net sales, $6,013,771; net income, $299,580.

CIRCLE NO. 354

Computer Communications, Inc., 701 W. Manchester Blvd., Inglewood, Calif.

Computer terminals, processors, modems and multiplexers.

1969: revenues, $6,832,055; net income (loss), ($82,576).

1970. revenues, $8,763,019; net income, $57,976.

CIRCLE NO. 355

Dewey Electronics Corp., 11 Park Pl., Paramus, N.J.

Digital techniques, microwaves, airborne equipment, sonar, transponders and medicine.

1969: sales, $6,366,230; net income, $273,509.

1970: sales, $7,561,600; net income, $226,998.

CIRCLE NO. 356

Gulf + Western Industries, Inc., 1 Gulf + Western Plaza, New York, N. Y.

Automotive parts, metals, systems, consumer products and foods.

1969: net sales, $1,563,564,400; net earnings, $72,050,000.

1970: net sales, $1,629,562,000; net earnings, $44,771,000.

CIRCLE NO. 357

Kings Electronics Co., Inc., 40 Marbledale Rd., Tuckahoe, N.Y.

Rf connectors, coaxial switches and flat-cable connection systems.

1969: net sales, $5,040,539; net income, $350,283.

1970: net sales, $5,120,039; net income, $119,210.

CIRCLE NO. 358

Nucleonic Products Co., Inc. 6660 Variel Ave., Canoga Park, Calif.

Semiconductors, ICs, hybrids, capacitors and resistors.

1969: net sales, $6,288,074; net income, $181,638.

1970: net sales, $5,744,738; net income, $137,424.

CIRCLE NO. 359

Perkin-Elmer Corp., Main Ave., Norwalk, Conn.

Medical, pollution, quality-control, research and food instruments; optical systems.

1969: net sales, $199,446,074; net income, $7,571,164.

1970: net sales, $203,471,547; net income, $8,117,990.

CIRCLE NO. 360

RCL Electronics, Inc., 700 S. 21st St., Irvington, N.J.

Precision and power wire-wound resistors, rotary switches, delay lines and resistor networks.

1969: net sales, $5,103,761; net income, $296,949.

1970: net sales, $5,653,677; net income, $180,367.

CIRCLE NO. 361

Varadyne, Inc., 3223 Wilshire Blvd., Santa Monica, Calif.

Chip capacitors, hybrid circuits, monolithic memories, a/d and d/a converters and active filters.

1969: revenues, $10,077,000; net income, $387,000.

1970: revenues, $13,547,000; net income, $344,000.

CIRCLE NO. 362

new literature

Magnetics courses

The Magnetics Materials Technical Center is a privately sponsored non-profit institution offering electrical and electronic engineers courses in low and high-permeability magnetics, ferrites and photochemically machined materials at no cost. Electrical and electronic engineers and managers may enroll without any fees. They will be provided with magnetics materials information, design data and a regular newsletter. Magnetics.

CIRCLE NO. 363

JFETs

New monolithic dual JFETs are features of a short-form catalog which lists complete lines of general-purpose, vhf/uhf-amplifier, fast-switching and low-noise JFETs. Unisem Corp.

CIRCLE NO. 364

Small computers

A six-page brochure describes solution-oriented small computer products for OEM and end-user markets. Systems Engineering Laboratories, Inc.

CIRCLE NO. 365

Connectors

A new design guide catalog describes plate and molded connector products. It explains the design and construction of components for wire wrapped plate systems and illustrates a wide variety of plate connector and PC components. Fabri-Tek, Inc.

CIRCLE NO. 366

TTL

A complete line of TTL is described in a new 112-page book. It contains specifications for more than 150 TTL circuit functions and includes design information about logic, memory and interface circuits in low-power and high-speed ranges. Fairchild Semiconductor.

CIRCLE NO. 367

Dc power supplies

A new brochure describes sixteen dc power supplies which include linear multiple, dual and single-output regulated types. Singer-General Precision, Inc., Kearfott Div.

CIRCLE NO. 368

Rf power transistors

A new catalog describes a line of rf transistors which are grouped by output power and frequency with suggested applications. RCA.

CIRCLE NO. 369

Modems

A fully-illustrated catalog includes descriptions and technical specifications on eleven modems operating at speeds from 300 to 10^6 bits/s. International Communications Corp.

CIRCLE NO. 370

Video recorder/players

Color and monochrome cartridge videotape recorder/players for CCTV and home-television recording and playback are shown in a brochure. Ampex Corp.

CIRCLE NO. 371

Oscillators

A catalog gives complete information on voltage-controlled, crystal, high-stability, low-current-drain, computer-clock, power and tuning-fork oscillators that range in frequency from 1 Hz to 250 MHz. Accutronics Div. of Gibbs Manufacturing & Research Corp.

CIRCLE NO. 372

MOS/LSI

Product descriptions for 34 standard MOS/LSI circuits are provided in a 212-page book. It contains complete product specification and includes many custom-programmed ICs. Texas Instruments, Inc.

CIRCLE NO. 373

Power supplies

Three series of power supplies for limited-space applications are described in a 6-page brochure. They include low-profile and miniaturized single and dual-output supplies for PC-board mounting. Acopian Corp.

CIRCLE NO. 374

Indicator lights

An eight-page, short-form catalog describes a line of lighted push-button switches and indicator lights. Marco-Oak Industries.

CIRCLE NO. 375

Instrument rental

A 108-page instrumentation rental catalog contains transducers, oscillographs, tape recorders, oscilloscopes, amplifiers, digital systems and computers available for rental. Datacraft, Inc.

CIRCLE NO. 376

Conversion modules

Multiplexers, a/d and d/a converters, sample-and-hold amplifiers, comparators, bridge amplifiers and power supplies are described in a new bulletin. Redcor Corp.

CIRCLE NO. 377

Buffer storage devices

A recently published booklet describes a new approach to buffer storage and introduces a line of three buffers. The 12-page booklet shows how the buffers operate and demonstrates how they can increase the efficiency of data communications systems. Wiltek, Inc.

CIRCLE NO. 378

Semiconductor devices

A new 34-page design guide and short-form catalog describes rectifiers, zener and microwave diodes, high-voltage rectifier modules, high-current bridges, thyristors SCRs, transistors, solid-state ac switches and gate turn-off SCRs. Included is a complete listing of JAN and JAN TX devices. Unitrode Corp.

CIRCLE NO. 379

Magnetic Alloys

A 16-page brochure lists a variety of magnetic and electronic alloys for stainless steel strip and foil. Magnetics.

CIRCLE NO. 380

Lasers

A series of data sheets cover an expanded line of solid-state lasers and optical mounts with complete technical information. Hadron, Inc.

CIRCLE NO. 381

Filters and inductors

A new brochure covers solid-state inductors and LC filters. Filters covered include low and high-pass, band-rejection and band-pass models. Cambridge Thermionic Corp.

CIRCLE NO. 382

Real-time peripherals

A 16-page technical brochure and a companion eight-page price list describe a series of real-time peripherals. Computer Products.

CIRCLE NO. 383

Power supplies

A power-supply-catalog supplement describes low-voltage logic, constant-current and dual-tracking power supplies and a programming interface to relieve grounding problems in systems work. The supplement also describes a high-speed line of programmable power supplies. Kepco Inc.

CIRCLE NO. 384

Microwave devices

A new comprehensive catalog describes and illustrates a full line of microwave components and solid-state sources. Engelmann Microwave Co.

CIRCLE NO. 385

Micro-circuit packaging

Proprietary electronic packaging techniques for complex electronic micro-circuitry are described in a four-page brochure. Bunker-Ramo Corp.

CIRCLE NO. 386

D/a converters

A complete line of 8 and 10-bit d/a converters in 14 and 16-pin DIP packages is presented in a four-page catalog. Micro Networks Corp.

CIRCLE NO. 387

IC op amps

Two data sheets cover high-performance monolithic integrated-circuit operational amplifiers. Analog Devices.

CIRCLE NO. 388

Power supplies

A 12-page catalog describes over 150 models of modular low-voltage power supplies. The supplies have outputs ranging from 3 to 150 V dc at current ratings up to 33 A. Texas Electronic Instruments, Inc.

CIRCLE NO. 389

CATV antennas

Antennas for CATV service are the subject of a catalog. They include vhf and uhf versions with 75-Ω outputs. Taco Div. General Instrument Corp.

CIRCLE NO. 390

Heat sinks

A new 40-page heat sink catalog contains data and specifications and also includes natural and forced-air convection curves. A section on thermal-engineering data is also provided. Wakefield Engineering, Inc.

CIRCLE NO. 391

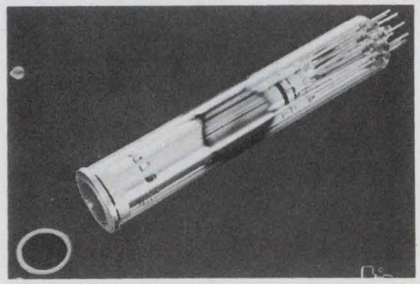


Image tubes

The technology and uses of the Tivicon image pickup tube which uses a solid-state target array as a light sensor are discussed in a 14-page brochure. Texas Instruments, Inc.

CIRCLE NO. 392

Ecology/pollution kits

Aquatic ecology and pollution studies are the subject of a new 22-page catalog of simplified test kits. It includes test kits for detergents, nitrogen, phosphate and many other relevant ecology and pollution tests. It also illustrates a portable direct-reading engineer's laboratory which provides a simplified, convenient and accurate means of testing water in the field. Hach Chemical Co.

CIRCLE NO. 393

Carrier amplifiers

A four-page data sheet describes standard solid-state 6 and 20-kHz carrier amplifier systems. Each carrier amplifier is a four-channel self-contained system suitable for 19-in. rack mounting. Rosemount Plug-In, Inc.

CIRCLE NO. 394

Pushbutton switches

A new eight-page catalog describes a line of lighted pushbutton switches. Switchcraft, Inc.

CIRCLE NO. 395

Thermistors

A revised and expanded 12-page catalog describes precision interchangeable thermistors with resistance values from 100 Ω to 1 MΩ at 25°C. It also includes data on linear-output thermistor devices. Yellow Springs Instrument Co.

CIRCLE NO. 396

Spacer/bushings

A new catalog describes press-in and turn-to-lock spacer/bushings. It includes more than 25 Teflon types in three styles. Sealectro Corp.

CIRCLE NO. 397

Tools

A new eight-page bulletin shows a multitude of new electronic tools for engineers, technicians, production managers and purchasing agents. Jonard Industries Corp.

CIRCLE NO. 398

Fiber-optic recorders

A new booklet discusses fundamental concepts of fiber-optic recorders and includes several models used in oceanographic applications. Edo Western Corp.

CIRCLE NO. 399

Rotary switches

A new miniature-rotary-switch catalog is available. It contains information on multi-position switches. RCL Electronics, Inc.

CIRCLE NO. 410

Machine winding

Design advantages of machine-wound components over hand-wound ones are outlined in detail for engineers planning to use servo motors and tachometers. Cedar Products, Magnetic Components Div.

CIRCLE NO. 411

Elapsed-time indicators

Covered in a new bulletin are various elapsed-time indicators with detailed descriptions and suggested applications. Curtis Instruments, Inc.

CIRCLE NO. 412

Instrument rental

Bulletin GEC-1551D is a 42-page catalog listing instruments for rental and giving monthly rates and ordering information. Included are analytical, electro-mechanical, electrical and electronic instruments. General Electric.

CIRCLE NO. 413

bulletin board

of product news and developments

Panasonic has introduced the low-cost WV-033V **CCTV camera** that weighs only 7 lbs and sells for $250. It features easy mounting, automatic light compensation and a standard 25-mm lens. Sensitive focus and beam controls are also included.

CIRCLE NO. 414

Design engineers can perform **nonlinear dc and transient analysis in a time-sharing environment** with I/TRAC (Interactive Transient Analysis by Computer) developed by Berne Electronics, 28 Havilands Lane, White Plains, N. Y. I/TRAC features a conversational free format input language to describe circuit topology and parameters.

CIRCLE NO. 415

Four new ICs for read-only memories have joined Motorola's TTL family. They are the MC4038P and MC4040P gated decoders, the MC4041P hamming code detector and generator and the MC4039P 7-segment character generator.

CIRCLE NO. 416

Vactec's VTL2C series of **LED photon isolators** have been reduced in price from $4.20 to $3.10 each for 1000-piece quantities.

The CM2400 **4096-bit read/write memory** of Computer Microtechnology, Inc. has been reduced in price to $400 each for single-unit quantities and $260 each for 100-unit quantities.

Electronic Design

Electronic Design's function is:

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

Want a subscription? Electronic Design is sent free to qualified engineers and engineering managers doing design work, supervising design or setting standards in the United States and Western Europe. For a free subscription, use the postfree application form inside the back cover. If none is included, write to us direct for an application form.

If you do not qualify, you may take out a paid subscription for $25 a year in the U.S.A., $35 a year elsewhere. Single copies are $1.50 each.

If you change your address, send us an old mailing label and your new address; there is generally a prepaid postcard for this inside the back cover. You will have to requalify to continue receiving Electronic Design free.

The accuracy policy of Electronic Design is:

- To make reasonable efforts to ensure the accuracy of editorial matter.
- To publish prompt corrections whenever inaccuracies are brought to our attention. Corrections appear at the end of the Letters column.
- To refuse any advertisement deemed to be misleading or fraudulent.

Microfilm copies are available of complete volumes of Electronic Design at $19.00 per volume, beginning with Volume 9, 1961. Work is now in process to complete the microfilm edition of Volumes 1-8. Reprints of individual articles may be obtained for $2.00 each, prepaid ($.50 for each additional copy of the same article) no matter how long the article. For further details and to place orders, contact the Customer Services Department, University Microfilms, 300 North Zeeb Road, Ann Arbor, Michigan 48106; telephone (313) 761-4700.

Want to contact us? If you have any comments or wish to submit a manuscript or article outline, address your correspondence to:

Editor
Electronic Design,
850 Third Avenue,
New York, N.Y. 10022.

Design Data from

How To "Design-Your-Own" Precision Power Supply In Minutes.

Super/reg® miniature, pre-packaged, precision power regulators (series and shunt types) make possible design/fabrication of **custom** power supplies with virtually no engineering time or effort. Data Sheets S201A, S202A, S204 show how just a front end of raw DC or a transformer with rectifying diodes and filter capacitor — and a heat sink mounting area — are all that are needed. Single or multiple outputs easily accommodated. 104 models provide wide range of voltage levels, maximum layout flexibility, low output Z(0.01% regulation), temperature compensation 0.01%/°C, 125°C operation, output adjustability ±10%, short circuit protection.

Trio Laboratories, Inc.
80 Dupont Street
Plainview, N.Y. 11803

CIRCLE NO. 171

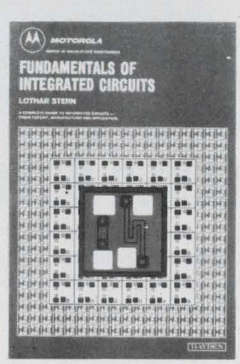
Circuit-Stik's Proto-Type Kit

The PROTO-TYPE KIT CONTAINS a total of one hundred eighty parts — enough to mount over four hundred electronic components and allows "instant" fabrication of several printed circuit boards. CIRCUIT-STIK'S printed circuit sub-elements are pre-etched, pressure sensitive adhesive substrates: pre-drilled, pre-plated-fluxcoated-ready for mounting and soldering of discretes, I.C.'s, transistors, connectors, and other electronic components. (U.S. patent #3,538,389 and other patents pending)
SEND FOR FREE KIT CATALOG AND SAMPLES.

Circuit-Stik, Inc.
1518 West 132nd Street
Gardena, California 90249

CIRCLE NO. 172

FUNDAMENTALS OF INTEGRATED CIRCUITS



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

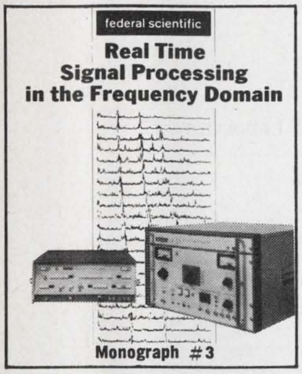
Hayden Book Company, Inc.
116 West 14th Street
New York, N.Y. 10011

CIRCLE NO. 173

Manufacturers

Advertisements of booklets, brochures, catalogs and data sheets. To order use Reader-ServiceCard.
(Advertisement)

New Monograph on Real-Time Data Processing Techniques



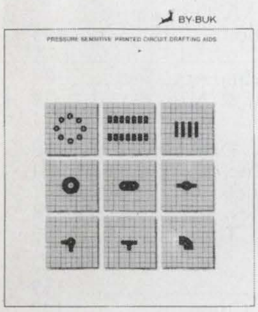
A new publication by Federal Scientific, originators of the Ubiquitous® Spectrum Analyzer, covers general and specific signal processing techniques and theoretical constraints.

- Random data processing and statistical certainty of Power Spectral Density Estimates
- Constraints in frequency analysis due to bandwidth, sampling and signal length
- Time domain weighting, with charts of theoretical performance using different weighting functions
- Theory of operation of time-compression analyzers
- Cross-property analysis and application in determing transmission and transfer functions by correlation and cross-power spectral density
- Processing of Transient data

Federal Scientific Corporation
a subsidiary of Elgin National Industries, Inc.
615 West 131st Street, New York, N. Y. 10027

CIRCLE NO. 174

New PC Drafting Aids Catalog

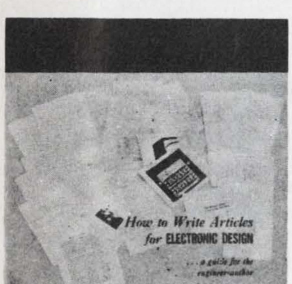


The By-Buk 1970-71 catalog of pressure sensitive printed circuit drafting aids is now available. With thousands of ideas to promote accuracy and efficiency in printed circuit master artwork layouts. Featured are new artwork patterns for: TO cans, multi-pads, dual in-lines and flat packs. Also the most comprehensive listings of conductor line tapes, pads, donuts, connector strips, elbows, corners, etc. Available in opaque black, transparent red and transparent blue materials. Send for your free catalog and samples.

By-Buk Company
4326 W. Pico Blvd.
Los Angeles, California 90019
(213) 937-3511

CIRCLE NO. 175

How To Write Technical Articles



A guide for the engineer-author, "How to Write Articles for Electronic Design" shows how easy it is to write for publication—once the engineer knows what to write and how to write it. The Author's Guide includes a complete run-down of the types of articles published by Electronic Design —plus detailed instructions on how to prepare technical articles and short special features. A MUST for every "would-be-writer" in the electronics industry. Send for your complimentary copy by circling the number to the right.

Electronic Design
850 Third Avenue
New York, N.Y. 10022

CIRCLE NO. 176

Electronic Design

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AMERICAN BUSINESS PRESS, INC.

advertiser's index

Advertiser **Page**

product index

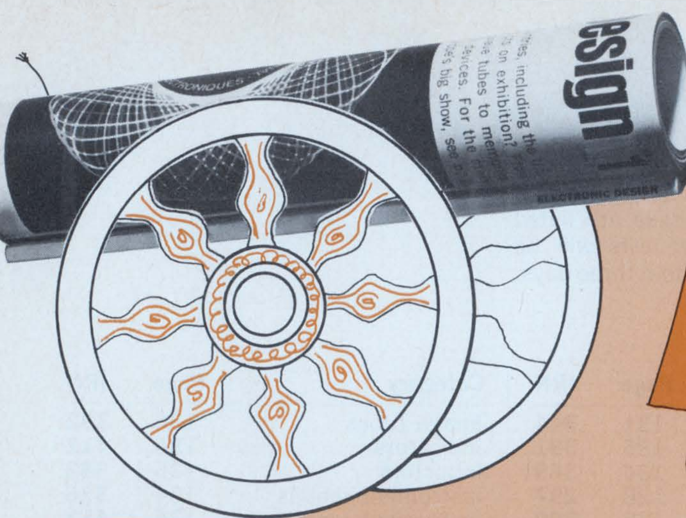
Information Retrieval Service. New Products, Evaluation Samples (ES), Design Aids (DA), Application Notes (AN), and New Literature (NL) in this issue are listed here with page and Information Retrieval numbers. Reader requests will be promptly processed by computer and mailed to the manufacturer within three days.

new literature

application notes

design aids

evaluation samples



Electronic Design 1971 TOP TEN CONTEST ENTRY BLANKS

(Use Information Retrieval Card at right)

PICK THE TEN BEST-READ ADS IN THIS ISSUE... WIN A FRIDEN PROGRAMMABLE PRINTING CALCULATOR—OR ONE OF 74 OTHER VALUABLE PRIZES!

READER CONTEST Examine this issue of Electronic Design with extra care. Pick the ten advertisements that you think will be best READ by your fellow engineer-subscribers. List these ten advertisements (in the order you think readers will rank them) on the special entry form included on Electronic Design's *Information Retrieval Card,* bound in at right.

Be sure to check the box marked "Reader Contest."

This year your selections will be measured against the ten ads ranking highest in the "Recall **READ MOST**" category of Reader Recall—Electronic Design's method of measuring readership. (In past years the judges used the "Recall **SEEN**" category. This change to "Recall **READ MOST**" should be kept in mind by all contestants in selecting the *Top Ten).*

In making your choices, *do not* include "house" advertisements placed by Electronic Design or Hayden Publishing Company, Inc. (such as this ad describing the contest).

Don't miss your chance to be a *Top Ten* winner! All entries must be postmarked no later than midnight, February 28, 1971. Winners will be notified by March 15, 1971.

RULES AND PRIZE INFORMATION APPEAR ON PAGE 57 OF THIS ISSUE

SEPARATE CONTEST—SEPARATE RULES FOR ADVERTISERS

There is a separate *Top Ten Contest* open to all advertising personnel at companies and agencies (you do not have to be an advertiser in Electronic Design to enter).

Use the entry blank included on the *Information Retrieval Card* bound in this issue, at right. (Be sure to check the box marked "Advertiser Contest".)

All ads that place in the *Top Ten* will be given free reruns. In addition, the six winners in the Advertiser Contest will be given a free rerun of a like ad of their choice—if they have an ad in the January 7 issue. (See rules, right, if the winning ad is an insert.)

PRIZES—ADVERTISER CONTEST

FIRST PRIZE:	Sylvania Model CE81W 21″ Color Television.
SECOND PRIZE:	EICO Model AX-5 "Light Fantastic" Color-Image Audio Lighting System (colors rise and fall in response to music).
3rd & 4th PRIZES:	Bulova Accutron® "Spaceview" wrist timepieces.
5th & 6th PRIZES:	EICO Model 3475 Audio-actuated, Solid State Strobe Lite. Each music beat creates a different flash rate, automatically.

Note: There is a change in contest rules this year. Be sure to read the instructions for the Reader Contest that appear above and on page 57 of this issue.

ADVERTISER CONTEST RULES

1. All rules for the *Reader Contest* will similarly apply for this contest, with two exceptions: readers engaged in electronic design engineering work, as defined in the *Reader Contest* rules, are *not* eligible to participate in this special contest. The box on the entry blank marked *"Advertiser Contest"* must be checked.

2. Entrants in this contest may use the official *Reader Contest* entry blank or any reasonable facsimile.

3. This special contest is open to advertising personnel at all manufacturing companies and advertising agencies whether or not their companies or agencies have an advertisement in the January 7, 1971 issue of Electronic Design. However, only those companies (or divisions thereof), advertising in the January 7 issue, and the advertising agencies placing such advertisements, are eligible for a free rerun of their advertisement should a member of their organization win.

4. Free reruns of any advertisement will be made only from existing plates or negatives. If the advertisement qualifying for a free rerun is an insert, Electronic Design will bind and run the insert, but furnishing the inserts is again the responsibility of the winner. The winner may run a two-page spread instead of the insert, if he chooses.

5. Hayden Publishing Company, Inc., reserves the right to schedule reruns at its discretion.

If you think uniquely styled enclosures have to cost a bundle... then take a look at

INTERFACE-33

IT'S A WHOLE NEW CONCEPT THAT WILL SAVE UP TO 75% OF YOUR STYLING COSTS.

READ ABOUT IT... JUST CHECK THE READER SERVICE NUMBER BELOW.

AMCO ENGINEERING CO.
7333 West Ainslie Street
Chicago, Illinois 60656

AMCO

STYLING is GREAT

but!

COLOR makes it OUTSTANDING

"See us at Booth #401, January Computer Designers conference in Anaheim • or • Booth #402, February Nepcon West in Anaheim."

If you think uniquely styled enclosures have to cost a bundle... then take a look at

INTERFACE-33

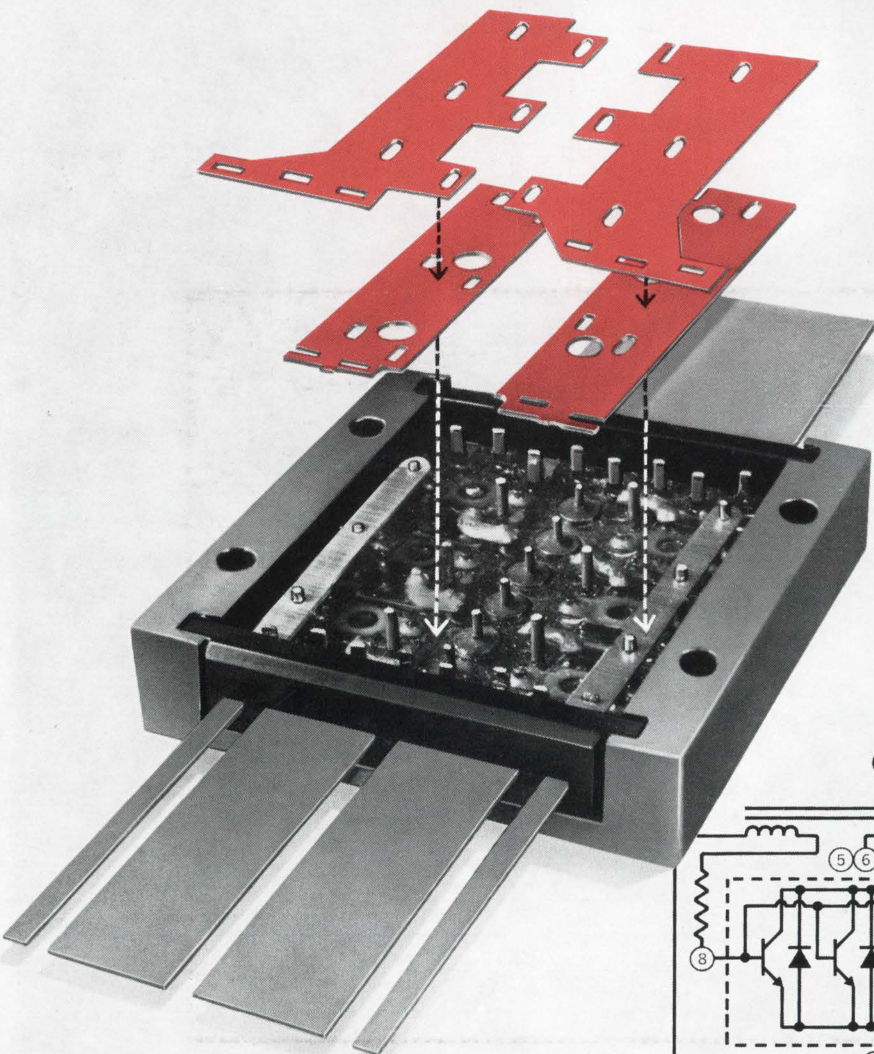
IT'S A WHOLE NEW CONCEPT THAT WILL SAVE UP TO 75% OF YOUR STYLING COSTS.

READ ABOUT IT... JUST CHECK THE READER SERVICE NUMBER BELOW.

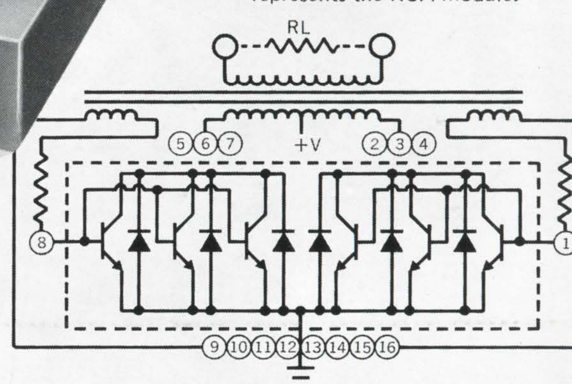
AMCO ENGINEERING CO.
7333 West Ainslie Street
Chicago, Illinois 60656

AMCO

Introducing... A New Modular Concept in RCA Hybrid Power Circuits



Exploded view shows one of the standard interconnections of the RCA hybrid power module as used in a common-emitter inverter. That portion within the dotted lines in the circuit schematic represents the RCA module.



Module shown actual size

Take RCA transistor chips with current capabilities up to 80 A, rectifiers with peak currents to 80 A, and resistors to 10 watts. Interconnect them – in any number of ways. What do you get? A power capability up to 800 W, current capability up to 300 A!

Right now, RCA is mass-assembling a variety of thick-film hybrid high-power arrays that are ideal for switching and amplifier applications in military and industrial equipment. Modules are also available in unconnected versions, if you prefer to create your own design.

These hybrid power circuits offer obvious power circuit advantages, including: compactness, light weight, fewer parts, minimum assembly costs, factory-selected and matched components, and efficient built-in heat dissipation.

Look over the inverter example illustrated. Then call your local RCA Representative or your RCA Distributor for more information on the modular concept. For RCA's new, detailed brochure, "High-Power Arrays" (HPA-100), write: RCA, Commercial Engineering, Section 57A-7/UC2R, Harrison, N. J. 07029. International, RCA, 2-4 rue du Lièvre, 1227 Geneva, Switzerland, or P.O. Box 112, Hong Kong.

INFORMATION RETRIEVAL NUMBER 182