VOL. 17 NO.

Electronic Design 10

FOR ENGINEERS AND ENGINEERING MANAGERS

MAY 10, 1969

This gear works in South Korea. Clustered on a hilltop south of Seoul, the communication center has withstood the rigors of cold, heat, transportation and storage to link successfully the hundreds of ground and airborne elements in the longest airborne assault in history. For designs wanted in the field, turn to page 34.

There's a New Look to the Scope System That Gives You Better Performance In Any Direction

Two new rectangular CRT's have been added to the Hewlett-Packard 140 scope system—the system that covers the entire oscilloscope spectrum from dc to 12.4 GHz with the extraordinary versatility you need to get step-ahead measurements—now and in the future!

The new HP 140B mainframe has an 8 x 10 cm CRT that provides additional display area for expanded measurement capability. The new HP 143A mainframe has an extra-large **8 x 10 inch** CRT for group-viewing or monitoring at a distance. Both of these mainframes and the HP 140A give you standard CRT persistence. For variable persistence and storage, there's the HP 141A mainframe. Or, for spectrum analysis, select the 140S or 141S.

Only the HP 140 scope system gives you this combination of capabilities: Sampling to 12.4 GHz . . . delayed sweep time base for sampling . . . 50 μV/cm sensitivity dc-coupled *with no drift* . . . four channel amplifier . . . plug-ins for direct readout of TDR, swept-frequency and spectrum analysis—with full compatibility between mainframes and all plug-ins.

With 20 plug-ins and three sampling heads to choose from, you can match your scope to your measurement requirements. Check the selection chart, see page 508 in your 1969 HP catalog, then contact your HP field engineer. Or, write to Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland. Price: 140 Mainframes, $640 to $1525; plug-ins, $250 to $1900.

HP 140 Scope System PLUG-IN CAPABILITIES	VERTICAL PLUG-INS										COMPATIBLE TIME BASES						SPECIAL PLUG-INS				
	1400A	1401A	1402A	1403A	1404A	1405A	1406A	1407A	1410A	1411A	1420A	1421A	1422A	1423A	1424A	1425A	1415A	1416A	8552	8553L	8554L
1. Wide Band			•		•	•					•	•		•							
2. Sampling									•	•					•	•					
3. High Gain Differential	•			•			•	•			•	•	•	•							
4. Dual Trace		•	•			•			•	•	•	•	•	•	•	•					
5. Four Channel					•							•		•							
6. X-Y	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•					
7. Delayed Sweep												•				•					
8. No Drift							•	•			•	•	•	•							
9. High Common Mode Rejection				•			•	•			•	•	•	•							
10. Algebraic Addition		•	•		•	•			•	•	•	•	•	•	•	•					
11. Time Domain Reflectometry																	•				
12. Wide Band TDR										•					•	•					
13. Swept Frequency																		•			
14. Spectrum Analysis																			•	•	•

INFORMATION RETRIEVAL NUMBER 215

HEWLETT hp PACKARD

OSCILLOSCOPE SYSTEMS

089/17

What can you expect from a $395 pulse generator?

- 0.2-Hz to 20-MHz PRF
- 25-ns to 2.5-s duration
- 5-ns rise/fall time
- ±10-volt outputs across 50Ω
- ±1-volt DC offset
- Independent control of amplitudes and offsets for + and — pulses
- Square-wave output
- Amplitude fully analog-programmable
- Period and duration modulatable

You get all these features and more in the NEW 1340 Pulse Generator. For more information call your nearest GR District Office, or write General Radio, West Concord, Mass. 01781. Telephone (617) 646-0550. In Europe Postfach 124, CH 8034 Zurich 34, Switzerland.

GENERAL RADIO

INFORMATION RETRIEVAL NUMBER 2

New Datapulse 112 gives you higher rep rates (to 125 MHz), faster rise times (1.3ns) and narrower pulses (to 3ns)—yet it costs you hundreds of dollars less.

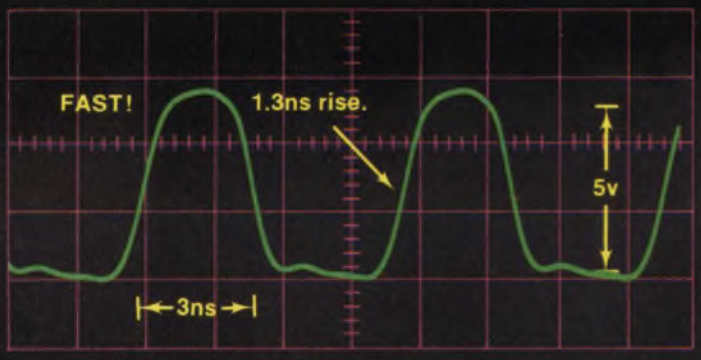
What's more it has all the pulse parameter control you need to test high-speed circuits: simultaneous ±5V outputs, single or double pulses, independent dc offset to ±2V, widths from 3ns to 5 ms, and delays to 5 ms.

You can control the pulse train with external gating pulses, produce complementary outputs for duty cycles approaching 100%, set the baseline at exact ground with a switch, and reduce rep rate to 10 Hz for low-speed testing.

No other high-speed pulser offers so much for just $1595.00 . . . and the 112 is being delivered now. For a demo contact Datapulse Division, Systron-Donner Corporation, 10150 W. Jefferson Blvd., Culver City, Calif. 90230 213-836-6100.

Why buy a high-priced 100 MHz pulser? Here's 125 MHz for $1595!

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



DATAPULSE
DIVISION
SYSTRON DONNER

Another first. One of 135 Systron-Donner instruments

- Electronic counters
- Pulse generators
- Microwave frequency indicators
- Digital clocks
- Memory testers
- Digital voltmeters
- Time code generators
- Data generators
- Analog computers
- Digital panel meters
- Microwave signal generators
- Laboratory magnets
- Data acquisition systems
- Microwave test sets

VOL. 17 NO.

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FOR ENGINEERS AND ENGINEERING MANAGERS

MAY 10, 1969

NEWS

TECHNOLOGY

PRODUCTS

Departments

COVER PHOTO by John F. Mason, Military/Aerospace Editor

Communications central for airborne assault exercise in South Korea was manned by the Eighth Army's 304th Signal Battalion.

ELECTRONIC DESIGN is published biweekly by Hayden Publishing Company, Inc., 850 Third Avenue, New York, N.Y. 10022. James S. Mulholland, Jr., President. Printed at Brown Printing Co., Inc., Waseca, Minn. Controlled circulation postage paid at Waseca, Minn., and New York, N.Y. 77,314 copies this issue.

If you want better designs,

Fairchild MSI lets you design a system in the time you used to spend designing a circuit. A few MSI building blocks will do more work than a hundred ICs. We have versatile, compatible off-the-shelf devices that function like shift registers, counters, decoders, latching circuits, storage elements, comparators, function generators, etc. Just about all you need for any digital application. *Like a scanning keyboard encoder:*

If you'd like a simple method of converting keyboard switch closures to a binary code, you need only 5 of our CCSL building blocks and the logic diagram on the right. (Conventional design techniques would require about 30 conventional ICs to do the same job.) Besides simplicity, this design provides fast rollover, insensitivity to contact bounce, and eliminates ambiguity when several keys are depressed.

The two major elements of the design are a 64-position matrix and a six-bit synchronous counter. (The counter is composed of a 9316 four-bit binary counter and a 9020 dual JK flip-flop.) The three Most Significant Bits of the counter output address the 1-of-8 decoder (9301) forming one side of the matrix, sequentially driving its outputs "low". The three Least Significant Bits address the 9312 scanning multiplexer (the other side of the matrix), sequentially looking at its eight inputs. With this arrangement, all multiplexer inputs are scanned once for every change in the decoder output.

Each intersection of the decoder outputs and the multiplexer inputs can be used as a key position. If one of the keys is depressed, a "low" from the decoder is detected by the multiplexer and converted to a "high" on its negation output. This triggers a one-shot that inhibits the counter from advancing further and provides a "data ready" signal. The duration of the one-shot is set to cover any possible contact bounce. The output of the counter can now be used as the encoded signal, and the matrix can be arranged so that any key closure provides any binary code from 000 000 to 111 111.

The code that appears corresponds to the first key depressed. As long as that key remains down, the retriggerable one-shot continues to receive reset pulses that hold the counter at the count independently of any other switch closures on the board. Once that key is released, the counter resumes its scanning after the one-shot time period has run out.

The addition of a few more MSI elements would add even greater capability to this design. As an example, the addition of another 9312, 9316 and 9601 can result in a single serial binary PDM output group in response to each key depression. Additional control inputs could be used to restrict the range of the scan counter if only certain keys should be enabled in a certain mode as is the case in key punch machines. Addition of a 9304 Read-Only Memory would allow the selection of any code output with a single keyboard design. A single monolithic parity generator could be added to provide parity at very little additional cost. Or, you might want to add two Read-Only Memories to drive a character display and a normal output simultaneously.

Our universal CCSL logic blocks let you build circuits that you couldn't even consider with less complex or less flexible ICs. We now have 15 off-the-shelf MSI devices that you can use to lower costs and increase performance. More are on the way. Write for additional specs and application notes. We'll put you on our list for future mailings, too.

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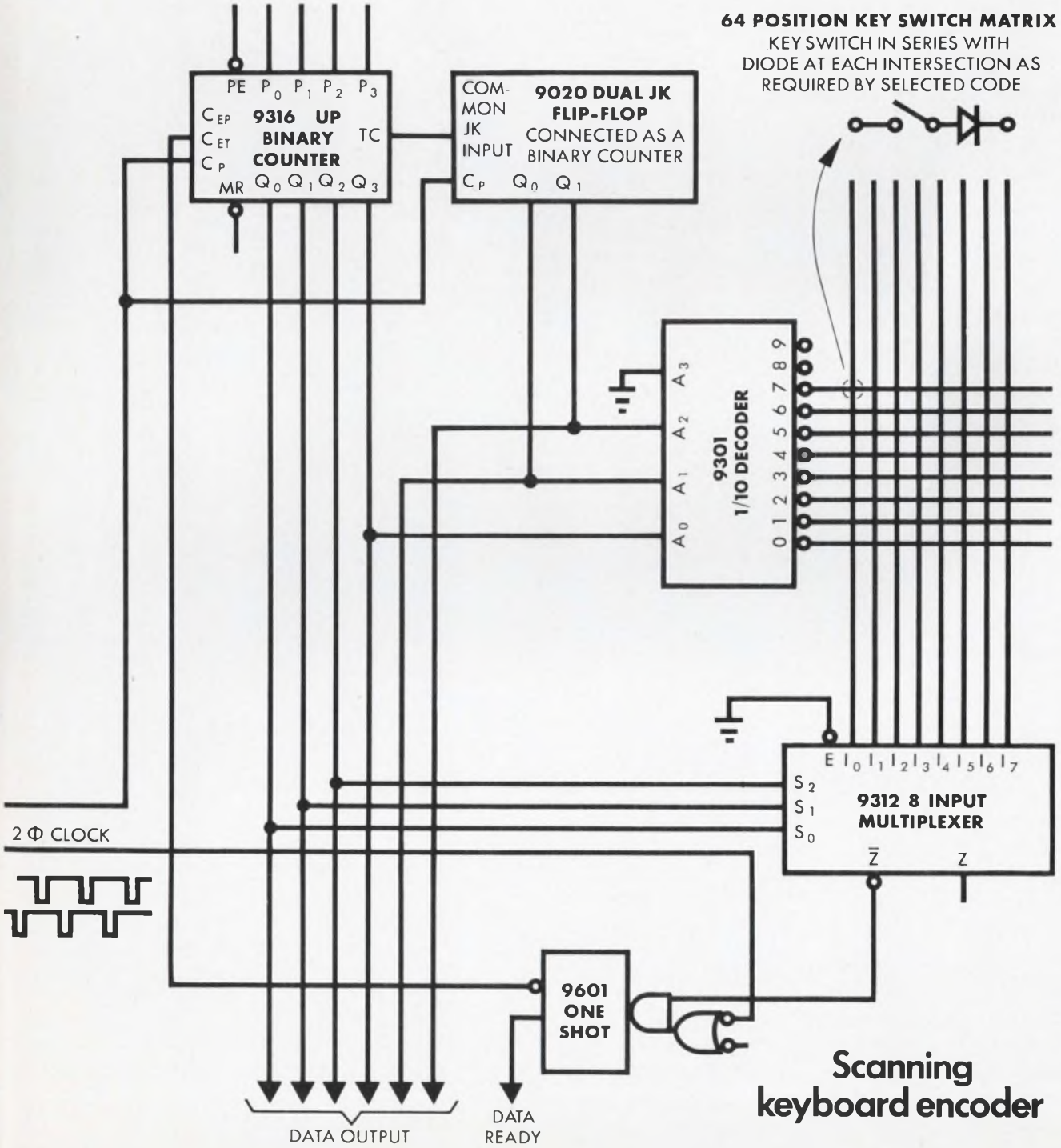
use fewer components.



Scanning keyboard encoder

INFORMATION RETRIEVAL NUMBER 4

This, the second in a series of Licon heroics, bears little resemblance to the first episode.

Caution: Although Licon's Type 63 environment free sealed switch is rated at 60,000 feet, most angels are ineffective at such heights.

A Licon blimp at 3500 feet. Pity, the Hindenburg was not equipped with Licon switches.

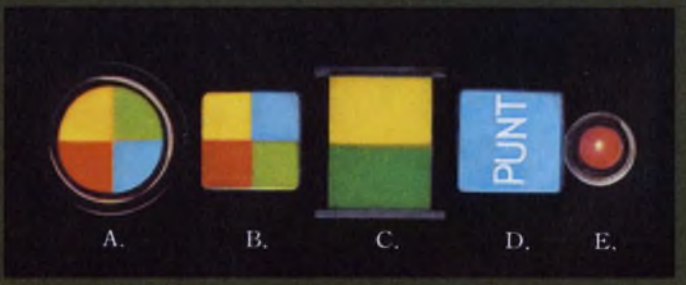
Shown above, the Incredible Wazuma, master of disguise, cleverly camouflaging a Licon toggle switch

An incredible free offer is hidden somewhere on this page. Hint: look for a fish.

Actual size Type 18 double break sub-subminiature switches with oak leaf cluster.

The most daring aircraft designers always specify Licon switches.

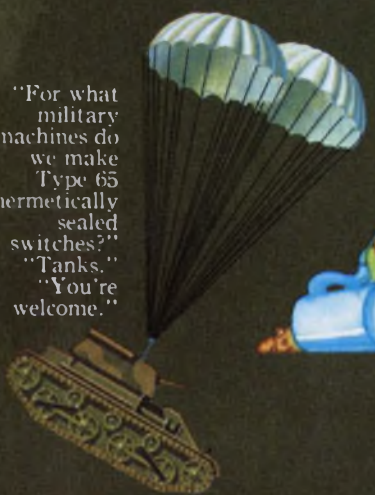
Free! Life size poster of the most amazing aircraft yet designed (shown here immediately before take-off). To get your very own space craft, write on your letterhead to: Licon Division, Illinois Tool Works Inc., 6615 West Irving Park Road, Chicago, Illinois 60634. Or circle No. 783 on the response card in the rear of this magazine.



A. Licon's original Fly By Night Switch. The multi-colored Type 44 illuminated indicator.
B. Type 04 Four Lite illuminated pushbutton switch in actual use on the battlefront.
C. A Type 02 illuminated pushbutton switch shot in the dark.
D. Type 04 illuminated pushbutton switch in dress blue.
E. The tiny 01-700 lighted switch. (Toughest little fella in the squad.)

Licon's butterfly® double break switches have a greater capacity than you could ever imagine—20 million mechancial cycles.

"For what military machines do we make Type 65 hermetically sealed switches?" "Tanks." "You're welcome."



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Tool Works Inc.

Sometimes the strangest things happen where you least expect...

like the revolution in San Diego

Union Carbide is a total supplier to the Electronics Community offering the finest in Capacitors (circle 234), Crystal Products (circle 235), Lasers (circle 236), and Water Quality Instruments (circle 237).

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Union Carbide's new mask repeater, a David Mann 1480 AF can dice up to .3″ x .3″ on the side.

These are just part of the most advanced MOS custom capability — a result of a new and exciting Union Carbide technology.

(Information Retrieval Number 238)

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ROM1K is Union Carbide's new 1024 bit read only memory. It's available in **four** different word and bit organization made possible by a unique on-chip 3 dimensional decoder. (128 words x 8 bits . . . 256 words x 4 bits . . . 512 words x 2 bits . . . 1024 words x 1 bit).

ROM1K has the typical speed of core — 1.0 μsec. Its packaging is 50 times denser than core. It uses less power than core—by a factor of 3-4. ROM1K's, MTFB, is reliable. It features static operation, bipolar compatible outputs, and for expanded memory organizations it has chip inhibit capability.

Why use Core?

ROM1K applications includes control logic, table lookup, code conversion, microprogramming, software emulation, input/output interfacing and numerous function tables like log, trig and memory location as well as character conversion and transducer calibration.

UNION CARBIDE

Great technology breeds great products like ROM1K and it's all happening in Union Carbide/ San Diego.

(Information Retrieval Number 239)

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Time was when refractory metals were used only as filaments and tube frame grids.

Times change.

Consider some more current design applications. Evaporating boats for vapor deposition. Spectrographic analysis equipment. Springs and washers in high temperature environments. And more.

Refractory metals could be the answer to some of your tough design problems. Examine the family characteristics. All readily lend themselves to forming, machining and welding. Melting point to 3410° C. Electrical resistivity to 20 microhms/cm. No other metals even approach in corrosion resistance capability. Or can hold a candle in high temperature environments. And the way we work them—with precision tolerances down to .00005"—there's no problem in getting predictable, repeatable performance out of your circuit designs.

You have a lot of flexibility, too. Because within the family each metal possesses a set of unique qualities which could make it a natural for your particular application—if it can be formed to just the dimensions you need.

That's where we come in. We roll to the tightest specs in the business. Ribbons, strips, whatever you need. Any width to .006". Any thickness to .0005". Any metal suitable for fabrication. With such superior results even the competition comes to us for the tough jobs.

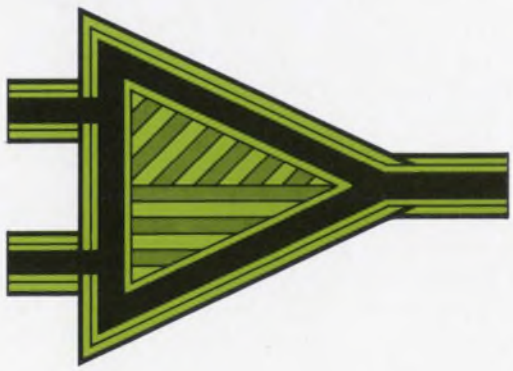
If you'd like to know more about what refractory metals can do for you in circuit design call (201) 863-1134 or write H. Cross Co., 363 Park Ave., Weehawken, New Jersey. We'll take it from there.

H. Cross Company

Tungsten – for filaments, heaters, grids, etc. **Rhenium Tungsten** – Tungsten containing 3% Rhenium. Used in application where resistance to recrystallization, room temperature, elongation, and pliability, after heating, are needed. **Thoriated Tungsten** – Tungsten containing 1% or 2% thoria. Used where relatively high electron emission is required. **Molybdenum** – Used as support for lamps and electron tube mandrels, for tungsten coil winding, traveling wave tube helixes, furnace windings, tube grids, etc. **Molybdenum Rhenium** – 50% Molybdenum and 50% Rhenium used for grids, heaters, supports etc. where high electrical resistivity and low thermal conductivity, ductility, weldability are of importance. **Rhenium** – Used for filaments in mass spectrographs and ion gauges and other electronic components where electrical resistivity, electron emission weldability and ductility are important. **Tantalum** – Used for heat exchanges. Electron tube capacitors, filaments, grid wires and getters. **Columbium** – Used for getters in electron tubes and electrical rectifiers.

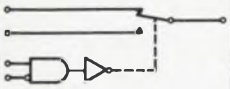
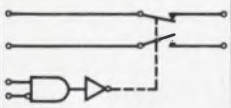
Applications Power*

multichannel ANALOG SWITCHES & OP AMPS for data transmission systems

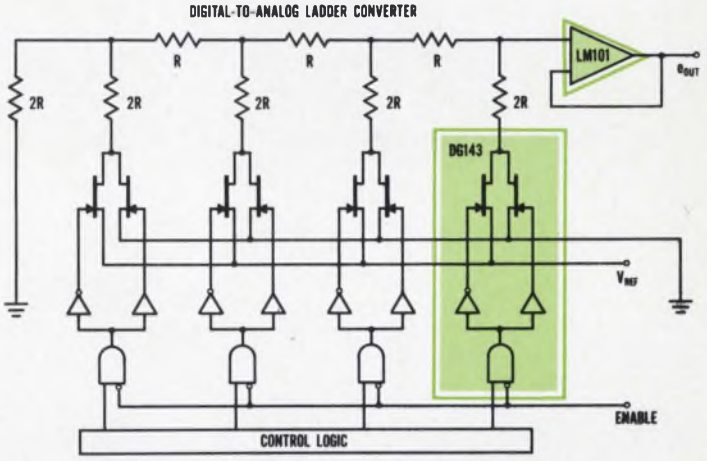


* Applications Power: A wide variety of driver/FET switch combinations and an in-depth applications team waiting to serve you!

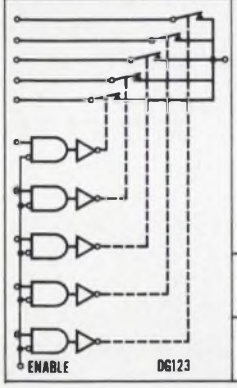
Siliconix offers over 32 integrated driver/switch combinations particularly suited to data transmission systems. Choose from a wide variety of junction or MOS FET switches, depending on your system requirements. These, combined with a Siliconix OP AMP, can be applied to a great variety of data transmission requirements.

Functional Description	Type	Max. $r_{DS\ (ON)}$ (ohms)	Switch Type
SPDT 1-CHANNEL 	DG136	600	PMOS
	SI3002	600	NMOS PMOS
SPDT 1-CHANNEL 	DG113	600	PMOS
	143	80	N
	144	30	N
	146	10	N

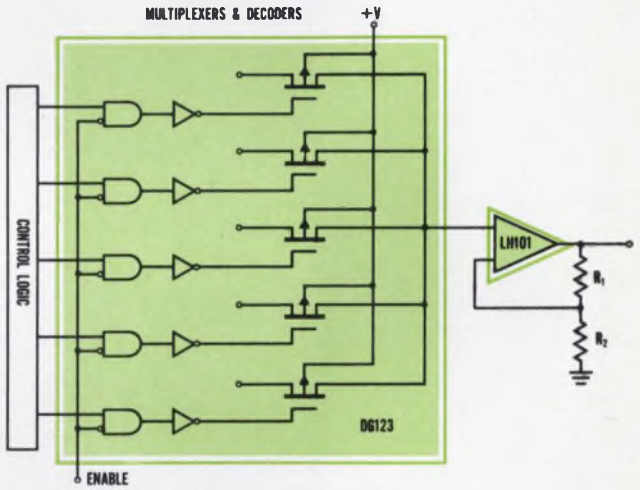
A number of switches with the ON resistance ranges best suited to your application are available from Siliconix. These driver-switches accept standard DTL, RTL, and TTL logic control inputs.



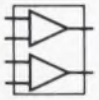
We recommend Junction FETs for this popular digital to analog converter, but if you prefer MOS FETs, we have them, too.

Functional Description	Channels	Type	Max. $r_{DS\ (ON)}$ (ohms)	Switch Type
	2	DG102	100	N
		103	100	N
		104	100	N
		110	600	PMOS
		111	600	PMOS
		112	600	PMOS
		133	30	N
		134	80	N
		141	10	N
		147	600	PMOS
		148	40	PMOS
	4	DG116	600	PMOS
		118	600	PMOS
	5	DG123	600	PMOS
		125	600	PMOS

System requirements will dictate which of the above combinations are best for your multiplexer combination.



Only one TO-86 package is required to accomplish the above switching functions. Packages include switch drivers that accept standard DTL, RTL, or TTL logic signals.

SILICONIX OP AMPS	Max. input offset voltage −55 to +125°C	Max. input current	Min. open loop gain	Output voltage swing	Slew rate	
 LM 101 LH 101 (Internally compensated)	6 mV	200 nA	50K	±12V	.25V/μsec.	• Operation from ±5 to ±20V power supplies • Low current drain • Continuous short circuit protection • Same pin configuration as 709 amplifier
 L 120	200 mV	50 pA	100	±12V	20V/μsec.	• Low input leakage • High slew rate • Unity gain stable • Ideal for sample and hold, integrating and fast voltage comparisons

Working on data transmission? Write today for complete information on all Siliconix FET switch combinations and OP AMPS.

For instant applications assistance, call the number below. Ask for Extension 19.

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INFORMATION RETRIEVAL NUMBER 7

Designer's Datebook

JUNE 1969						
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JULY 1969						
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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		

For further information on meetings, use Information Retrieval Card.

June 9-10
Chicago Spring Conf. on Broadcast & Television Receivers (Des Plaines, Ill.) Sponsor: G-BTR, N. T. Waters, Zenith Radio Corp., 6001 W. Dickens Ave., Chicago, Ill. 60606

CIRCLE NO. 821

June 9-11
Int'l. Communications Conference (Boulder, Colo.) Sponsor: G-ComTech, M. Nesenbergs, Inst. for Telecommunications Science, R-614, Boulder, Colo. 80302

CIRCLE NO. 822

June 17-19
Computer Conference (Minneapolis) Sponsor: IEEE, D. L. Epley, Dept. of EE, Univ. of Iowa, Iowa City, Iowa 52240

CIRCLE NO. 823

June 17-19
Electromagnetic Compatibility Symposium (Asbury Park, N. J.) Sponsor: IEEE, C. Joly, Honeywell, Inc., POB 54, Eatontown, N. J. 07724

CIRCLE NO. 824

July 7-11
Nuclear & Space Radiation Effects Conf. (Philadelphia) Sponsor: IEEE, NASA, et al., E. A. Burke, Air Force Cambridge Research Lab., Hanscom Field, Bedford, Mass. 01730

CIRCLE NO. 825

July 20-25
Engineering in Medicine & Biology (Chicago) Sponsor: IEEE, L. Stark, Univ. of Illinois, Chicago 60612

CIRCLE NO. 826

These specialists can't wait to get their hands on our new plastic transistors. How about you?

If you fit one of these descriptions, our new family of B-133000 plastic power transistors is for you:

You're a power-circuit designer. Interested in V_{CEO} up to 80 volts? Good gains up to 4 amps? And isolated collector? You know you are.

You're a manufacturing man. Get rid of those extra insulating washers and bushings. Our plastic transistors are electrically isolated. Mount them in a one-step operation with just a self-tapping screw.

You're a mechanical engineer. Here's a plastic package surrounded by a corrosion-resistant, protective metal form.

You're a components specialist. Now you can get interchangeability with other plastic configurations and TO-66 mounting arrangements.

You're a circuit reviewer. We're offering safe operating areas for all the 20-watt (T_C = 25°C) B-133000's. They're rugged, second-breakdown-resistant, silicon mesa NPN devices.

You're a purchasing man. You get low cost two ways—a low price tag and you don't need any expensive mounting kits. Delivery is fast—from distributor stock or directly from us.

No matter who you are, you've got a good reason for checking on our B-133000's. Write: The Bendix Corporation, Semiconductor Division, Holmdel, New Jersey 07733.

B-133000-008 SERIES

Symbol	Characteristics
I_C Max.	4.0A
$V_{(BR)CEO}$	40, 60 or 80V
V_{CES}	60, 80 or 100V
P_T	20W at Case Temp. T_C=25°C
P_T	2.8W in free air at T_A=25°C
h_{FE}	100-300 at I_C=0.5A*
h_{FE}	12-48 at I_C=4.0A**
f_T Min.	1 MHz

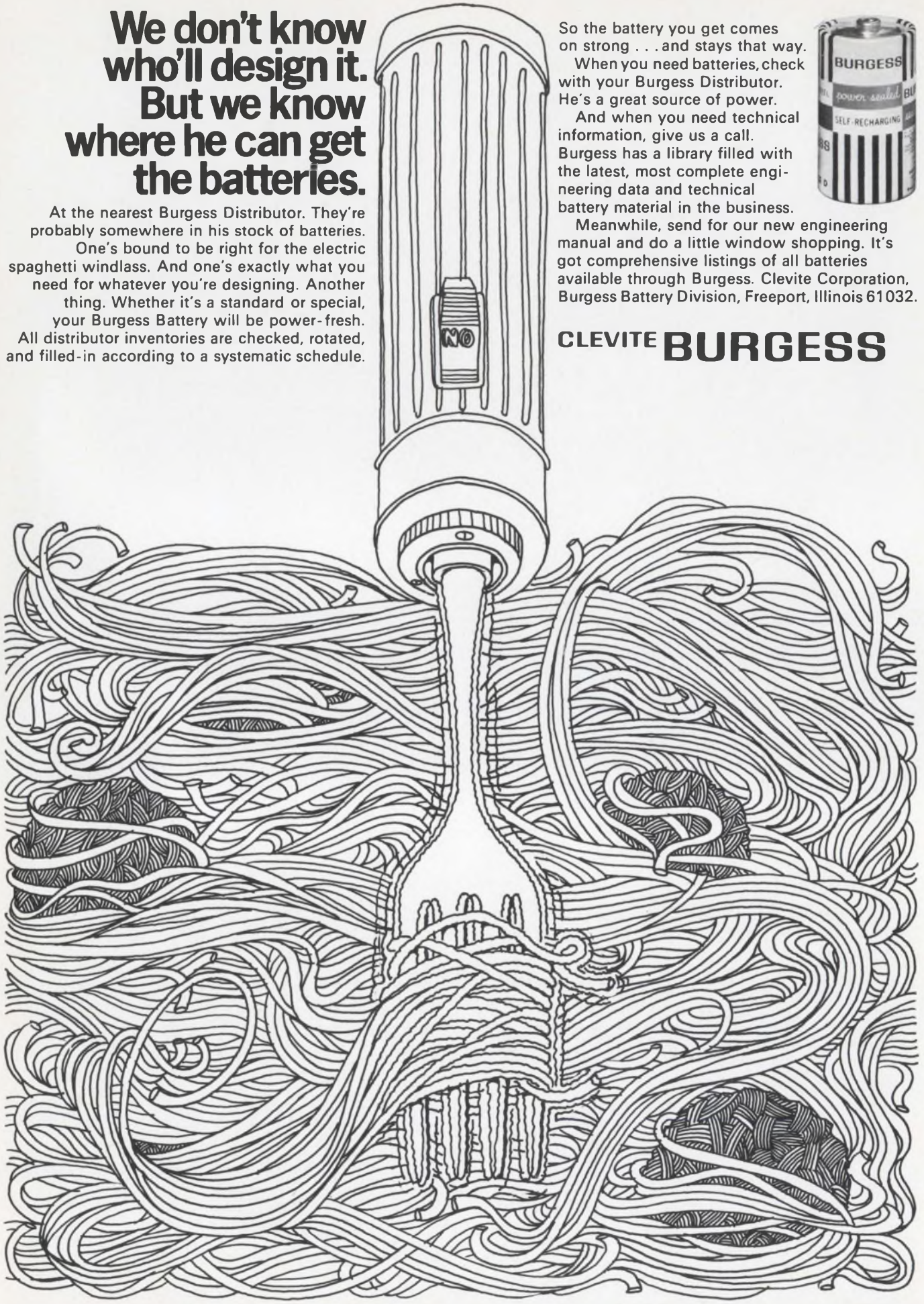
*B-133000,3,6 **B-133002,5,8

Bendix Electronics

Chicago—(312) 637-4633; **Denver**—Electronic Component Sales, (303) 771-6200; **Detroit**—(313) 548-2120; **Greenwich, Conn.**—(203) 869-7797; **Holmdel, N.J.**—(201) 946-9400; **Horseheads, N.Y.**—(607) 732-1882; **Lexington, Mass.**—(617) 861-8350; **Los Angeles**—(213) 776-4100; **Merriam, Kansas**—Mid-America Marketing, (913) 432-8678; **Minneapolis**—(612) 926-4633; **Orlando, Fla.**—(305) 423-6048; **Richardson, Texas**—P. J. Scanlon Co., (214) 213-4661; **Rochester, N.Y.**—(716) 266-5550; **Runnemede, N.J.**—(609) 933-2550; **Seattle**—Ray Johnston Co., Inc. (206) 542-5170; **Timonium, Maryland**—(301) 828-6877; **Export**—Cable: "Bendixint," 605 Third Avenue, New York, (212) 973-2121; **Ottawa, Ont.**—Computing Devices of Canada, P.O. Box 508 (613) 829-1800; **San Juan, Puerto Rico**—Southern International Sales Co. 723-3879.

We don't know who'll design it. But we know where he can get the batteries.

At the nearest Burgess Distributor. They're probably somewhere in his stock of batteries. One's bound to be right for the electric spaghetti windlass. And one's exactly what you need for whatever you're designing. Another thing. Whether it's a standard or special, your Burgess Battery will be power-fresh. All distributor inventories are checked, rotated, and filled-in according to a systematic schedule.



So the battery you get comes on strong . . . and stays that way.

When you need batteries, check with your Burgess Distributor. He's a great source of power.

And when you need technical information, give us a call. Burgess has a library filled with the latest, most complete engineering data and technical battery material in the business.

Meanwhile, send for our new engineering manual and do a little window shopping. It's got comprehensive listings of all batteries available through Burgess. Clevite Corporation, Burgess Battery Division, Freeport, Illinois 61032.

CLEVITE BURGESS

INFORMATION RETRIEVAL NUMBER 10

INFORMATION RETRIEVAL NUMBER 231 ►

Bob Dobkin
National Semiconductor

LINEAR BRIEF 2

FEEDFORWARD COMPENSATION SPEEDS OP AMP

A feedforward compensation method increases the slew rate of the LM101A from 0.5/μs to 10V/μs as an inverting amplifier. This extends the usefulness of the device to frequencies an order of magnitude higher than the standard compensation network. With this speed improvement, IC op amps may be used in applications that previously required discretes. The compensation is relatively simple and does not change the offset voltage or current of the amplifier.

In order to achieve unconditional closed loop stability for all feedback connections, the gain of an operational amplifier is rolled off at 6 dB per octave, with the accompanying 90 degrees of phase shift, until a gain of unity is reached. The frequency compensation networks shape the open loop response to cross unity gain before the amplifier phase shift exceeds 180 degrees. Unity gain for the LM101A is designed to occur at 1 MHz. The reason for this is the lateral PNP transistors used for level shifting have poor high frequency response and exhibit excess phase shift about 1 MHz. Therefore, the stable closed loop bandwidth is limited to approximately 1 MHz.

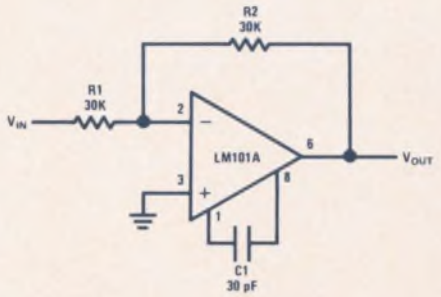


FIGURE 1. Standard Frequency Compensation

Usually, the LM101A is frequency compensated by a single 30 pF capacitor between Pins 1 and 8, as shown in Figure 1. This gives a slew rate of 0.5V/μs. The feedforward is achieved by connecting a 150 pF capacitor between the inverting input, Pin 2, and one of the compensation terminals, Pin 1, as shown in Figure 2. This eliminates the lateral PNP's from the signal path at high frequencies. Unity gain bandwidth is 3.5 MHz and the slew rate is 10V/μs. The diode can be added to improve slew with high speed input pulses.

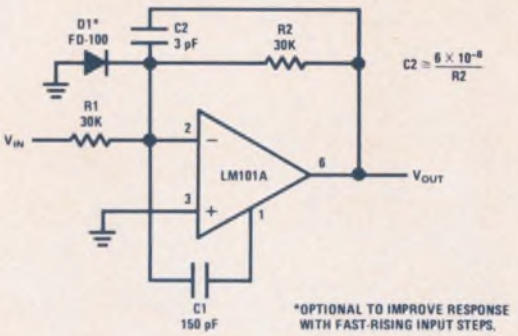


FIGURE 2. Feedforward Frequency Compensation

Figure 3 shows the open loop response in the high and low speed configuration. Higher open loop gain is realized with the fast compensation, as the gain rolls off at about 10 dB per octave until a gain of unity is reached at about 3.5 MHz. Figures 4 and 5 show the small signal and large signal transient response. There is a small amount of ringing; however, the amplifier is stable over a −55°C to +125°C temperature range. For comparison, large signal transient response with 30 pF frequency compensation is shown in Figure 6.

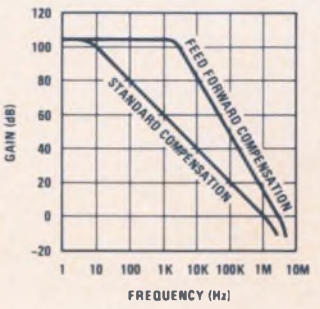


FIGURE 3. Open Loop Response for Both Frequency Compensation Networks

LINEAR BRIEF 2 FEEDFORWARD COMPENSATION SPEEDS OP AMP Write: National Semiconductor Corp., 2975 San Ysidro Way, Santa Clara, California 95051

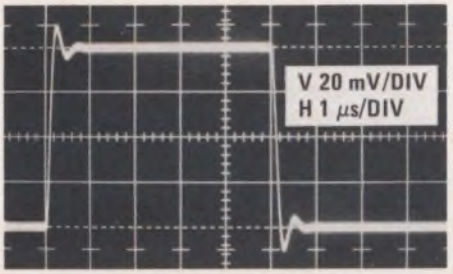


FIGURE 4. Small Signal Transient Response with Feedforward Compensation

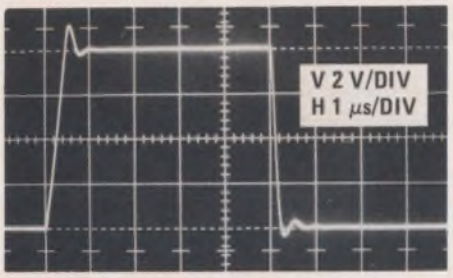


FIGURE 5. Large Signal Transient Response with Feedforward Compensation

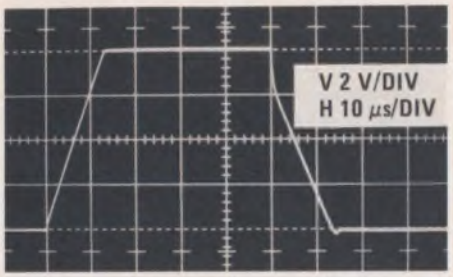


FIGURE 6. Large Signal Transient Response with Standard Compensation

As with all high frequency, high-gain amplifiers, certain precautions should be taken to insure stable operation. The power supplies should be bypassed near the amplifier with .01 μF disc capacitors. Stray capacitance, such as large lands on printed circuit boards, should be avoided at Pins 1, 2, 5, and 8. Load capacitance in excess of 75 pF should be decoupled, as shown in Figure 7; however, 500 pF of load capacitance can be tolerated without decoupling at the expense of bandwidth by the addition of 3 pF between Pins 1 and 8. A small capacitor C_2 is needed as a lead across the feedback resistor to insure that the rolloff is less than 12 dB per octave at unity gain. The capacitive reactance of C_2 should equal the feedback resistance between 2 and 3 MHz. For integrator applications, the lead capacitor is isolated from the feedback capacitor by a resistor, as shown in Figure 8.

Feedforward compensation offers a marked improvement over standard compensation. In addition to having higher bandwidth and slew, there is vanishingly small gain error from DC to 3 kHz, and less than 1% gain error up to 100 kHz as a unity gain inverter. The power bandwidth is also extended from 6 kHz to 250 kHz. Some applications for this type of amplifier are: fast summing amplifier, pulse amplifier, D/A and A/D systems, and fast integrator.

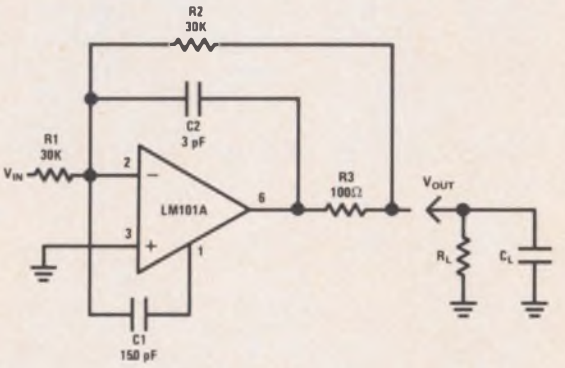


FIGURE 7. Capacitive Load Isolation

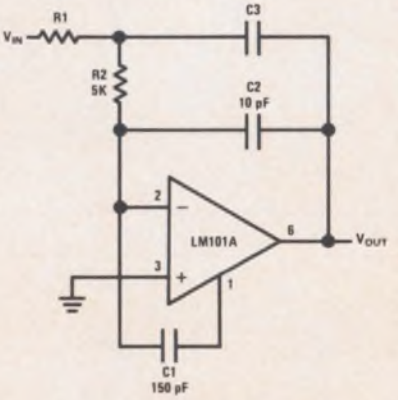


FIGURE 8. Fast Integrator

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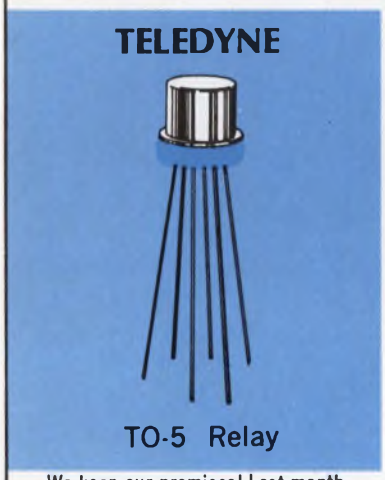

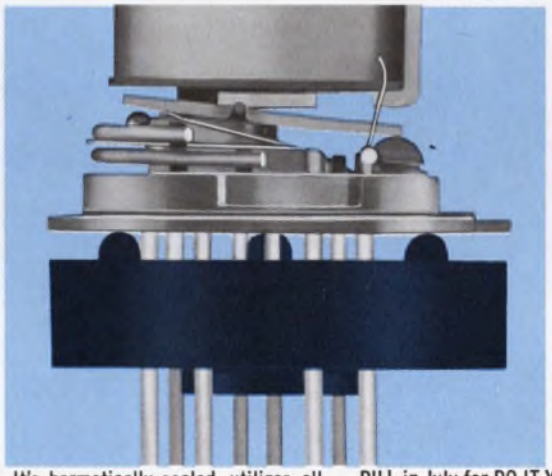

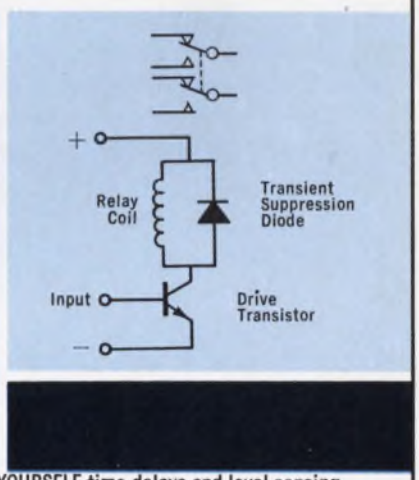

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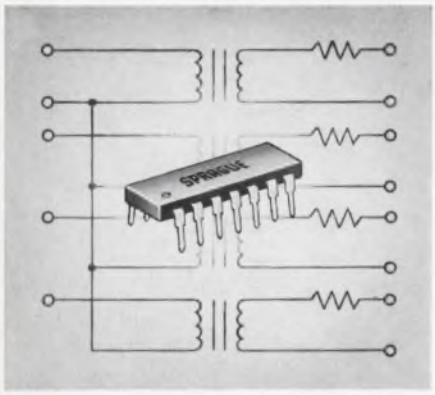

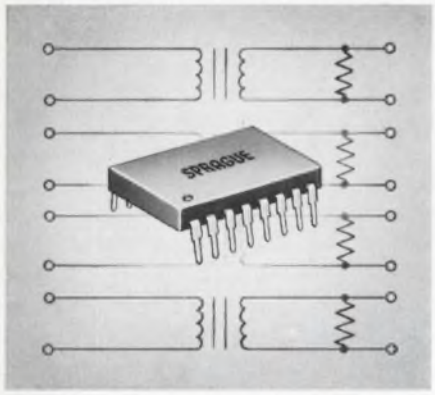

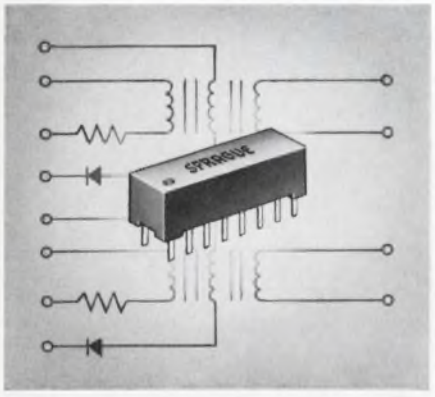

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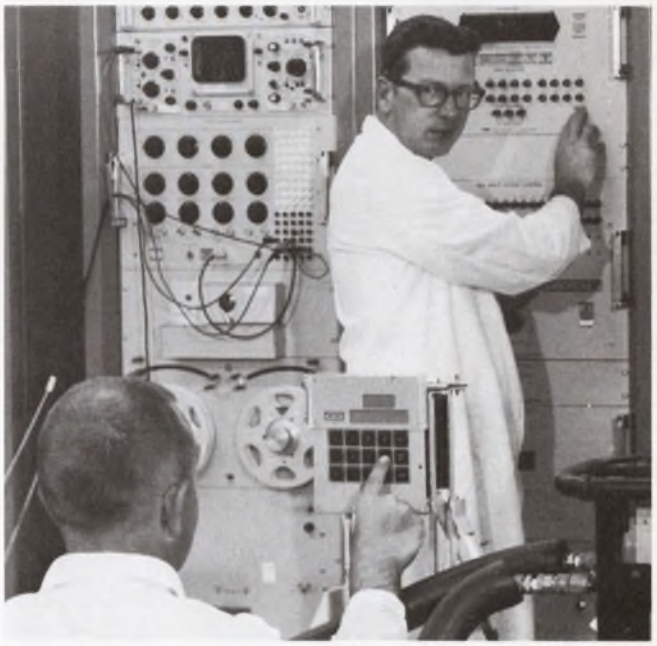
INFORMATION RETRIEVAL NUMBER 12

News

Focus Retina proved today's combat electronics can take the strain of an airdrop mission to Korea. Men working in this hostile environment, however, have complaints worth hearing. The opinions they expressed may be tomorrow's specifications. Page 34.

A solar-powered space probe, of the type that took this photo of the surface of Mars, will be sent to Jupiter in 1972. Page 25.



The safety of the moon landing mission, especially the critical descent, depends on an intricate abort guidance system. Page 30.

Also in this section:

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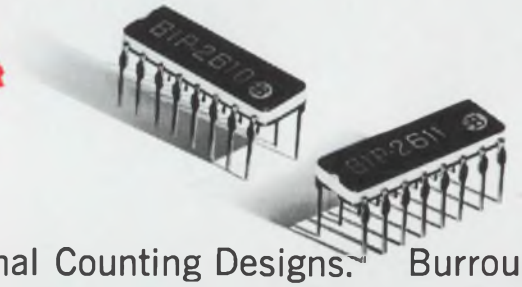

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INFORMATION RETRIEVAL NUMBER 13

News Scope

Eastern Test Range getting ready for MIRV

Although there has been no official announcement, it's apparent that the Air Force Eastern Test Range is preparing even now for tests of a multiple-warhead atomic missile in fiscal 1972-73.

The missile is MIRV (Multiple Independently Targeted Re-Entry Vehicle), now in the R&D stage, and hints of Eastern Test Range preparations for it are contained in "Report to Industry on Instrumentation Programs," an outline of the range's procurement needs. The emphasis in the report is on major modifications to two Advanced Range Instrumentation Ships in the next two years and new and modified equipment for under-water acoustic locator systems. The latter would be systems that could locate several targets at once. Radars would also be improved for ultimate tracking of multiple targets.

If the funds are approved, procurement by the test range for fiscal '70 should come to around $14 million, according to Henry Barrows, chief of the range's Instrumentation Branch. This would be just slightly under the sum authorized last year but far below the fiscal '67 total, which included $38 million for a major telemetry rehabilitation program.

MIRV is being developed for use with the Navy's Poseidon rocket and the Air Force Minuteman III.

Some $12 million of the funds sought by the test range would equip the two range ships for radar-signature recording measurements and with telemetry for multiple-re-entry vehicles. The C-band radars would be modified to double their operating range. A splashdown-detection radar, TACAN (Tactical Air Navigation equipment) and coherent uhf radars for collecting atmospheric wake data on re-entering missiles would also be installed.

The range's Broad Ocean Area Acoustic Impact Location System —which covers an area beginning 300 miles down-range from Patrick Air Force Base, Fla., to a point 3400 miles beyond—would be modernized in preparation for a more advanced system, to be requested in fiscal '71. The latter, called the Redeployable Advanced Impact Location System, would resemble the Project Mohole platform used for ocean-bottom deep drilling. The platform would be deployable anywhere down-range and would be equipped to permit precise location of multiple, closely spaced warhead impacts.

Beginning in fiscal '72, three major trajectory-determination systems would be procured. An advanced metric tracking radar system would require pulse radars of high power and high sensitivity, and would be capable of tracking several objects simultaneously from launching to impact, the Air Force says.

A new continuous-wave advanced metric measurement system would be required to determine the operational performance of self-guided weapon systems. The network would include high-precision, very-long-range cw radars.

A laser ranging system would be procured for determining trajectory of missiles in the phase immediately after launching.

IBM gets into the telephone business

Despite mounting legal pressure to put a lid on IBM's growth and diversification, the company's phenomenal talent and resources have spawned still another product: a voice and data switching system that integrates data processing and private telephone services. So far the system, called IBM 2750, is being marketed only in France and Italy, but, according to the IBM World Trade Corp., the list will grow.

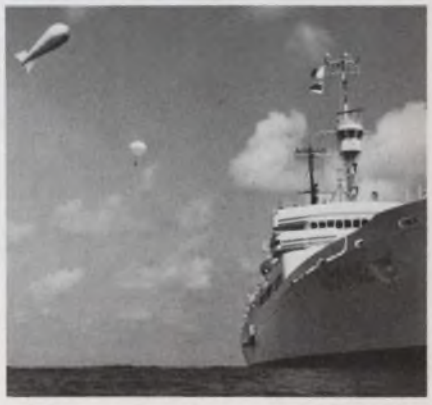
Built for banks, insurance companies, manufacturers and other major users of data-processing equipment, the 2750 combines a private telephone system and a low-cost data-collection system capability—using push-button telephones as terminals. Voice features and data capabilities can work in combination or separately.

The system can serve over 700 extension lines, as many as 80 outgoing trunk lines and from two to eight operator control desks. Switching is entirely electronic, including up to 25,000 cross point switches. The switching and all other related functions, such as scanning, path marking and signal distribution, are under the permanent control of a built-in computer. The switching section is made up of a matrix of semiconductor thyristors or switching diodes.

The over-all system design was carried out at IBM France's laboratory at La Gaude.

Sea study is seeking better clues to weather

On May 3 an array of electronically equipped planes, ships, buoys and satellite terminals converged off the east coast of Barbados to begin the most intensive investigation ever made of the interaction between the sea and the air above it. The result will, it is hoped, enable meteorologists to predict weather longer in advance.



Bomex "weather" ship Discoverer releases meteorological balloons.

News Scope CONTINUED

Using the services of 1500 people, 24 planes, 10 ships, several satellites and a dozen buoys, tests will be made over a 90,000-square-mile area of ocean stretching vertically from the sea floor, 18,000 feet down, to 100,000 feet above the surface.

Called Bomex (Barbados Oceanographic and Meteorological Experiment), the investigation will continue through July 28. Headed up by the Dept. of Commerce's Environmental Science Services Administration, the project will be carried out by the Dept. of Defense, the Atomic Energy Commission, the National Aeronautics and Space Administration and the Government of Barbados. Nineteen universities and seven industrial laboratories also have roles.

The 82 planned experiments use such sensors as hot wire anemometers, sonic and mechanical anemometers, thermistor arrays on buoys and telemetering and recording buoys. For navigation the Omega system and the Navy's Navigation Satellite will be used. Stationary satellites will photograph the test area. All data will to flown back to NASA's Mississippi Test Facility's computerized data management system where they will be processed.

One area that stands to benefit from the experiment is antisubmarine warfare. The ability to predict sea state from the air-sea interface will enable better measurement of undersea sound propagation—still the major approach for detecting enemy submarines.

First U.S.-made LSI-MOS calculator introduced

The first U.S.-made electronic calculator using large-scale integration with MOS elements has been introduced by the Smith-Corona Marchant Division of the SCM Corp., New York City. The 8-pound unit, named the Cogito 414, was designed to compete against similar foreign imports such as Hayakawa Electric Co.'s smaller 3-1/8-pound QT-8D calculator, which sells for less than $500 (ED No. 8, Apr. 12, 1969, p. 118).

The machine, which has a 14-digit capacity, is suitable for general office or accounting work rather than for engineering computations. It will sell at $895, with deliveries in the fall of 1969.

An outgrowth of an early SCM electronic calculator, it has been progressively whittled down in size from the original 600 transistor, resistor and diode components in 1964, to 20 integrated circuits in 1967, to the present eight MOS chip elements that are equivalent to 4800 discrete components.

The keyboard is logically arranged with a 14-place credit-balance adding machine, plus separate multiplication and division registers. A special "transfer" keyboard memory links all mathematical functions together by transferring figures back and forth between registers.

Chain multiplication and division can be performed without re-entering figures. Answers to individual problems are accumulated and stored in an "adder" register, providing a grand total in one operation.

The Cogito 414 has automatic decimal positioning, and answers are automatically rounded off in multiplication and division with all insignificant numbers eliminated to the right.

Electronic failures in Mariners discounted

The "trouble" that has been rumored to plague the two Mariner '69 spacecraft speeding toward Mars has been spotted as telemetry and Star Tracker malfunctions, say NASA officials. Corrections were made, and the probes are expected to fly-by the planet as planned.

From a range of 2000 miles, Mariner VI will look at the equatorial regions of Mars, while Mariner VII will scan the polar cap. Televised photos and infrared and ultraviolet spectrometric data will be transmitted to Earth detailing the Martian surface and atmosphere.

Mariner VI is now estimated to come closest to Mars at 1:18 a.m. E.D.T. on July 31; Mariner VII will pass closest at 1:00 a.m. on August 5.

Late in April, says Assistant Program Manager Robert Kennedy, the Mariner VI telemetry downlink revealed fluctuations, probably caused by the local oscillator in the transponder. These were small—"less than one watt," he says—and the received signals are now operating nominally. Similar signal variations occurred during the launch last February 4, he reports. That problem was generated by the low-gain antenna drive, but it, too, self-corrected.

The Star Tracker problem could have become more serious. The subsystem is employed to locate and lock-on to the star Canopus to assure proper vehicle spatial orientation with respect to Earth. The Canopus sensor, says JPL, has been "distracted" several times by bright reflective particles emanating from the spacecraft. The particles are believed to be produced by pyrotechnic squibs used for the staging or deployment of various subsystems. The result is that the tracker loses lock-on, and the vehicles begin a roll mode in attempting to relocate Canopus.

To prevent this from happening —particularly when the vehicles make their critical Mars lock-on maneuvers this summer—both crafts have been reprogrammed to use the Honeywell 3-axis inertial reference subsystem for stabilization. The Canopus Star Tracker can still be used to provide the navigational fix necessary for gyro alignment, but no problem is anticipated for this operation.

Delay-line expert returns

After realizing that the state of the art in delay-line manufacture was still as he had left it a year ago, Walther M. A. Andersen—called "Father of the delay-line industry"—has started a new company in Tariffville, Conn. Known as Walther M. A. Andersen and Associates, the company will manufacture high-frequency, broad-band crystal filters and acoustic delay lines. Andersen has been doing consulting work since he left Laboratory for Electronics Inc.

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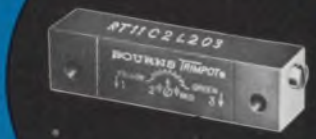


RT11

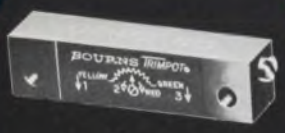
RT12

RT22

RT24

RT26*

MIL-R-22097



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Hop to Jupiter: Takeoff, 1972; Arrival, 1974

U. S. planning to send probes 340 million miles, and they could lead to a 'grand tour' of the planets

Elizabeth deAtley
West Coast Editor

NASA plans to build two enlarged Pioneer solar-electric-power spacecraft for a trip to Jupiter—far beyond the outermost flights of any space probe to date.

The first flight is scheduled for launch in February or March, 1972, and the second will follow it about one year later. Both unmanned flights will take about two years to reach Jupiter, some 340 million miles away from the earth. The spacecraft will have to fly through such potential hazard areas as the asteroid belt of flying rocks and the region of high-energy particles trapped by Jupiter's magnetic field —and thought to be far more intense than the Van Allen belt.

If the flights are successful, a spectacular grand tour of the outer planets some time between 1976 and 1980 may become a reality. During that time the planets will be astronomically lined up so that a spacecraft could be sent bouncing from one to the next like a celestial billiard ball. Launched from earth with just enough thrust to reach Jupiter, the spacecraft would be deflected by Jupiter's enormous mass and pushed on its way toward the outer planets with greatly increased speed.

By use of the slingshot effect of a close approach to Jupiter, says Dr. Homer J. Stewart, manager of the Advanced Studies Office, Jet Propulsion Laboratory, Pasadena, Calif., it would be possible to visit Jupiter, Saturn, Uranus and Neptune in a single 9-year trip. Once Jupiter moves ahead of Uranus and Neptune in 1980, however, the opportunity for such a grand tour will be over until about the year 2150. Hence there is a sense of urgency in plans for the Pioneer flights to explore the hazards of Jupiter.

Jupiter—the first lap

According to plans currently under study at NASA's Ames Research Center, Moffett Air Force Base, Calif., the Pioneer spacecraft will carry scientific instruments to measure the fields and charged particles around Jupiter, explore the asteroid belt and send back data on the surface characteristics of the planet itself. The spacecraft would be some 341,000 miles from Jupiter at its points of closest approach.

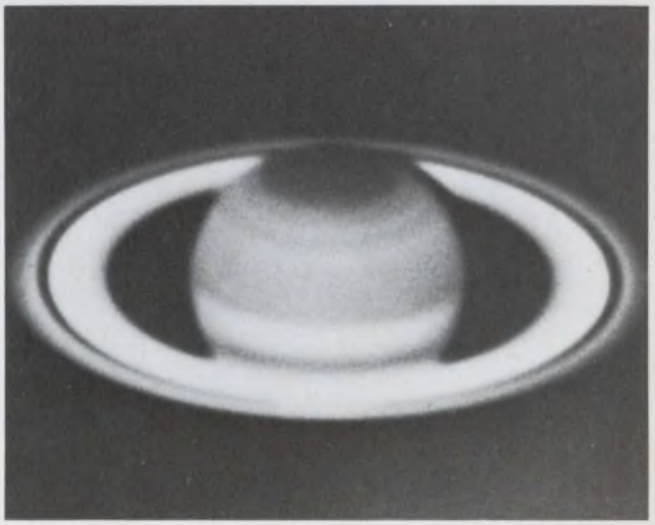
Instruments likely to be chosen for the mission are, according to Charles Hall, Pioneer project manager at Ames:

- A simple imager to record and transmit brightness readings of Jupiter's surface as the spacecraft spins on its axis. The spacecraft will probably carry instruments of this type for imaging both the visible and the infrared.
- A magnetometer.
- Detectors for both high- and low-energy particles.

Second-choice candidates are:

- An ultraviolet sensor that will measure radiation in the 300- to 1500-angstrom range, where hydrogen and helium emit wavelengths. By measurements in this region, scientists hope to determine the abundance of these gases in Jupiter's atmosphere.
- An X-ray detector.
- An electric-field detector.
- Radio-Astronomy equipment.

The spacecraft will probably carry a 9-foot paraboloid antenna.



The planet Jupiter (left), some 340 million miles from earth, is the target for two Pioneer spacecraft scheduled to be launched in 1972 and 1973. Saturn (right) would be visited by other probes as part of a proposed "grand tour" of the planets beginning in 1976. Photos courtesy of Mt. Wilson-Palomar Observatories.

Both flights are scheduled for launch with an Atlas/Centaur 364 —the vehicle used for sending the Mariners to Mars. It will however, have an added third-stage booster, the TE 364, to give the Pioneers the extra initial thrust they need to go beyond Mars to Jupiter.

The spacecraft will use solar energy, but, because of the distance from the sun—more than 400 million miles at Jupiter encounter—the solar panels will be much larger than those for a Mars flight. The vehicle will carry a midcourse-maneuver motor with sufficient propellant to redirect it slightly in midflight. The position of Jupiter is not known with precision. Based on data telemetered back from the first Pioneer, therefore, the second vehicle would be redirected if necessary.

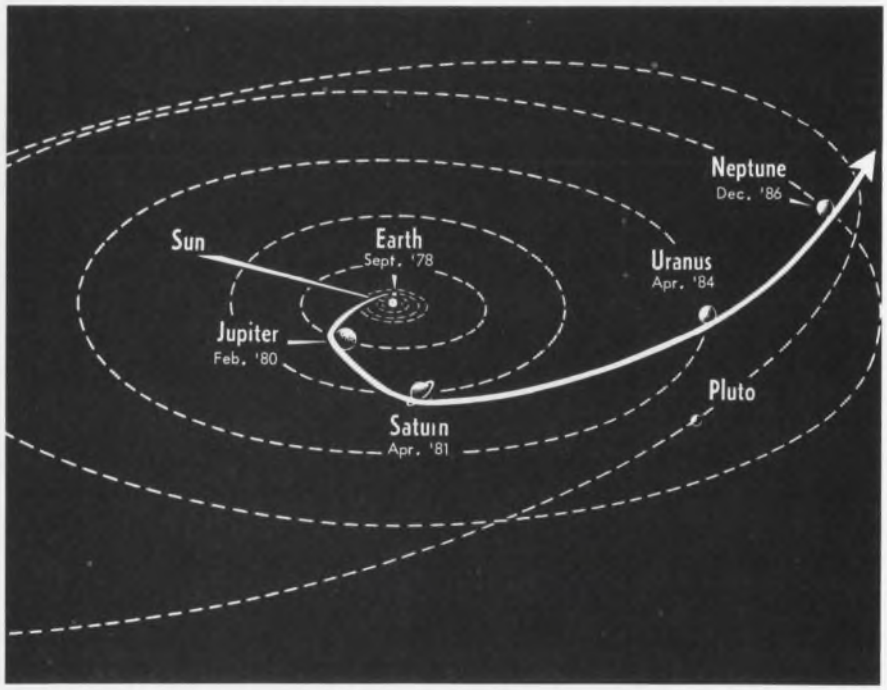
Rock and rubble

To reach Jupiter, the Pioneer flights must cross the asteroid belt, a region some 300 million miles wide between Mars and Jupiter, where flying rocks abound. Presumably debris from small broken planets, these rocks travel at speeds ranging from about 6 to 43 miles per second. About 50,000 of them are large enough to be viewed by telescope—some of them being hundreds of miles in diameter.

These visible rocks are scarce enough so that the likelihood of a spacecraft striking one of them is considered small. "However," says Charles Hall, "we don't know the density of the particles that can't be seen from the earth—particles the size of, say, a grain of sand. We don't know whether we may be going into an environment like a sandblasting machine."

Several interesting instruments have been suggested to measure the density and momentum of these particles, according to Hall, although there is no certainty that any of them will be included on the flight. One method suggested for measuring fairly large particles (10^{-9} to 10^{-6} grams) is to fasten a microphone to the spacecraft. The larger the microphone, of course, the greater the likelihood of a hit.

For smaller particles, (10^{-15} to 10^{-9} grams), Hall says, "You could put two thin-film sensors some distance apart, and behind the second sensor you would put a microphone. As the particle hits each sensor, it gives off a signal. The time difference between the two signals would give the particle's velocity. When it hits the microphone behind the second sensor, the microphone rings. The extent of the ring would indicate how hard the particle had hit, and hence its momentum."



A "grand tour" of four planets could be made by a spacecraft launched from earth in September, 1978, scientists say. Such a tour would begin with Jupiter and end with Neptune in December 1986. Using the mass of Jupiter to give it extra boost, the spacecraft would "bounce" from one planet to the next, coming close enough to each to transmit to the Earth TV photos and other data.

A hydrogen magnet?

The prime purpose of the missions is to measure the fields and charged particles around Jupiter. These particles, which come from the sun, are apparently trapped in a doughnut-shaped region around Jupiter by a magnetic field that emanates from the planet. Many scientists now believe that Jupiter may have a metal-like core, which acts as an electric generator to create a magnetic field. They believe, however, that this "metal" may be composed of solid hydrogen.

One possible technique for determining the number of charged particles at a given energy level, says Hall, is to use an instrument consisting of two curved plates with a sensor at one end and a space to admit particles at the other. A voltage across the plates would cause charged particles traveling between them to move toward the plate whose charge is opposite to their own.

Since this plate curves away from the line of flight, particles traveling at a certain critical speed, determined by the voltage, would strike the sensor at the far end. Particles traveling below this speed would hit the plate, and those traveling faster would hit the other plate. By increasing the voltage level across the plates, one could cause particles of higher energy to curve and strike the sensor. Thus it would be possible to detect particles over a range of energy levels by changing the voltage.

A star is born

Not only will the Pioneer missions examine the hazards of the journey to Jupiter—they will also investigate some of the characteristics of this strange planet. Jupiter is of particular interest to

Speed costs

particularly when you don't need it.

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INFORMATION RETRIEVAL NUMBER 16

astronomers because of its enormous size. It is far the largest of the planets. Superimposed on its surface, the earth would look like a blue bottletop on a gray dinner plate.

Jupiter is 11 times larger than the earth and 300 times heavier. In fact, astronomers now believe that it may be close to the maximum limit in size a planet can attain without collapsing in on itself and starting a thermonuclear reaction that would cause it to become a star.

Jupiter's atmosphere consists largely of hydrogen, helium, ammonia, and methane. In its outer cloud layers, the forces of gravitation are 2.6 times as strong as those of the earth. As a result, objects are extremely heavy and pressures are great. A few thousand miles below the cloud tops, the pressure is believed to be so large that hydrogen turns into a frothy slush. Still farther down it becomes a kind of metallic solid, causing Jupiter's magnetic field.

In some layer of Jupiter's atmosphere, water may exist, and possibly some early forms of life. In fact, astronomers now believe that an atmosphere like Jupiter's may have existed on earth when life first appeared here.

In addition to carrying instruments to study the planet and its surroundings, says Hall, the spacecraft can itself be used to determine many of the constants of celestial mechanics.

Jupiter—and beyond

The total weight of the enlarged Pioneer—including the spacecraft itself, 55 pounds of scientific instruments, and the launch-vehicle adapter fitting—will be less than about 500 pounds. Its flight will be directed by earth-based computers.

A subsequent grand tour across some 3 billion miles of space to Neptune, and passing close to three other planets on the way, would require a sophisticated on-board guidance system. This would have to be capable of turning the instruments on and off as the spacecraft approaches and leaves a planet, and of correcting its direction and speed of flight. With a four-hour time lag in communications to Neptune, this cannot all be done from the earth. On the other hand, the on-board equipment must be minimized to stay within weight requirements.

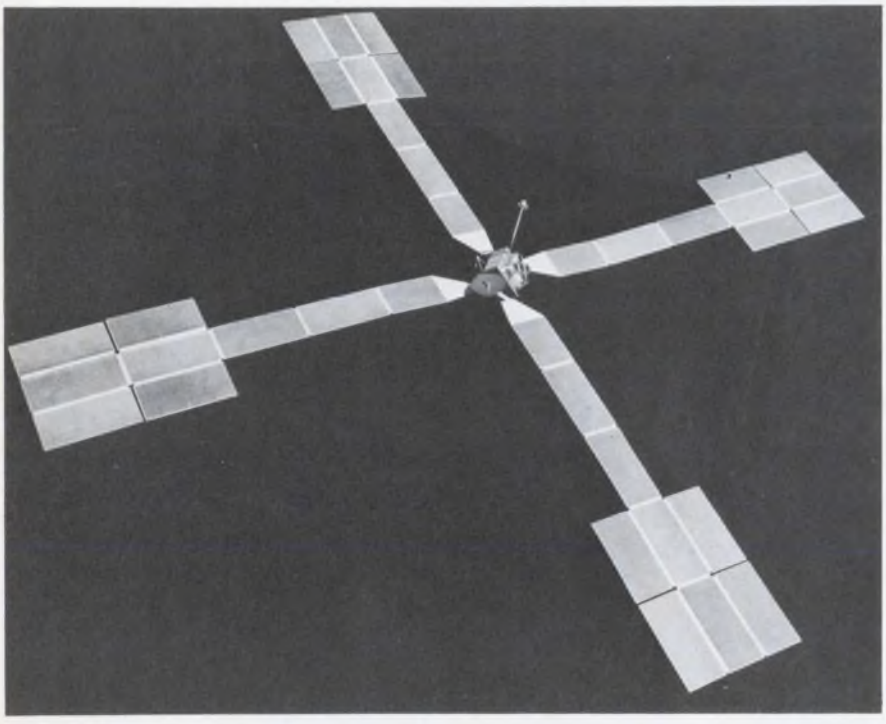
A flight program under study at the Jet Propulsion Laboratory calls for a 1200 to 1500-pound spacecraft including 150 pounds of scientific instruments, an auxiliary on-board engine—possible an ion engine—and an on-board computer. According to Dr. Stewart of JPL, the spacecraft would be tracked on the earth by a deep space net that would determine its velocity and distance from the earth and other planets.

An on-board computer would determine the angular position of the spacecraft with respect to the sun and one of the stars. This information would be telemetered to earth, where it would be combined with the velocity and distance information obtained by the ground tracking system. Instructions for correcting the direction of flight would then be transmitted to the spacecraft, where the on-board computer would make the necessary adjustments in speed and direction.

Because the positions of the planets are not precisely known, says Dr. Stewart, it will be necessary to make corrections in the direction of travel as the spacecraft approaches each one. "You could get by without this at Jupiter," he points out, "but the uncertainties for the most distant planets are about twice as great, so you have to make corrections as you go."

For this purpose, some kind of optical system on board—probably a TV camera—would be used, he says, to determine the position of the planet with respect to the sun and one star. This information would be telemetered to earth and processed there with the other flight data.

The spacecraft cannot depend on solar energy for its flight beyond Jupiter, because of the enormous distance from the sun. Therefore, it will carry some other power source. A likely candidate is the so-called RTG—a system that makes use of a radioactive isotope to generate heat that is converted to electrical energy. The vehicle will have to carry a large antenna —about 15 feet in diameter—to communicate across the vastness of space with minimum power. ■■



This model of a solar-electric power spacecraft for a Jupiter mission was developed at the Jet Propulsion Laboratory, Pasadena, Calif. The large size of the panels is required because the spacecraft will be more than 400 million miles from the Sun at Jupiter encounter.

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Strap-down guidance system passes test

The astronauts have just finished their landing mission on the moon and are back in their Lunar module ready to blast off and rejoin the command service module orbiting patiently some 60,000 feet above. Suddenly warning lights flash—the primary navigation system has gone out! They're stranded on the moon—or would be, except that a multimillion-dollar piece of equipment, hopefully designed never to be used, is standing by and ready to take over: the abort guidance system.

This abort system gives the astronauts a vital backup means to guide the lunar module to a rendezvous with the command module at any point during its descent from the command-module parking orbit or during the ascent phase from the moon's surface.

The first in-space test of the abort system was made during the Apollo 9 flight. Its performance pleased everyone, according to David Meginnity, project manager of the abort guidance program at TRW, Systems, Inc., Redondo Beach, Calif.—except for a few shaky moments after the astronauts first turned the system on and warning lights appeared.

But rapid ground evaluation of in-flight telemetered data, comparing the performance of the abort system with the primary guidance system, showed that the warnings were obviously due to a fault in the alarm system.

The abort guidance system, developed and produced by TRW for Grumann Aircraft Engineering Corp., Bethpage, N.Y., is a strapped-down, inertial navigation system that provides an attitude reference, navigation facilities, system monitoring, and abort guidance for the lunar module.

The system is comprised of three units: an abort sensor package provided by Hamilton Standard Systems Center, Farmington, Conn., for TRW; a data entry and display unit with a keyboard by which the astronauts communicate with the abort-system computer; and the abort electronics unit containing the system "brain"—a navigation and guidance computer, plus input-output electronics and memories.

A first for strap-downs

Strap-down control systems have been used before, according to Dave Meginnity of TRW, but the Apollo 9 flight is the first time a complete strap-down system has been used for long-term guidance.

That function has been traditionally performed by three accelerometers and three gyros mounted on a stable platform, and isolated from vehicle motion, usually by three gimbals, each referenced to one axis of the vehicle. The platform remains motionless in space while the vehicle rotates about it, and the navigation system keeps track of vehicle motion by comparing the attitude of the vehicle with that of the stable platform.

But platform costs are high. And they suffer from gimbal lock, which can throw the system out of kilter. Constant attention is required from the astronauts to prevent this—time that has to be taken from other tasks.

In contrast, the abort system gyros and accelerometers are assembled in a rigid frame that is bolted to the vehicle skin. These sensors are aligned with the axes of the vehicle and they move along with the changes in attitude. In this system, space-vehicle motions are tracked by outputs from the accelerometers and gyros that are fed into the abort system's navigation computer, the memory and "brains" of the strap-down system.

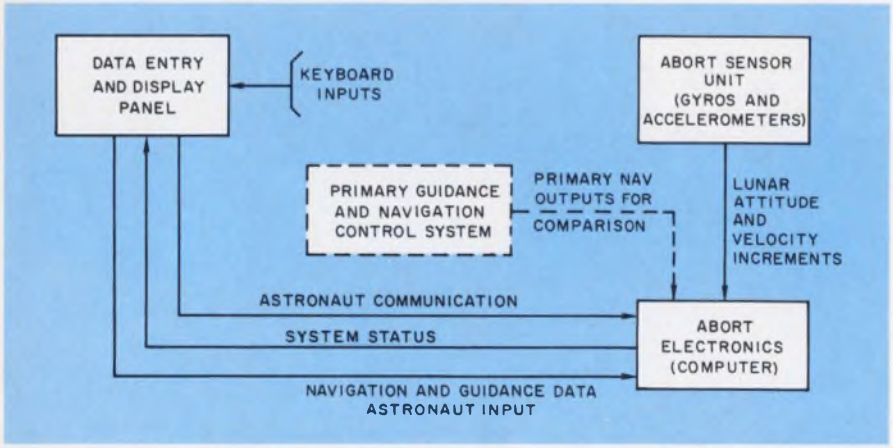
As Dave Meginnity describes it, ". . . the equivalent of the stable platform is provided by the mathematical calculations of the computer. The sensors pick up the motions and rates and the computer takes into account where a stable platform would be pointing if there were a stable platform. It's really a mathematical model of a platform."

Computations sub for gear

Advantages of the strapdown platforms are several, Meginnity claims. For the abort mission in particular, and others in general, they are lighter and use less power than the gimbaled platform systems. Further, there is no such thing as a gimbal lock with the strap-down system, since the motions of the "platform" are mathematical computations.

There are limitations, however. Accuracy of the equivalent "platform" is lower than that of its gimbaled counterpart. But for navigation purposes it is more than sufficient, as evidenced by its use in the backup system of the Apollo 9 lunar module.

Another important advantage of the strapped-down system pointed out by Meginnity is simpler maintenance; high skill is required for electromechanical platforms. ■■



Lunar-module abort guidance-system is checked by comparing performance with inputs from the primary system displayed on the panel. The system was developed by TRW Inc., Redondo Beach, Calif.

Top-Ten contest winners announced by magazine

Round-trip tickets for two between New York and Paris go to James P. Gross, an electronic systems engineer at LTV Aerospace, Dallas, Tex.

Gross won first prize in ELECTRONIC DESIGN's 1969 "Top Ten" contest by correctly picking nine of the ten advertisements best remembered by his fellow engineer-subscribers in the January 4, 1969 issue.

His selections were measured against the ten ads ranking highest in the "Recall Seen" category of Reader Recall—ELECTRONIC DESIGN's method of measuring readership.

Second prize went to Robert Hedin, member of the Technical Staff at SDS Corp., El Segundo, Calif. Hedin won a Heathkit/Thomas "Paramount" transistor Theater Organ.

Third prize, a Heathkit color TV, was awarded to F. A. Raymond, project engineer at the Goss Co., Chicago, Ill.

The 4th to 10 prize winners won Bulova Accutron "Spaceview" electronic timepieces. The winners are:

C. Ulrick, Collins Radio Co., Cedar Rapids, Iowa.

R. F. Hintz, Bissett/Berman Co., Santa Monica, Calif.

J. M. Gerstenberger, TRW Inc., Redondo Beach, Calif.

D. J. Matson, Atlantic Research Corp., Alexandria, Va.

F. W. Furland, Systems Science Corp., San Diego, Calif.

R. L. Kauffman, IBM Corp., Hopewell Junction, N. Y.

J. Derby, Collins Radio, Dallas, Tex.

The winners in a separate "Top Ten" contest for marketing-sales people were:

D. M. "Mike" Smith, copywriter at Hugh Dwight advertising agency, Portland, Ore. He also won a Paris trip for two.

Dennis F. Hayes, sales engineer with Dentronics Inc., Hackensack, N.J., who won a 14-inch portable color TV.

Alan Maier, advertising manager for Raytheon Co., Waltham, Mass. He was given a Bulova Accutron. ■■

We make components for guys who can't stand failures.

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Take our glass capacitors, for instance. There's only one reason why they've been designed into the Surveyor, Minuteman, Gemini, Apollo, Saturn, Titan, Syncom, Sparrow, Hawk, and a number of other major aerospace and missile projects. With our glass capacitors, circuit designers could get the proven stability and reliability that these important systems demanded. U.S. Air Force tests have established that our glass capacitors have much better stability and much higher insulation resistance than ceramic and mica capacitors can deliver.

And take our precision tin oxide resistors. They're the best of the metal film class. Because the resistive tin film is completely oxidized and molecularly bonded to the glass substrate, our tin oxide resistors are impervious to moisture and environmental degradation. No other resistor can deliver the same stability and reliability over load life. They offer guaranteed moisture resistance across all ohmic values to set a standard of reliability that can't be matched by metal film, wire wounds, carbon comps or metal glaze resistors. After a 56-day-long heat test in an environment of extremely high humidity, our tin oxide resistors showed a resistance change of just 0.2 per cent. And in an ambient temperature test—now in its ninth year—not one of the 600 tin oxide resistors being tested has exceeded a resistance change of 1.5 per cent.

But don't only think of Corning for aerospace and other precision applications. We've got something to offer when economy and value are the prime considerations. At Corning we've been active in improving these important capacitor and resistor characteristics, too.

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If you don't have our catalogs, ask your Corning distributor for copies or drop us a line at: Corning Glass Works, Electronic Products Division, Corning, New York 14830.

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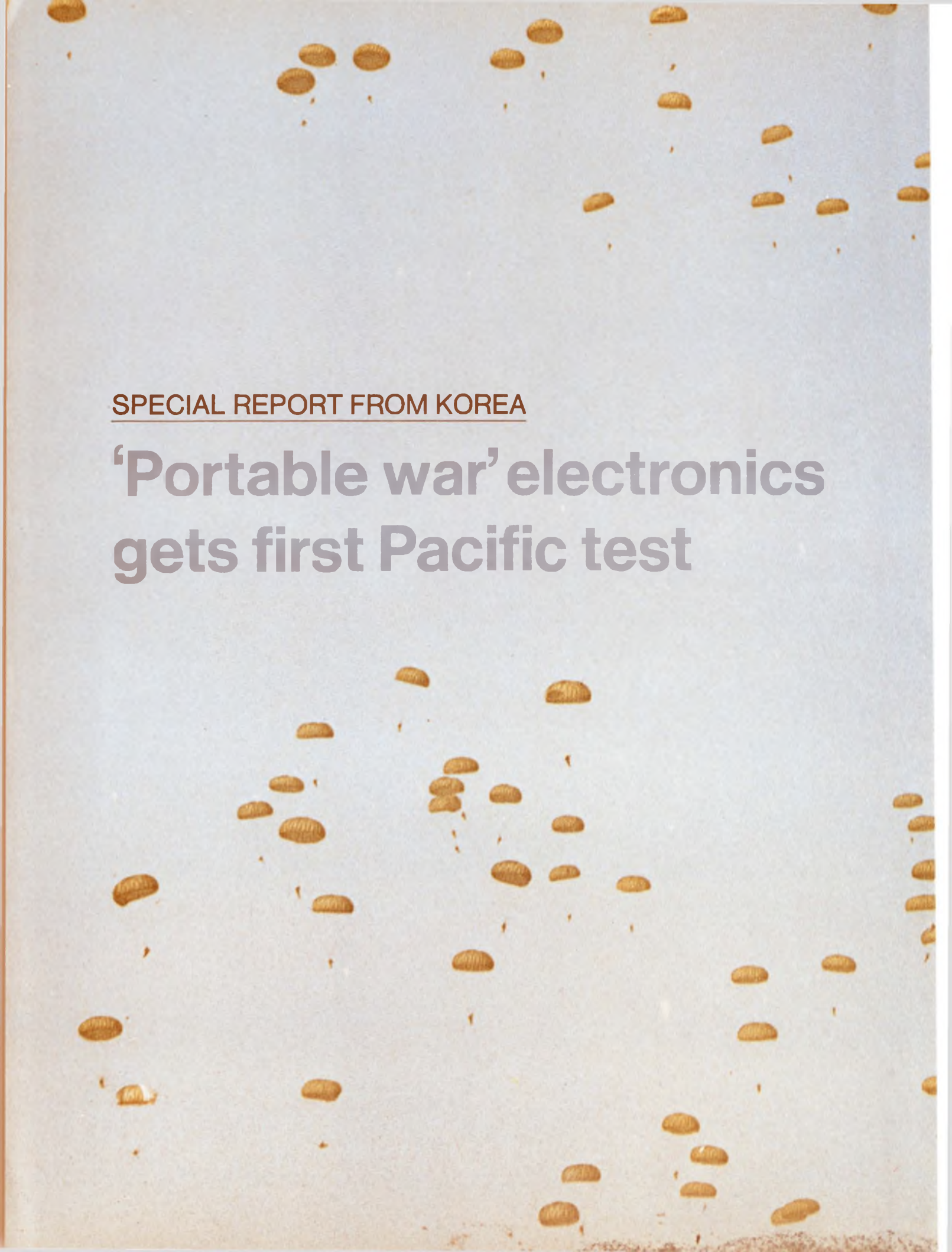
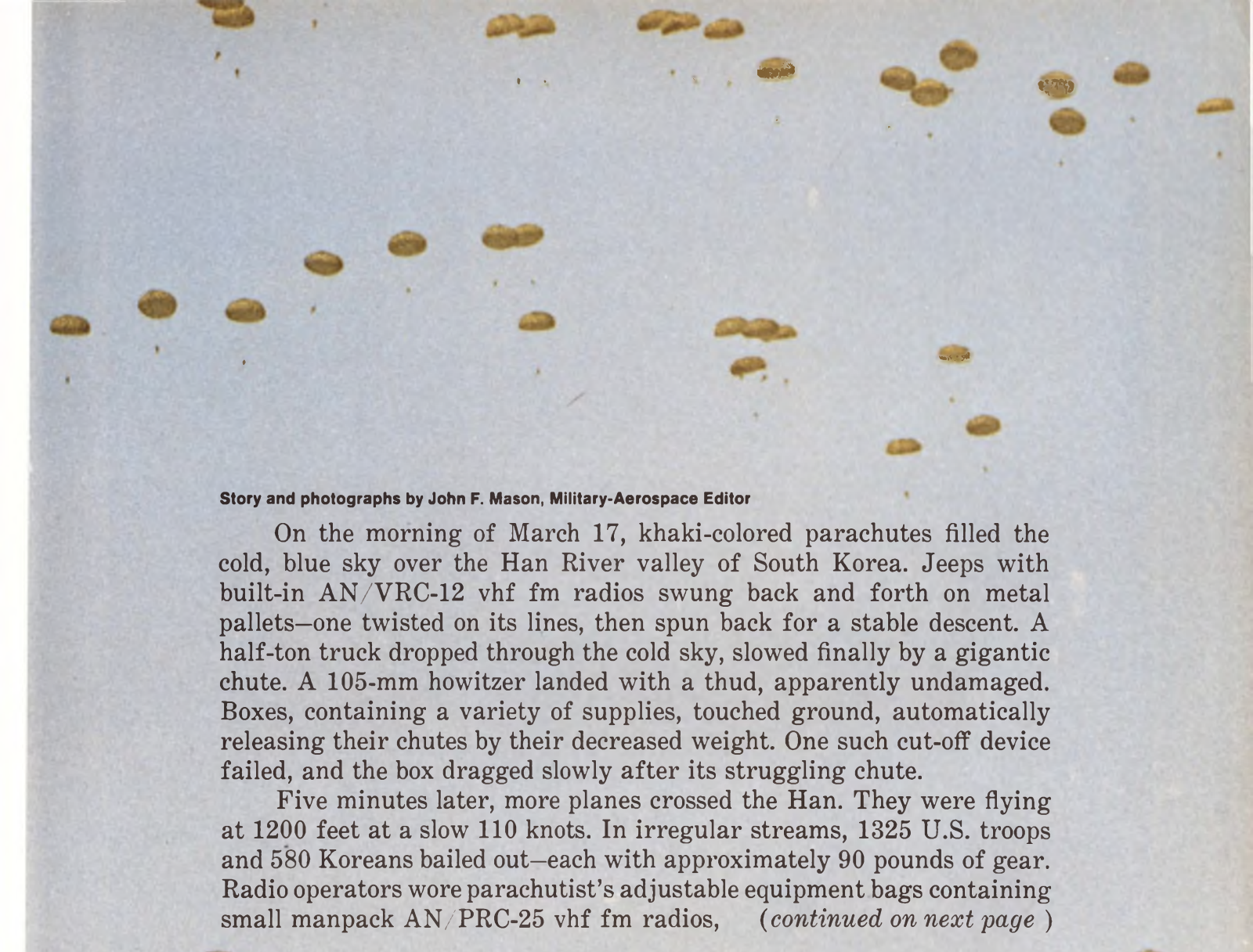
INFORMATION RETRIEVAL NUMBER 18

SPECIAL REPORT FROM KOREA

'Portable war' electronics gets first Pacific test





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

On the morning of March 17, khaki-colored parachutes filled the cold, blue sky over the Han River valley of South Korea. Jeeps with built-in AN/VRC-12 vhf fm radios swung back and forth on metal pallets—one twisted on its lines, then spun back for a stable descent. A half-ton truck dropped through the cold sky, slowed finally by a gigantic chute. A 105-mm howitzer landed with a thud, apparently undamaged. Boxes, containing a variety of supplies, touched ground, automatically releasing their chutes by their decreased weight. One such cut-off device failed, and the box dragged slowly after its struggling chute.

Five minutes later, more planes crossed the Han. They were flying at 1200 feet at a slow 110 knots. In irregular streams, 1325 U.S. troops and 580 Koreans bailed out—each with approximately 90 pounds of gear. Radio operators wore parachutist's adjustable equipment bags containing small manpack AN/PRC-25 vhf fm radios, (*continued on next page*)

Korean frogmen "infiltrators" fly to "safety" after high-altitude air drop into river where they blew up a simulated bridge. Originial plan to detonate a cardboard Pueblo was abandoned as being too emotional.

Communications headquarters for the entire Focus Retina exercise were set up on five hills alongside the command center. Waffle-like antennas reveal the old vhf AN/TRC-24 radio as still the Army's workhorse.

uhf PRC-41s and the small, modular vhf PRC-88 squad radio that can be dismantled and slipped into two pockets. This new unit is built by Delco Radio Div. of General Motors in Kokomo, Ind.

Except for a few men who landed in shallow, icy streams there was only one serious mishap: one trooper's chute lines caught on the plane, dragging him around through the below-freezing air and back over the drop zone, where he was cut loose. Other than for temporary shock, he was unhurt.

The exercise, called Focus Retina, was a success. The five-day operation was the Pentagon's first quick reaction, dual-based defense exercise in the Pacific and the most distant airborne assault operation ever held.

It proved to the Pentagon that 2500 Army and Air Force personnel can be rushed with full combat equipment 8500 miles to the aid of an ally in Asia in less time than the ally's own troops can march 40 miles from their base in Seoul.

As for electronics, it proved that existing equipment will do the vital and complicated job required for a joint-nation, multi-service and multi-command operation that must be carried out over great distances and with speed.

But improvements are needed. The men who jumped with radio units and set them up in the field, and who worked in mud-bogged communications vans, had praise for many of the systems but complaints about others. These opinions, disclosed to ELECTRONIC DESIGN in the snow-covered fields of South Korea in March, may be the specifications of tomorrow.

A constant complaint was that equipment is too big, and, for the airborne troops, too heavy. "The design engineer sitting in his ivory tower has forgotten what a man is able to carry," said Maj. Richard Earle, assistant division signal officer for the 82nd Airborne Div.

But even airborne troops agree that heavy equipment is not entirely industry's fault. Much solid-state, microminiaturized equipment exists and much more is on the drawing boards. But because of the cost of the war in Vietnam, there just hasn't been enough money for procurement or development of all the new systems the men in the field would like.

If, however, Korea continues to be a prime trouble spot, new gear must be brought in.

Another problem is the military's fault, communicators said. Normal Defense Dept. procedures cause leadtime on new items to be so long that a device is sometimes old before the troops get it. ". . . seven years is the average," one officer said.

Another problem is that equipment is bought in such quantities that the troops have to continue

Outgoing communications are scrambled and incoming, unscrambled in the cryptography van, which is protected by barbed wire, a guard, and—thanks to rain and then snow—by rolling red hills of slippery mud.

All-solid-state vhf/fm PRC-77 sends take-off instructions to chopper pilot leaving communications center.

to use it after newer-generation gear is available at a reasonable price. For example, a multiplexer built to accommodate 12 voice channels "is about the size of half this desk," an Air Force colonel complained, "while Electronic Communications, Inc., over in St. Petersburg, Fla., has a microminiaturized multiplexer that accommodates twice as many channels and occupies one cubic foot."

Besides bulk and weight, the men cite problems with radio frequency interference on the ground and in the air, redundant redundancy, awkward antennas and printed circuits that wear out.

For the troposcatter communications gear, however, there was only praise. And as its popularity goes up, vhf's desirability goes down. High frequency is held in even lower esteem, but it will be tolerated until satellite communication gets to the field—a day that may come sooner than many expect.

What it takes to run a war

A conglomerate of electronics is brought together fast in a big assault of this kind.

An Air Lift Communications Center at Osan, Air Force headquarters in Korea, communicated successfully by hf radio with the big C-141 and C-130 troop-carrying planes from the time they left the United States to arrival over the drop zone in Korea. The center also kept in touch with several subsidiary air-lift stations in jeeps. Besides hf/ssb, their equipment included uhf/a-m and vhf/fm.

With the small, hf KWM-2A radio, using a double antenna and a transmitter power of 175 watts PEP, the center communicated easily with Washington, although once the circuit had to be routed through the Dew Line communications network in Canada.

The 2500 U.S. troops flown over from Fort Bragg, N.C., carried with them vhf, uhf and hf units. The Korean troops and Korean-based U.S. troops they joined on the ground had all this equipment plus troposcatter.

Two more communications elements consisted of an Air Force Forward Air Control team and an Army Combat Control team. Both jumped into the drop zone a few minutes before the big equipment and personnel drop. They carried manpack uhf and vhf radios.

When asked if they jumped with the hf PRC-47, built by Collins Radio, the 82nd Airborne's Major Earle told ELECTRONIC DESIGN: "The Air Force may have used it, but we left that white elephant back at Fort Bragg. It's so heavy, you need two men to carry it. All the PRC-47s the Army bought for the Airborne are still sitting in warehouses, where they'll probably stay."

There were Air Force Tactical Air Control Post teams in jeeps in the battle area to request fighter support by the U.S. and Korean air forces. These requests went by hf radio to an elaborate, but still not-automated, Tactical Air Control Center in Osan, where airmen stand behind Plexiglass boards writing status reports backwards with grease pencils.

Meanwhile, guarding the zone against infiltrators from Communist Korea to the north, American troops watched the scrubby, heavily mined no-man's land at night with infrared Starlight scopes mounted on rifles and with larger night optical devices. They listened and watched for movement via TPS-33 personnel detection radars. And to communicate, they used the vhf/fm PRC-25—which is solid-state except for one tube—or its successor, the PRC-77, which got rid of the tube.

In the air, there was the Air Force Strike Command's C-130 communications-relay plane, called Jack Pot, that circled the drop zone during the equipment and personnel drops to relay line-of-sight communications from any of the ground and airborne elements that wanted to communicate.

Running the show

Controlling the entire exercise was the Eighth Army from a hast-

Flying the North Pacific

"What's that light ahead of us? An island?"

"It's Venus," the pilot shouted back over the din of the jet engines. "The closest islands are 200 miles to the north."

Other faint lights along the horizon then were also stars, not friendly island villages with long runways.

"There's nothing out here but ocean," the pilot added. We had taken off from Elmendorf AFB, Alaska, a half hour before. Korea was 3500 miles ahead.

Black ocean and black skies. There was no moon. Distances and angles were confusing. Our only stable frame of reference was our own crew compartment, round and comfortable, rushing straight and level through the dark skies.

There was order and precision on the flight deck of the Lockheed-built Air Force C-141 transport jet. The two pilots faced an impressive bank of instruments, but neither touched the controls. The automatic pilot was flying the plane while the pilots watched.

On the left, a navigator faced a wall of meters and sensors, and on the right the engineer watched an equally large array. In the rear a two-star general stretched back in a comfortable lounge chair, earphones on. Between naps he half-listened to someone talk halfway around the world. In one of the double-deck bunks at the rear, an off-duty crew member slept.

The pilots said they did not like their high-frequency radio, which was their only means to give position reports and to make an emergency call.

Only an hour out of Elmendorf and we could hardly hear the tower, nor they us. Much better was the reception from Guam and the Philippines. Drowning out Elmendorf was a pilot asking the tower at Kadena Air Base in Okinawa how much a room would cost at the VOQ. "Two dollars a night," the tower replied.

"I wonder if that will change his plans," our pilot said. "More than a two-dollar room, we need satellite communications. We can't get through on high frequency," He paused, "Sometimes, I can't reach anyone. Of if I do, I get a priority number to call in, like number 14. Sometimes I have to relay my position by uhf to another plane."

An all-weather landing system is being installed in all the C-141s. With the automatic pilot it will put the plane down on the runway without the pilot's touching the controls.

The navigator's console consists of some 20 avionics systems operated and interpreted by two computers. All the navigator has to do is take a fix with one of his many navigation aids every hour and 20 minutes. With it, he checks the running account of the plane's position that both computers continuously calculate and then readjusts the one he decides is more in error.

The main navigation aid is doppler radar, which continuously furnishes ground speed and drift angle. Through a computer, it presents distance-to-go, cross track and track angle error, wind direction and velocity.

The navigator got his first position fix from a VOR station in Anchorage before leaving the Alaskan coast. Departing the coast, he got another line of position with ADF (automatic direction finder). He then let his doppler-computer complex do the work until he crossed over the small island of St. Paul.

Later, after a check with a Loran C station in Japan, the navigator turned on his search radar. "We'll pick up several islands," he said. "This is where Seaboard Airlines got too close to the Russian chain and was forced down by a Russian fighter."

"In a few minutes we should be exactly 210 miles from the first island, at a bearing of 310 degrees" the navigator said.

A row of dots, "spoking," appeared on the scope. "That's Soviet ground radar picking us up," he explained. Soon two more lines of spoking appeared from the other islands. "I hope we're not keeping them up," he said, measuring off the distance on his map for another fix.

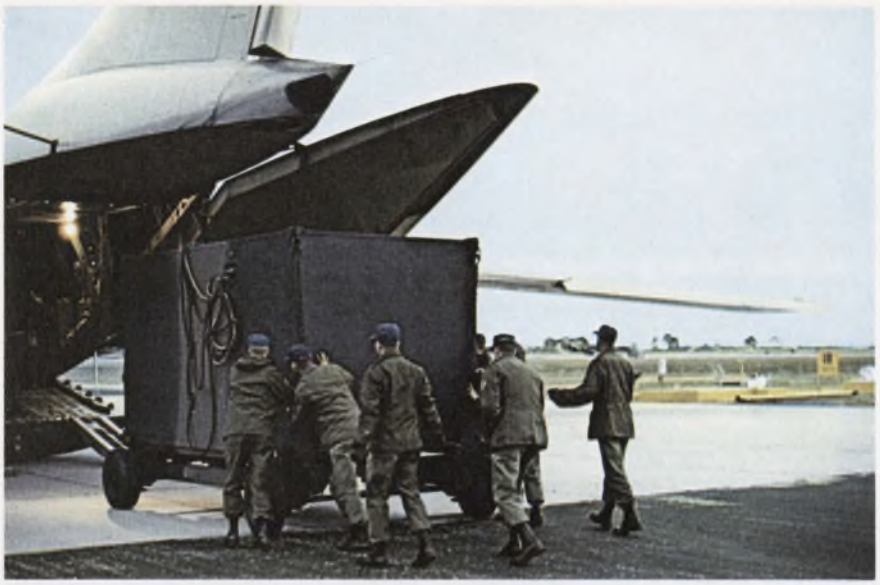
One of the most advanced features of the system is the astro tracker. After taking a reading on a handheld sextant through a blister in the aircraft ceiling, the navigator enters the reading into the computer. In seconds, the computer works out the celestial problem and provides a line of position. "When all the information is stored," the navigator said, "it will work out positions for 58 stars."

Suddenly the ground speed dropped off by 50 knots. "We are in the Japanese jet stream," the navigator explained.

The pilot was flying manually for a change. "Why?"

"The cross wind," he said. "The computer would never believe 20 degrees."

C-141 transport jet that flew troops and equipment to South Korea is getting all-weather landing system that permits hands-off touchdown.



Jack Pot communications relay/command-control system is rolled into C-141 transport jet for flight to Korea. On arrival its four vans, weighing 12 tons, will be put on a specially configured C-130 for the flight.

Airborne communications van carries long and short-haul radios and cryptographic equipment.

ily built headquarters 12 miles from the drop zone near the village of Koju. A small city in itself, the camp was built of new, olive drab tents laid out with military exactness on rolling red hills. Before the exercise, however, it rained and then snowed, changing the red hills to slippery mud (see cover). Communications vans that would serve as the command and control central were pulled or pushed by bulldozers to their hilltop sites.

The day before the air drop, Lt. Col. Morris La Fever, commander of the 304th Signal Battalion of the 8th Army, showed ELECTRONIC DESIGN the communications complex. "During the air drop tomorrow—if this snow ever stops—we will communicate with every element in the exercise through this communications central," he said. "We have about 15 vans grouped in small clusters at five locations."

All five clumps appeared to be within a mile of each other and were visible in spite of the snow. "They are operated and maintained by 500 men," Col. La Fever said.

Rising above the colonel, who stood on the steps of the headquarters van, were waffle-like, square, reflector-dipole antennas, each made up of nine small squares. These small antennas, above all the clusters except the tropo van, revealed that the AN/TRC-24 vhf/fm radio was still the workhorse of Army communications.

"To extend the range of these line-of-sight vhf radios," the colonel said, "we built that little relay station called Tucson, on top of the mountain." He pointed to a low peak some 15 miles away.

In the van a TRC-24 was being discussed. A sergeant, hanging up a telephone, turned to the colonel. "There was trouble wath a TRC-24 terminal at the drop zone," he reported. "One link was down for four minutes, but it's repaired now. A coaxial cable was loose and the antenna was wobbling. It had to be taken down and adjusted."

Do these masts cause much trouble?

"Not often," the sergeant said. "Wind is a factor, though, when you use the full-section mast. You just have to guy them firmly to prevent toppling."

The men are looking forward to getting a replacement for the TRC-24, the GRC-50. The GRC-50 will move the Army communicators from the vhf to the less-crowded uhf band (601 - 999 MHz and 1350 MHz - 1850 MHz), but it won't usher them into the world of solid-state. The GRC-50 is primarily built with tubes. In fact, RCA began design on the radio 14 years ago. The first unit was delivered seven years later, in 1962. Future units are being produced by ARF Products, Inc., of Raton, N. M. and Frequency Engineering Laboratory, Farmingdale, N. J.

The basic transceiver is 17.5 inches long, 16 inches wide, 32.5 inches high and weighs 325 pounds.

One of the few changes the Army has called for over the older RCA model is removal of the primary automatic frequency control circuit and use of the secondary afc unit to do the job, according to Robert Scheafer, technical assistant to ARF's vice president. "The two units were always fighting each other in the field," Scheafer said "switching frequencies. With just one unit, it should work better."

Unlike the TRC-24 antenna mast, which must be put together by hand and then hoisted, the GRC-50 mast can be cranked up. The troops in Korea say they look forward to this luxury, but they're concerned that aligning two horn-shaped antennas will be difficult. Scheafer, however, says the beam width is not narrow and alignment will not be a problem.

When is redundancy redundant?

What is the main problem with vhf now?

"Radio interference," was the unqualified reply of several communicators. "In one small area, 100 feet by 100 feet—enough room for one big antenna—we have about 16 different vhf frequencies in use. And this gives us interference. For the vhf/fm radios, we have about

85 frequencies assigned."

The solution? "Cut down on redundancy."

A sergeant explained: "So we'll never be without a circuit, we often have as many as three vhf channels going at once. Right now, we have trouble with two vhf frequencies going to Tucson, up on the hill. According to the book, the frequency separation is more than adequate. Who knows, maybe it's Korea.

"As for equipment reliability, the only problems we have are tubes burning out and wires and connectors breaking. Last night we had a cable stolen, but I don't think industry can prevent that."

It was not necessary to ask which equipment was the most popular. "Tropo has really proved itself over here," said Lt. Col. Lee Sexton, chief of the communications division and assistant chief of staff of the Eighth Army. "This is only the second time we've actually used it in a real-life situation, but we're convinced it's good."

Tropo's first real-life job in Korea was to transmit communications between Army headquarters in Seoul to Panmunjom during negotiations for release of the USS Pueblo. The circuits via tropo were much superior to those over the vhf radio operating alongside.

"Tropo has less tendency to drift off frequency than vhf," Colonel Sexton said. "And it requires less alignment and readjustment."

He continued: "There is, however, a longer baking period—the set needs longer to warm up. But once it's working, it requires less attention."

He was describing Collins Radio's AN/TRC-129A.

Van for tropo communications, AN/TRC-129A, sits on 2-1/2-ton truck in Korea. It's a little bigger than similar units to provide an hf radio, a teletypewriter and more room for the operators, Collins Radio says.

Asked about the TRC-129 back in Dallas where it was built, Charles Devoll, who has worked "most of his life" on Collins' tropo equipment, said: "The 129 evolved naturally from our earlier TRC-90. When solid-state components and tunnel diodes became available, we put them into a new unit."

Operating in the 4.4-5.0 GHz band, the terminal contains multiplexing and radio equipment to provide 24 full-duplex voice channels with 16 narrowband telegraph channels in one voice channel. Integral metering and test equipment permits changes in frequency and monitoring of system performance without external test equipment. Tuning time is from five to seven minutes. Normally, fixed plant equipment takes from two to four hours to tune.

Frequency synthesizing techniques provide a total of 12,000 discrete transmitting and receiving frequencies from 4400 MHz to 4555.95 MHz with a channel separation of 50 kHz.

Bigger van makes happier troops

"We also added a teletypewriter and an hf radio and made the shelter a little bigger," Devoll said. The shelter is larger than the one used for RCA's similar unit, the TRC-97A, which is operated by the Air Force in Korea. But this is an advantage, according to Devoll: "The added space gives the operators much needed room."

The two Army operators in the 304th Signal Battalion in Korea did have room and said they were happy with the TRC-129. The van was mounted on a two-and-one-half-ton truck. Behind the van two dish antennas rose like giant sunflowers 25 feet apart. If one figures that for an operating frequency of 4700 MHz a wavelength is 1/4 foot, a 25-foot separation puts the incoming signal paths 100 wavelengths apart. As short as this seems, a signal received by one antenna may be much stronger than one received by the other—both on the same frequency. When the outputs from both are combined electronically, the resulting signal is usually strong.

"All we have to do," one of the operators said, "is to choose the correct location for the antennas, especially in mountainous country like Korea. But with a little moving around and testing we find the best spot." Then he added, pointing to Tucson, the vhf relay station on the small mountain top, "At least we don't need that."

The Army would like to use tropo over very short distances. "This can be done," Devoll said, "but the shorter the range, the more multipath, quick-fading problems you have. The solution is to put more emphasis on faster reaction in the electronic combining function."

Colonel La Fever said: "For long distances—for example, to call Okinawa to tell the planes that are waiting for the snow here to stop before they take off—there is the GRC-26D hf/am radio. It's big, requiring a 2-1/2 ton truck; it uses tubes and it's old, but it's the best we've got. Eventually, we'll get the newer GRC-122, which uses the hf GRC-106 radio."

The Army says the 122 has a "reliable range of at least 50 miles, with no skip distance and excellent communications up to 1600 miles." It provides 28,000 discrete tuning points with a 1-KHz spacing. The unit rests on a 3/4-ton vehicle.

The ultimate replacement for hf is communications via satellite. Colonel Sexton said: "We'd like to use satellites in a normal division area, 50 miles by 75 miles. This would enable us to get rid of some of our vhf but more of our hf. Vhf fades, but hf, of course, is worse. We'd have more channels, and more units could use the network."

The Joint Service Program for developing tactical communications satellite terminals for all the services—for use in the air, in vehicles and submarines—is now receiving test terminals. All of them should be delivered by the end of summer. Collins Radio is making units to operate in the uhf range and RCA in the shf range. Testing will probably take a year.

Meanwhile at Strike Command headquarters at MacDill AFB, Fla., an effort unrelated to the official program has produced five terminals. Lt. Col. Harold Johnson, aided by engineers from Electronic Communications, Inc., in nearby St. Petersburg, has built the terminals, which can be used on trucks or in aircraft. They operate with the Lincoln Laboratories' uhf Les-6 experimental communications satellite, which is hanging in synchronous orbit over the equator west of Chile, and the Defense Dept.'s uhf/shf tactical communications satellite, TacSat I, also over the equator a little farther west.

Electronic Communications provided much of the equipment for the terminals from instrumentation from the 23 terminals the company built for the military to experiment with Les-5. These terminals operated on submarines, ships, aircraft and mobile vans. The company is currently building a number of airborne systems to fly in the Air Force's EC-135 Worldwide Airborne Command Post aircraft.

The Electronic Communications terminals operate at 70 MHz, the standard frequency for all Defense Dept. tactical satellite communications. The 60-watt transmitter is all-solid-state, smaller, lighter and more reliable than previous equipment, the company says. Amplifiers produced by Electronic Communications for the Les-5 program are used in the new terminals to bring power levels up to one-kilowatt.

Each terminal can transmit and receive teletype. Each is equipped with a page printer, keyboard, tape reader and tape reperforator.

A special feature of the data demodulation scheme provides a means for rejecting unwanted radio signals in the receiving system. To accomplish this, the data demodulator samples the modulation frequency of all signals received during its normal automatic frequency control search function. If the wanted modulation frequency

The Army in Korea favors tropo communications, like this TRC-129A, over hf and vhf and wants to use it over shorter distances. "This can be done," Collins Radio says, "with more work on the electronic combining function."

Tactical Air Control Center at Osan, still not automated, shows status of all aircraft in South Korea, flying and on the ground. Advances in big wall displays could relieve airmen from having to write backwards.

(within very close tolerances) is not present, the receiver rejects it and continues sweeping until a properly modulated carrier is detected. A sweep stop signal is then generated and the vernier automatic frequency control loop takes over, locking onto the wanted signal and subsequently processing the received signal.

One of Strike Command's five terminals will be deployed overseas for tests next month. The others, in keeping with Strike Command's mission, will be available for sending wherever they are needed.

The teletypewriters are capable of transmitting 400 words per minute but will be used in their 100-wpm mode.

A nondirectional discone antenna is used, "so we won't have to worry about where the satellite is—just so long as it's in line of sight," Colonel Johnson said. A digitized voice modem was provided by Sylvania.

Electronic Communications has successfully built and tested, with Les-6 and a nearby ground station, an experimental, handheld transmitter, operating on a battery. It has used antennas ranging from two inches in diameter to a two-foot log periodic.

Patching is no problem

"Mobile vehicles near tent city can communicate with anyone in or out of the area," Colonel La Fever explained. "We have two RWI [radio wire integration] facilities housed in vans. They contain vhf/fm, uhf/a-m and hf/ssb radios. Anyone in a jeep five miles down the road can ask on his vhf radio to be patched into the telephone switchboard and connected here, or if he's got the priority, to the United States."

Strike Command hopes to update its RWIs soon. "They're about 1-1/2 years old," Colonel Johnson said in his office at MacDill. "There are no hard plans to replace them, but we should start thinking about it." He added: "The RWI should have a uhf built just for it. Airborne ARC-54 radios have been installed, and while good for aircraft, they're not built for the ground. Airborne equipment uses dynamotors—there's a moving parts problem and the maintenance rate is high. Someone should make a transistorized unit for the ground that would put out the same power levels the airborne ARC-54 does."

In the complex in Korea, Colonel La Fever said, "we have 185 telephones and about 3000 calls a day."

"An automated switchboard is badly needed," said Col. Robert C. Doctor, deputy assistant chief of staff for communications and electronics with the Eighth Army in Korea. "A number of transistorized systems have been tested—some at Fort Huachuca, Ariz., at the Army's Electronic Proving Grounds, but we don't have one."

On a brighter note, Colonel Doctor said: "We are getting some new equipment here in Korea, the GRC-103 operating in both vhf and uhf [76 MHz to 1000 MHz and 1350 - 1850 MHz]. This is a fine little tactical radio relay set. It's rapid-moving, not like the MRC-69 [which weighs more than 10 tons, including its shelter and 2-1/2-ton truck]. Two GRC-103s with multiplex and other equipment plus a shelter fit into a one-and-a-quarter-ton truck—all of which weighs about 6400 pounds. The radio can be set up quickly and is easily operated." Its range is between 220 and 1000 MHz; it accommodates up to 24 telephone channels, when used with appropriate PCM equipment, and four channels when used with FDM equipment. Canadian Marconi Co. in Montreal, the developer, is presently the sole-source producer. However, a call for competitive bids has been published.

"Also coming," Colonel Doctor said, "is the MRC-115 radio, vhf extending into uhf [220 MHz - 404.5 MHz]. It's mounted on a 1/4-ton trailer pulled by a jeep." He added: "I don't like a trailer. There's no protection for the crew. I think the radio could be mounted on a one-and-a-quarter ton truck."

View from the air

Strike Command's C-130 Jack Pot, which acted as a communications-relay plane for Focus Retina, would, in a real mission, serve as the command-and-control headquarters for the entire assault operation—especially if the contested ground were held by an enemy. The 12 tons of electronics that Jack Pot carried in four vans warrants a close look, because it is important and, as Colonel Johnson at MacDill says, "it is getting old."

"We've only got three, two of which are four years old and one is three," the colonel noted. "We need a replacement. We have funds earmarked, but we haven't decided what kind of unit it should be.

"Jack Pot requires extensive maintenance. Data display is manual—we use a grease pencil. And we want communications reliability —we want to get through all the time and we want quality circuits. We can't do this with hf radio."

He added: "Besides increased

"Ice cream" parlor at Panmunjom houses communist guards who shout down assorted obscenities at guests.

Infrared Starlight scope on rifle helps American GI and Korean colleague to prevent communist infiltrators from slipping through heavily mined demilitarized zone at night from the mountains of North Korea beyond.

path reliability, we want increased bandwidth."

Jack Pot's four vans can be rolled into a C-130 and be made ready to operate in 30 minutes. On the ground, the vans can be rolled off and set up for operating as a ground station in an hour and a half. The generator operates from jet fuel drained from the C-130 tanks. After 72 hours of ground operation, Strike Command's rules call for flying in a bigger ground station, an AN/TSC-38, to permit Jack Pot to fly back to MacDill to be ready for the next command-and-control mission that comes up.

The communications van contains a switchboard, long- and short-distance radios and cryptographic equipment. It can handle voice and teletypewriter traffic simultaneously between short-range stations while keeping in touch with MacDill or Washington, more than 5000 miles away. The operations van is the command post and teletypewriter center. The accessories trailer contains the antenna equipment, spare parts and two 35,000-BTU air-conditioning units. The generator trailer houses two lightweight 60,000-watt turbine generators, power cables and two collapsible fuel cells.

The communications shelter has one 10-kW radio, two 1-kW and three line-of-sight systems: a uhf/a-m, vhf/a-m and fm. In the air, for long-haul communications, only the 1-kW is activated because of the radiation limitations in the fuselage and the antennas.

"We split the signal, to give us voice and teletype off the same transceiver," Colonel Johnson said. "On the ground, we set up a whip antenna for the 1-kW system and a sloping V antenna for the 10-kW radio. With the big radio, we can get back to MacDill or to the closest station in the worldwide Defense Communications System, which will patch us in to Washington.

"We use the 1-kW systems to the Air Force and Army commanders in the area, and the line-of-sight radio for little outposts around the Jack Pot station."

What the crew says about it

Jack Pot was not operated on the way to Korea; it rode like eight tons of dead weight in the tail of a C-141. In Korea, it was rolled into its specially configured C-130 and was ready to fly. But on the trip over, the Jack Pot B crew (there are three planes and three crews at MacDill: A, B and C) had time to talk.

"We have to do a lot of our own small repairs because there are so few Jack Pots that no one makes spare parts," a sergeant said.

"Also," another crewman spoke up, "we have to work fast because we never know when the plane will be called for another mission.

"We have a bad radio interference problem that we don't understand," the crew chief said. "Suddenly, interference of some kind makes the relays and lights chatter—turn on and off—and the meter indicators move.

"Bad weather may have something to do with it. Or it could be that the antenna coupler is not tuned properly to the antenna."

Another crew member said: "We transmit on a long wire antenna on top of the aircraft, and we receive with the same type antenna on the belly. In bad weather, the signal just wraps itself around and you get all the reflected power on the receiver. We get so much noise sometimes we can't receive the teletypewriter. When we send out 250 watts, we might get 100 of this back in noise."

The problem is serious. Collins Radio, which makes the radio equipment, has not discovered a solution, and the crew hoped Focus Retina would provide clear-cut clues to its real origin.

"The biggest gripe," one crew member said, "is with the hf antenna. It's big and awkward to handle." This is true of the 10-kW hf radio antenna used in Jack Pot on the ground and also with the van that is flown in to replace Jack Pot, the AN/TSC-38.

"To put the antenna up, it takes three men from 45 minutes to one and a half hours. It's about 50 feet high and its two legs are run out about 500 feet each. The mast has to be cranked up, piece at a time, attaching each with a guy line. A small, high-gain antenna for the

Electronics maintenance van is flown into trouble spot, landed, and its sides expanded to create a roomy work area. "We can do as much here in the field as we can back at the base," repairmen say.

Non-directional discone antenna rises above one of five air-transportable satellite communications terminals built and ready for use by the Air Force at MacDill AFB, Fla., with the aid of Electronic Communications, Inc.

10-kW radio would be welcome."

One of the crew said: "We are facing a problem in the switchboard. We have 200 printed-circuit cards, and they're starting to go bad. We're going to get a printed-circuit power checker, but it isn't ready yet."

The crewman added: "In our multiplexer equipment, we were never issued a polar relay checker. Finally, we made one ourselves. We used a tube socket to hold the relay. We then applied a test message to one of the socket pins. We monitored the performance of the relay with an oscilloscope attached to another pin. It worked."

After the mission, the crew discussed the way their equipment had worked.

How bad was the radio interference?

The crew chief paused. "There wasn't any," he said. This didn't mean a cure had been effected. It meant, they knew no more than they had. "The only clue," he said, "was that bad weather may be the culprit. As you know, today was bright and sunny."

Jack Pot had flown for eight hours—above the drop zone, out to sea to come back to simulate the drop plane's route before they arrived. They communicated with every element in the area and relayed line-of-sight vhf communica-

tions between ground troops separated by hills.

Did they talk to MacDill back in Florida?

"No, but we could have," the crew chief said. It just wasn't in our orders." He added: "Everything worked out just the way it was supposed to."

The TSC-38, which would have been flown in to replace Jack Pot, had it been a real mission, is also old—four years. It provides two radios: one 1-kW hf/ssb and one 10-kW hf/ssb, and a telephone switching central. Collins Radio built the -38 and the 38A and Raytheon is building the 38B.

A TSC-38 radio maintenance man who has worked on a number of systems had praise for the 38's linear power amplifier, the 208U-10. "It tunes fast," he said. "The protection circuits prevent damaging the final amplifiers. And it is automatic."

"All of our hf equipment is protected by error correction devices," Colonel Johnson said. "We use a USC-17V variable data micrologic pack that sends out not only teletype information but also another piece of information on another circuit that is mathematically related to the desired information. At the receiver end the two are glued together, and out of white noise you get a good signal.

"An example of hanging on to old equipment after newer units are on the market is the UCC-1 multiplexer we used in our TSC-65 teletypewriter central. The UCC-1 is a four-channel multiplexer. If you want 24 channels, it comes in a box about the size of an office desk. We use three UCC-1s so that makes 12 channels. And it's transistorized. ECI [Electronic Communications, Inc.] in St. Petersburg makes a micro-multiplexer that is far smaller."

When asked about its company-funded unit, a spokesman for Electronic Communications said: "It's the smallest and lightest ever developed, and it has a mean-time between-failure of 10,000 hours.

"Design highlights include universal channel modems, lower sideband or twin-sideband capability, extensive use of microcircuits [particularly in the amplifiers] and redundancy for all active circuits common to more than one channel.

Technical control van provides quality control for all circuits leaving a center, plus retransmitting doubtful channels on another band.

"A 24-channel package occupies less than one cubic foot. A functional building-block mechanical concept makes possible pyramiding system capacity into 132 channels. A typical 132-channel set would have a volume of only 7.4 cubic feet, including signaling, as compared with 52 cubic feet for present day all-solid-state multiplex sets. Ac power consumption for 132 channels, including signaling, is only 250 watts.

"The principal efforts to reduce the size of the channel modem were directed toward the channel bandpass filter. Early in development it was decided to concentrate on a universal channel modem. This led to a 'pregroup-of-one' channel modulation concept which was implemented by a channel bandpass filter designed to provide minimum delay and ripple and to be identical for all channels. This allows the universal channel modem to be used in all frequency slots."

A brand new van that has just arrived at MacDill will undoubtedly become an important element in the Strike Command package. Designed by Senior M/Sgt. C. C. Andrews at MacDill and built by the Lexington Bluegrass Army Arsenal in Kentucky, the van will provide a central testing point for quality control for all circuits.

"The unit, which we call the technical control van, can handle 300 four-wire circuits plus 50 two-wire to four-wire conversion equipments. This gives a total of 350 four-wire circuits plus all the equipment needed for tests," Sergeant Andrews said. "We have 50 line conditioning devices—that is, level adjustment devices and amplifiers. And in our two-wire to four-wire conversion equipment we have 50 channels available using 2600 cycle ringing. We have the 24-channel order wire capability, push button, hands off type operation.

"The man in this van will have control of all circuits in a remote headquarters. To bring the circuits in, there are 26 pairs of cables on the side of the van, and going out there are 18. All appear on the matrix panel, where they can be patched to any jack we want.

"We have remarkable control. If the tropo, for example, should lose its path, we could store the information and then send it out on another circuit. If any radio becomes inoperative, we can reroute the circuit to a radio with a good circuit. There'll be two vans per field unit when we get them into production."

The prototype Andrews was describing at MacDill has since been deployed in the field. ■■

Cimron's DVM outguns the rest!

We don't believe you can match this second generation digital multimeter for speed, accuracy and stability in this price range. It provides you with the greatest number of options, including sample and hold, AC, millivolts and ohms. With the autorange and combined ohms/millivolt converter plugged in, it can autorange through all 6 DC ranges. For systems applications it has a digitizing rate of 1,000 readings per second, but that's only part of the story. It offers 5 printout options, buffered or non-buffered remote control of all front panel functions and unparalleled flexibility for interface design. The handles retract so it can be flushmounted in a rack. Pushbutton controls are mounted directly to the master pc board, minimizing hand wiring for even greater reliability. All IC logic and the newest design features insure that it won't be obsoleted before you turn around. The basic Model 6653A, including DC and DC ratio functions with an accuracy of ±1 digit, is just $1740. And it all adds up to Cimron *customern concern!* Write to Cimron, Department C-140, 1152 Morena Boulevard, San Diego, California 92110.

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INFORMATION RETRIEVAL NUMBER 19

Washington Report

CHARLES D. LAFOND
WASHINGTON BUREAU

FAA wants $2 billion

FAA makes bold 10-year estimate

On the theory, apparently, that if you don't ask, you won't get, Federal Aviation Administration planners are seeking over $2.1 billion for facilities and equipment and over $600 million for research and development over the next 10 years. Their requests are outlined in two booklets published recently by the FAA.

The bulk of the requirements, which are, of course, subject to approval of both the President and Congress, involve long-needed airborne and ground electronic systems. For fiscal 1970, FAA is seeking new funds for facilities and equipment totaling $250 million. Its projections show a jump to $400 million in fiscal '71 and taper off to more than $183 million in 1973 and 1974.

Over the next decade the following electronic expenditures are asked: airport surveillance radar and beacon systems, $192.2 million; collision-avoidance systems, $19.5 million; communications, $217.6 million; en route navigation aids, $60.1 million; FAA aircraft avionics, $13 million, plus $19.5 million for associated ground equipment; long-range radar systems, $196.7 million; and terminal navigation aids, $224.9 million.

NASA awards contracts on lunar vehicle

A lunar "rover"—a vehicle that would propel astronauts about the moon and later make 600-mile trips on its own for operations up to a year in length—is now under study.

Bendix Corp. and Grumman Aircraft have been selected by NASA to perform preliminary system-design and contract-definition studies for the dual-mode lunar vehicle. And the $400,000 competitive contracts will be completed within eight months, according to Marshall Space Flight Center, which will direct the program.

The craft will be designed for two operating modes on the lunar surface—one controlled by a single astronaut and the other, unmanned, under remote control from Earth. The craft will be capable of speeds up to 9 mph.

The design of the vehicle must include a capability to carry 100 pounds of instruments for scientific measurements, a television camera, and both the radio and control instrumentation required for remote operation. Power will be provided by heavy-duty batteries. The craft would collect up to 200 pounds of lunar samples and return to a potential Apollo landing site for rendezvous with future astronauts.

Manned program pushed in NASA budget

In amending President Johnson's fiscal 1970 NASA budget request, the Nixon administration has revealed that it intends to strongly support the nation's manned space program. The $131 million cut in NASA's budget requests has been offset by new increases totaling $86 million so that there is a net loss to NASA of only $45 million.

The funding reductions include $57 million for the Apollo Applications Program (this will cause a one-year deferral, delaying first launch about a half a year); $41 million for unmanned scientific and applications satellite programs—but with no cut in the new Earth Resources Program; $20 million for tracking and data acquisition; and $13 million for advance research and technology projects.

On the positive side, the $86 million increases include $40 million for changes in the three Apollo modules to implement extended periods of lunar exploration, and $46 million for Saturn V launch vehicles.

In describing the budget changes, Dr. Thomas O. Paine, NASA administrator, revealed that he has agreed with Dr. Robert C. Seamans, Jr., Air Force Secretary, on a joint USAF-NASA study of a space-shuttle type vehicle. The two agenices would make an investigation of whether or not a joint development project could produce a system that would meet

Washington Report CONTINUED

the needs of both the Air Force and the space agency.

Dr. Paine indicated that the USAF-NASA study agreement is in fact looking ahead to a next-generation space station. The space shuttle, he disclosed, would be the first step in this direction. The joint study will be completed by the summer, in time for the fiscal 1971 budget request.

School X-ray hazards to be studied

How dangerous is the radiation-producing equipment used in the science courses in public high schools? The U. S. Public Health Service proposes to find out, through a study by its Bureau of Radiological Health. Some 200 schools have been selected for investigation, according to Commissioner Chris A. Hansen. The survey will be conducted as a joint state-federal project.

In a preliminary look at several schools, investigators have found unshielded X-ray units in use, says Hansen, as well as several types of dangerous hand-held fluoroscopes. Equipment to be checked in the survey includes X-ray machines, Van de Graaf accelerators, and microwave and laser transmitters.

Radar research will clue in on storms

A hard look will be taken at severe storms, this spring, by the Environmental Science Services Administration of the Department of Commerce. Radar technology will play a leading role in the six-week study, an annual task performed by the National Severe Storms Laboratory at Norman, Okla. Seven aircraft, eight upper-air sounding stations, and a variety of ground stations will support the effort to improve storm detection and identification techniques.

Vertical storm sampling will be provided by releasing balloon-borne radiosondes every 30 minutes during the storm. These will be tracked by radars while the balloon instruments, rising at over 1000 feet per minute, will transmit the profile of pressure, temperature and relative humidity.

A 1500-ft. television tower near Oklahoma City has been instrumented at six levels to obtain wind and temperature measurements. And a ground weather-radar system developed by the NSSL will record precipitation intensity at 14,400 different locations within a radius of 100 miles of the laboratory. A recently developed Doppler radar will be used as a means of determining thunderstorm rotation.

Other radar research will attempt to define more clearly air movements within a storm center. Aircraft observations and airborne photography will provide data for correlation with radar observations.

ESSA will use an instrumented B-57 aircraft to dispense aluminized chaff just outside the storm areas for radar studies of air flow surrounding the storm centers.

Scientists seek undersea frequency control

To avert interference due to possible crowding of acoustical frequencies used in future underwater research, a committee has been formed to come up with some solutions. The problem is that sonar and other acoustic systems all operate in the range of 5-100 kHz.

At present, systems are used for ranging, ocean-bottom sounding, navigation and sea-floor mapping, and for communications. In addition, acoustic instruments are used to make detailed measurements of undersea conditions. While there is little interference now, scientists are concerned with the need for frequency management if this country expands its oceanographic efforts to any great extent.

In 1967 the National Marine Council asked the U.S. Coast Guard to look into the problem of marine acoustic-system management. In turn, the Coast Guard has sought assistance from the National Academy of Sciences-National Research Council. The result was establishment of the present Committee on Underwater Telecommunications.

There seems to be common agreement that frequency standardization with respect to particular uses is necessary. However, there also seems agreement that voluntary control should be favored over federal regulation.

One approach considered to ease the problem includes the coding of signals so that a number of different devices might use similar frequencies without intolerable interference.

If you've been thinking about
DVMs and counters,
think about this:

nk about promises
es and how they don't
nt to a hill of beans
specs, service, integrity,
h and the resources of
ics giant to back them up.
Fairchild Instrumentation.
t's way to the top.

Model 8220/FM01
500 MHz Frequency Counter, $1,795

Direct reading
7-digit display with memory
Quality IC construction
Convenient operation
Self check

FREQUENCY MODE	
Range	10Hz to 50MHz 50MHz to 500MHz (Prescaler)
Gate Time	0.1sec, 1sec, 10sec
Reads In	kHz with automatically positioned decimal point
COUNT MODE	
Maximum Count Displayed	9,999,999
Maximum Count Rate	50MHz
TIME BASE	
Frequency	1MHz
Aging Rate	<3 parts in 10^7 per week after 1 day continuous operation Guaranteed $< \pm 2$ parts in 10^7 per month after 1 month continuous operation ($< \pm 7$ parts in 10^9 per day)
Temperature Stability	$< \pm 3$ parts in 10^7 over 0°C to +55°C range
INPUT SPECIFICATIONS	
Sensitivity	
10Hz to 50MHz	50mV rms
50MHz to 500MHz	100mV rms
Impedance	
50MHz	Approximately 100kΩ in parallel with 40pF
500MHz	50Ω resistive
GENERAL	
Dimensions	5¼" H x 9" W x 12½" D
PRICE (including FM01)	$1,795.00
Optional Medium Stability 1MHz Oscillator	Price $190.00 Guaranteed $< \pm 1$ part in 10^7 per month ($< \pm 7$ parts in 10^9 per day)
Optional High Stability 1MHz Oscillator	Price $350.00 Guaranteed $< \pm 3$ parts in 10^8 per month ($< \pm 1$ part in 10^9 per day)

Model 7000A
4-full Digit Multimeter, .01%, $1,175

Multifunction – DC volts, DC millivolts, AC volts, ohms, current, BCD
Dual slope integrating
Automatic polarity
Manual and automatic ranging
20% overranging

Specifications:

DC VOLTAGE MEASUREMENTS	
Ranges	1.0000V F.S. + 20% overrange to 1000V F.S. in 4 ranges
Accuracy	± (0.01% reading + 0.01% F.S.) @ 23°C ± 1°C for 3 months
Resolution	100μV (10μV DCV only)
Measurement Rate	~ 5 readings per second
Input Impedance	1V > 1kMΩ 10V > 1kMΩ 100V ~ 10MΩ 1000V ~ 10MΩ
Normal Mode Rejection	> 30dB at 60Hz > 40dB at 120Hz > 50dB at 400Hz
Common Mode Rejection	> 100dB at 60cps
OPTIONS (Options are plug-in cards)	
Option 01-Auto Range	Price $125.00
Option 02-AC Volts Frequency from 10Hz to 100kHz on all ranges	Price $450.00
Option 03-Resistance Ranges	Price $110.00 1.0000kΩ F.S. to 10000kΩ F.S.
Option 04-DC Current Ranges	Price $175.00 1.0000mA to 1000.0mA
Option 05-BCD Output	Price $125.00
Option 06-AC Volts Frequency from 10Hz to 20kHz on all ranges	Price $350.00
Option 07-100mV Range	Price $175.00 Adds 100mV F.S. with 20% overrange
GENERAL	
Dimensions	5¼" H x 8⅜" W x 12" D, Half rack size
PRICE 7000/7000A with options 01, 02, 03, 04 or 07	$1,175.00 $1,895.00
with options 01, 03, 04, 06 or 07	$1,795.00

Model 8050
30MHz Frequency Meter, $650

Period, Multiple period average, Totalize
5-digit display with memory is standard
Crystal controlled time base
True trigger level control
Input impedance: 1MΩ
Reliable IC construction
Self check

Specifications:

FREQUENCY MEASUREMENTS	
Range	DC to 30MHz
Display	kHz with automatically selected decimal point
Gate Times	10sec, 1sec, 0.1sec, 10ms, 1ms
PERIOD AND MULTIPLE PERIOD AVERAGE RANGE	
Single Period Resolution	100μs
Multiple Period Resolution (for 10^3 periods)	500ns
Periods Averaged	1, 10, 10^2, 10^3
TOTALIZE FUNCTION	
Gate is manually opened and closed by function select switch	
TIME BASE	
Aging Rate	$< \pm 2$ parts in 10^6 per month
INPUT SPECIFICATIONS	
Sensitivity	100mV rms sine wave: 300mV peak to peak for pulses Attenuator: DCX1, X30, ACX1: true trigger level control, AC and DC coupled input
Impedance	Approximately 1MΩ shunted by 25pF
GENERAL	
Dimensions	3¼" H x 6⅜" W x 7¾" D (8¼" D including knobs)
Weight	3½ lbs
Power Requirements	115V ± 10%, 60-400Hz, 11 watts
PRICE	
115-60Hz	
1-9	$650.00
10-24	$635.00

Model 7050
3½ Digit Multimeter, 0.1%, $354

Multifunction — DC volts, ohms, current
Dual slope integrating
Display storage (non-blinking display)
Automatic polarity
Input impedance: 1000MΩ

Specifications:

FUNCTIONS	
DC Volts	DC Volts, Ohms, External Current Shunts Available 1.500V F.S. to 1000V F.S. in 4 ranges (1mV resolution)
Input Impedance	1.5V Range: >1000MΩ 15V to 1000V Ranges: ~10MΩ
Common Mode Rejection	Typically >60db DC to 1kHz with up to 1KΩ unbalance
Normal Mode Rejection	Typically >40dB at 60Hz
Resistance	1.500k F.S. to 15.00MΩ F.S. in 4 ranges (1Ω resolution)
ACCURACY FOR 6 MONTHS	
15°C to 35°C	
DC Volts	± (0.1% reading + 1 digit)
kΩ	± (0.2% reading + 1 digit)
MΩ	± (1% reading + 1 digit)
GENERAL	
Dimensions	3¼" H x 6¼" W x 7¼" D
Weight	Less than 4 lbs
Power	115V ± 10%, 50-400Hz, 7 watts
Alternate Power Models:	
Line Voltage	
230V ± 10%, 50-400Hz	Order Model 7050-230
100V ± 10%, 50-400Hz	Order Model 7050-100
PRICE	
1-9	$354.00
10-25	$324.00
ACCESSORIES	
Current Shunts	
Range	150μA F.S. to 1.5A F.S.
PART #93000259	Price $50.00
Tilt Stand/Handle	
PART #93000258	Price $16.00

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PURCHASE ORDER

Take a look at our products. Compare our specs and prices with anybody else. Then buy Fairchild because we'll do a little more for you.

☐ Model 8220—500MHz Direct Reading Frequency Counter. 7-digit display with memory. Price: $1795.00.
(additional specs on reverse side)

☐ Model 7000A—Dual Slope Integrating 4-full Digit Multimeter. 0.01% accuracy. Measures DC volts, DC millivolts (10μv resolution), AC volts, ohms, current, BCD. Price: $1175.00.
(additional specs on reverse side)

☐ Model 8050—30MHz Frequency/period meter (with 8051 pre-scaler, capability extended to 300MHz). Also measures multiple period average and totalizes. Price: $650.00.
(additional specs on reverse side)

☐ Model 7050—Dual Slope Integrating 3½-Digit Multimeter. 0.1% accuracy. Measures DC volts, ohms, current. Price: $354.00.
(additional specs on reverse side)

OK, I looked. I compared. And I decided to buy Fairchild. Please send me the instruments I've checked.

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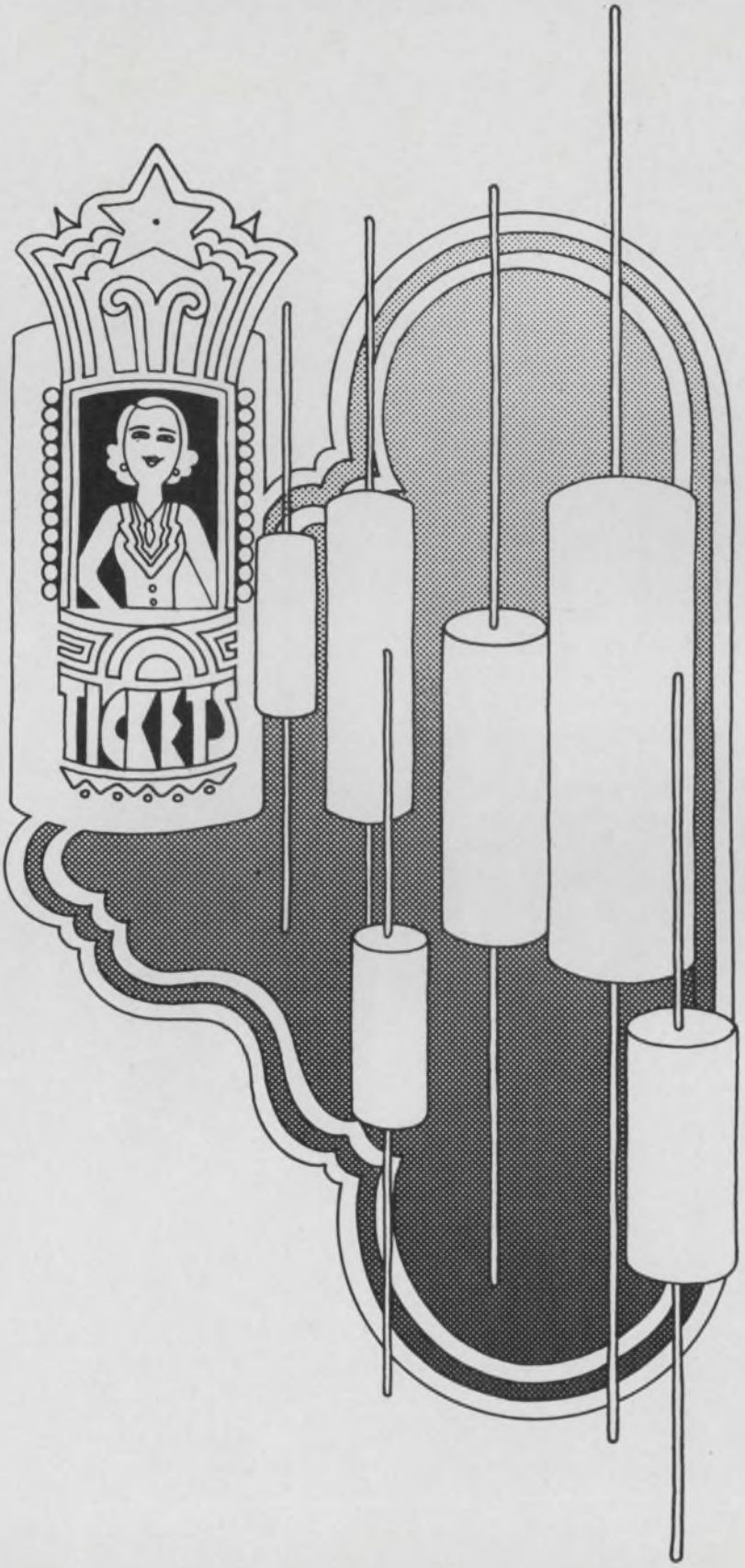
Our Scotchpar® film is playing to capacitor audiences.



Capacitor makers bought more 3M Scotchpar® Brand polyester film this year than last year.

So did motor makers.

And transformer makers.

And wire and cable makers.

This isn't just us thumping our chest. It simply proves again, when you have a great show, you sell more tickets.

And we give you a great show. 3M Scotchpar now comes in a wider variety of thicknesses and types . . . for all these insulating uses. There's even a heat-sealable version (called Scotchpak.®)

We've made it tough, flexible, stubbornly resistant to moisture, solvents. We've given it excellent dielectric strength, and a tensile ruggedness as great as steel.

And we've given you a choice. There's more than one big-time show in the film business these days.

Have you seen the new one?

Write to 3M Company, Film & Allied Products Division, 3M Center, St. Paul, Minnesota 55101 . . . or the Dielectric Materials Desk at the 3M Office nearest you.

Scotchpar®
BRAND POLYESTER FILM

INFORMATION RETRIEVAL NUMBER 20

◄ INFORMATION RETRIEVAL NUMBER 192

Reliability is 756 little dents and one big one.

The big squeeze.

The heelpiece and frame are the backbone of our Class H relay. The slightest squiggle or shimmy out of either and the whole relay is out of whack.

756 tiny dents on the heelpiece, plus one big one on the frame, make sure this'll never happen.

They're the result of planishing, a big squeeze. Planishing is an extra step we go through in forming the pieces to add strength and stability by relieving surface strain. It also makes the parts extra flat.

This takes the biggest press in the industry and the biggest squeeze. Both exclusively ours.

A different kind of coil.

The heart of a relay is the coil. If ours looks different, it's because we build it around a glass-filled nylon bobbin. It costs us more, but you know how most plastic tends to chip and crack.

Also, moisture and humidity have no effect on glass-filled nylon. No effect means no malfunctions for you to worry about. No current leakage, either.

The coil is wound on the bobbin automatically. No chance of human error here.

We didn't forget the solder.

We use a solderless splice. That's because solderless splice connections are sure-fire protection against the coil going open under temperature changes, stress, or electrolysis.

A solderless splice is more expensive to produce, so it's usually found only on the most reliable relays. AE is the only manufacturer to use this method on all of its relays.

Finally, we wrap the whole assembly with extra-tough, mylar-laminated material. A cover is not really necessary here; but why take chances?

Springs and other things.

We don't take any chances with our contact assembly, either. Even things like the pileup insulators (those little black rectangles) get special attention. We precision mold them. Other manufacturers just punch them out.

It makes a lot of difference. They're stronger, for one thing; and because they're molded, there's no chance of the insulators absorbing even a droplet of harmful moisture. Finally, they'll withstand the high temperatures that knock out punched insulators.

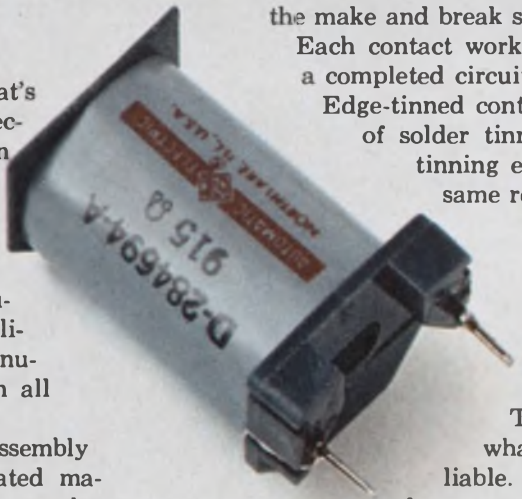
Then there are the contact springs. Ours are phosphor-bronze. Others use nickel-silver. Our lab gave this stuff a thorough check, but found nickel-silver too prone to stress-corrosion. Atmospheric conditions which cause tarnish and ultimately stress corrosion have almost no effect on phosphor-bronze.

Two are better than one.

Our next step was to make sure our contacts give a completed circuit every time. So we bifurcate both the make and break springs.

Each contact works independently to give you a completed circuit every time.

Edge-tinned contact springs save you the job of solder tinning them later. Also, edge-tinning enables you to safely use the same relay with sockets or mounted directly to a printed circuit board. A simple thing, but it takes a big chunk out of the inventory you have to stock.



Etc. Etc. Etc.

There's a lot more to tell about what makes our Class H relay reliable. Now we're waiting to hear from you. Automatic Electric Company, Northlake, Ill. 60164.

AUTOMATIC ELECTRIC

SUBSIDIARY OF GENERAL TELEPHONE & ELECTRONICS

INFORMATION RETRIEVAL NUMBER 21

Letters

Sorry! We misspelled an important 'wurd'

Sir:

Your excellent cover story (ED 7, April 1, 1969, p. 112) on our CTL II circuits was great, except that Fairchild was printed as "Fairfield," We at Fairchild try not to mispel wurds, especially our own fair name.

Jack K. Ayre

Public Relations Dept.
Fairchild Semiconductor
313 Fairchild Drive
Mountain View, Calif.

Nyquist sampling-rate requirement is clarified

Sir:

I wish to comment on the article titled "The FFT Computer: Designer's Missing Link," which appeared in the Dec. 6, 1967 issue of ELECTRONIC DESIGN. On page 26 of the article, the assumption is that the Nyquist sampling-rate requirement is twice as great as the highest frequency of the waveform.

The correct Nyquist rate should be "greater than twice the bandwidth of the waveform." The Nyquist sampling rate requirement has been often misstated in literature as being greater than twice the highest frequency of the waveform; this is only true if the waveform contains all frequencies down to dc. In this case, the highest frequency and the bandwidth have the same value. In the case of high frequency sampling of bandlimited signals, such as radar returns, the carrier frequency may be in the gigacycle region and the individual bandwidths may be reduced by comb filters to be in the kilocycle region. Sampling at a rate greater than twice the comb filter bandwidth (kilocycles) will permit reconstruction of the radar signal.

Henry H. Ho

Hydrotonics
Falls Church, Va.

Take the 'Donald Duck' out of divers' speech

Sir:

Your recent news feature on the Sealab project (ED 2, Jan. 18, 1969) emphasizes the voice communications problems encountered at great depths, particularly the "Donald Duck" effect due to the high partial pressure of helium, which raises the resonant frequency of the human larynx and makes speech practically unintelligible.

A simple solution to the problem, which eliminates the need for complex analyzing equipment, would be to provide the divers with an artificial larynx similar to the type Bell Telephone Laboratories have developed to aid people who have had laryngectomies. The "voice" frequency would be set by the device, not the diver, who would only have to modulate the output of the artificial larynx by mouthing his words, not speaking them. While this approach could be somewhat constraining within the tight confines of a diving mask, it might be perfectly workable within the relatively spacious environment of the Sealab capsule.

R. M. Zilberstein

58 Deerfield Road
Sharon, Mass.

Reader expands slide rule trick

Sir:

I find Mr. Dunbar's Idea for Design on using a slide rule as a handy wire table to be quite useful ("Use Your Slide Rule as a Quick dB Calculator and a Wire Table," ED 4, Feb. 15, 1969, p. 130.) In fact, I have extended this technique for rapidly computing the current-carrying capability of wires in such applications as magnet and transformer windings. My procedure is as follows: proceeding as in Mr. Dunbar's example, set 6 on the "C" scale over 1000 on LL3. Divide the AWG wire size by 10, add 1, and double the resulting number. Set the final result on the "C" scale. The cross-sectional area of the wire in circular mils is the corresponding reading on the LL03 scale times 10^6.

Now, by using the conservative rule that the current-carrying capability of wires in coils is 1 ampere per 1000 circular mils, the maximum current in amperes is the reading on the LL03 scale times 1000.

These techniques offer good accuracy over the range of AWG sizes of usual interest.

Ernest P. Gagnon

Supervisor, Electronic Systems,
United Aircraft Research Labs.,
East Hartford, Conn.

He tests himself and scores 100%

Sir:

With regard to the "Test yourself exercises" in the article "Don't Wait for Brainstorms" (ED 4, Feb. 15, 1969, p. 105): What about $\sqrt{1} = 1$ as an answer to No. 3?

C. P. Means

Bendix Aerospace Systems Div.
Ann Arbor, Mich. 48107

You're right. That is a solution the author suggested, but unfortunately, it was left out of the magazine—Ed.

Among human beings the respect is mutual

Sir:

Every so often an advertiser will deliberately insert a subtle error in his ads, on the premise that the number of letters pointing out the error will provide an index on how widely the ad is read. I suspect you may have been following a similar line of reasoning when you prepared your editorial of 18 January ["Take a tip from an old slogan: 'the customer is always right,'" ED 2, 1969, p 47] to

Push the bar, save some money

It's the Series 7438 counter, part of our new MOD 7400 line. And even though it has push bar reset, it costs less than most rotary reset counters. Because of the simplicity of its design.

The frame is one piece and all working parts affix to it. From the coil to the verge clapper and wheel shaft which seat in molded receptacles. And since the acetal resin frame serves as the reference point for all components in assembly operations, you're assured of close tolerances.

The Series 7438 also offers a multi-purpose frame, and a variety of mounting configurations. It's ideal for test equipment, analytical instruments, control equipment and office machines. (This counter is also available in the nonreset version—Series 7437.)

It's just one of a full line of Veeder-Root counters and controls for data acquisition—mechanical, electrical and electronic. For complete information, write: Veeder-Root, Hartford, Conn. 06102.

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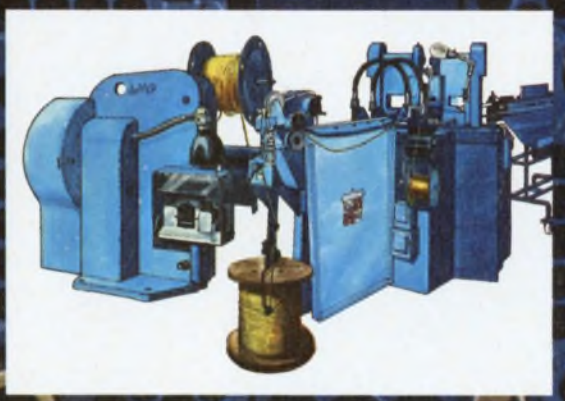
Now, with over 800 items... our "M" series means the most



The most choices. The most combinations.

The most reliable connectors to meet your toughest rack and panel specifications. You can choose from the industry's biggest selection of connector types and sizes, pin and socket combinations and related hardware. You also get the most in savings. Because our connectors and our automatic tooling right in your own plant give you the lowest total installed cost.

Our AMP-O-MATIC★ Stripper-Crimper Machine, for example, strips each cabled wire and crimps on pins or sockets — up to 1000 an hour. And our AMPOMATOR★ Automatic lead-making machine feeds, strips and crimps at speeds up to 12,000 finished terminations per hour. That's what we call ECONOMATION . . . economy, reliability and range of choice.

For complete "M" Series Connector information, write to
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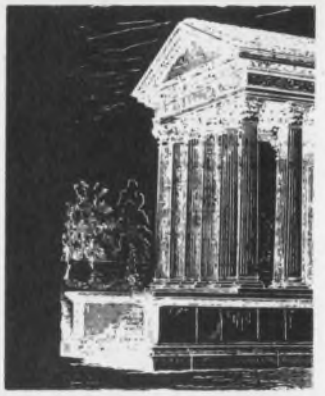
INFORMATION RETRIEVAL NUMBER 23

SWITCH CRAFT FORUM



Ho-hum, another Forum. What have you got to say about "Multi-Switch"® switches that's new and exciting? Frankly, I get tired of just rehashing old product specs.

So do we. But, just the other day we discovered that a long standing customer of ours didn't know about our "Multi-Lite" pushbuttons that can couple two adjacent stations on a "Multi-Switch" switch.

Two stations?

Right. But, maybe we ought to start from the beginning. A single station can accommodate up to 6PDT circuitry. The "Multi-Lite" arrangement mechanically interlocks two adjacent stations for twice the switching capability without adding to the overall height of the switch stack. And, each station has a total of four lamps for sectionalized or redundant lighting, since we have combined two, dual lighted pushbottons. Fig. 1. gives a good example of the flexibility we're talking about.

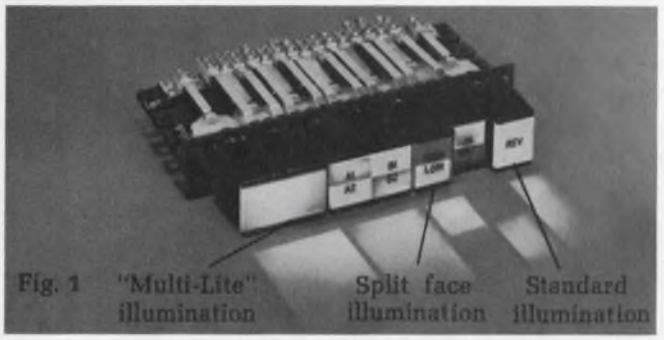


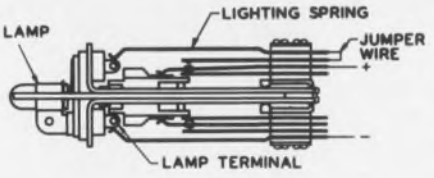
Fig. 1

How does the "Multi-Lite" arrangement tie into the mechanics of your switch? I'm talking about lighting circuitry and switch functions.

Lighting circuitry on the Series 37000 & 38000 littel "Multi-Switch" switches is accomplished by means of a lighting stack of the type shown in Fig. 2. The extra-long lighting springs extends the lighting circuit from the lamp terminal to the rear of the switch for convenient wiring to the N.O. or N.C. contacts on the lighting switch stack. Naturally, direct wiring to the pushbutton lights is another alternate.

Regarding switch functions, the coupled stations can be furnished for interlock, momentary, push-to-lock,

Fig. 2



push-to-release, and all-lock operation. Of course, the all-lock arrangement will require a single button for a release station. (Forum readers may obtain complete info on switch functions from our engineering specification catalog. Just circle the reader service number below.)

"Multi-Switch" REGD. T.M.

The increased size of the "Multi-Lite" pushbutton would be ideal for a cancel bar on our new check-writer, but we'll need smaller pushbuttons for most of the other functions. How much legend information can I get on either type? And what about display screen colors and lamps?

The "Multi-Lite" pushbuttons will accept up to 4 lines of 11, ⅛" high characters per line. The smaller pushbuttons provide a $^{31}/_{32}$" x $^{19}/_{32}$" rectangular area for hot stamping or engraving. This should accommodate any of your legend requirements for each station. We have nine standard display screen colors plus color inserts to give you unlimited color flexibility.

As a convenience, Switchcraft has available, standard industry lamps #328 (6v.), #718 (6v.) or #327 (28v.). Or if you need **zero** power consumption on an "illuminated" switch, why not use the Switchcraft "Glo-Button." Available on certain switches, the "Glo-Button" produces a highly visible illumination change by strictly mechanical means without consuming any power.

I must admit we've learned something, but I suspect the Forum won't be dismissed until we've heard a "life & versatility" pitch.

Our catalog tells all about "life & versatility" and how you can specify a "Multi-Switch" switch anywhere from 1 to 18 stations in a row or up to 100 stations in ganged and coupled matrixes. The almost unlimited adaptability of this switch to countless applications is difficult to express. When we sit down to discuss your requirements in detail, the value of a "Multi-Switch" switch will become more apparent. We've dwelled on lighting pretty much, but the total versatility of these units doesn't begin to "shine" until you can see it solving your particular application problems.

Forum dismissed, but but don't forget that we have extra bound copies of "FORUM FACTS on 'Multi-Switch' Switches", that describes these units, their accessories and applications. Just have your engineers drop us a line on your company letterhead, asking for this handbook. We'll also place their name on our mailing list for TECH-TOPICS, our semi-monthly application engineering magazine. Ten-thousand engineers already receive TECH-TOPICS and tell us that the technical stories are interesting and useful.

SWITCHCRAFT® INC.

5529 North Elston Avenue • Chicago, Illinois 60630

ascertain how many human factors specialists read ELECTRONIC DESIGN. Please be assured that ELECTRONIC DESIGN is highly respected among our fraternity, as we rely heavily on electronic instrumentation in many of our studies.

The more dynamic features of our work are concerned with such studies as decision-making, controls and displays, human information processing, communications, perception, driver performance, systems reliability, etc. In fact the very questions you posed are the ones we work on (How do little kids learn? How does a housewife view the controls on her washing machine? Why do air controllers make mistakes?).

The Human Factors Society has over 1500 members, most of them with advanced degrees in psychology, physics, engineering and related sciences. Although we still attend to "knobs and dials," the major part of our work is more involved, and we hope you will expand your impression of our duties.

With best wishes to the editor of an outstanding journal.

B. H. Finley, H. E. Guttmann, L. V. Rigby, G. C. Shelton, R. G. Webster, A. D. Swain
Sandia Laboratories
Albuquerque, N. M.

Marine Sciences Council updates publication

Sir:

I note that in the ED 1, Jan. 4, 1969 issue you have published another fine article on the potential of the oceans ["Rich, untapped oceans beckon prospectors" pp. 56-59].

On p. 59 there is a reference by Dr. Rechnitzer to a publication produced by the Interagency Committee on Oceanography in December 1965. For your information, the Interagency Committee on Oceanography was formally reconstituted as the Interagency Committee on Marine Research, Education and Facilities, which is one of five committees under the Marine Sciences Council. In addition, the publication cited has been updated and is now called University Curricula in the Marine Sciences.

The latest edition, published in 1967 as ICO #30, is available from our Committee in limited quantities.

I personally have found that the coverage given to marine technology in your magazine has been of great help to us in trying to communicate with the engineering community. I hope, as this emerging area of technology expands, that your coverage will follow.

Edwin B. Shykind
National Council on Marine
Resources and Engineering
Development
Washington, D. C. 20390

Accuracy is our policy

Donald B. Heckman has requested that the following corrections be made in his article "Sense Signal Levels With a Tunnel Diode" (ED 17, Feb. 1, 1969, pp. 48-51):

Page 50, line 34: Change $I_P \leq I_{IN}$ to $I_P > I_{IN}$.

Page 50, line 42: Change $T_P\ R_D$ to $I_P\ R_D$.

Page 51, Col. 1, line 47: Change V_B (off) $\approx$ to V_B (off) max-.

Page 51, Col. 2, lines 6 and 7: The equation should read:

$$R_c = \frac{V}{I_{c\ sat}} \geq \frac{12\ V}{1.4\ \text{mA}}$$

Page 51, Col. 2, lines 17-20: The equation should read:

$$R_{in(min)} = [V_{T\ min} - (V_{P\ max} + I_{P\ max}\ R_D)]/I_{P\ max}$$

$$1.5 - [0.8 + (0.55)\ (0.549)]/0.55 = 2.04\text{K}$$

An error appeared in the logic table of the Idea for Design titled "Two Wires Transmit and Identify Remote Switch Closures" (ED 5, March 1, 1969). The logic table should actually read:

Line	$\overline{A}\overline{B}C$	$A\overline{B}C$	$\overline{A}B\overline{C}$	$\overline{A}\overline{B}\overline{C}$
1	0	1	0	1
2	0	0	1	1

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INFORMATION RETRIEVAL NUMBER 25

'For years I worried about this . . .'

Sir:

May I comment on the editorial, "Technology and politics: Better rapport needed," in the Feb. 15, 1969 issue (ED 4, p. 63)?

There's no doubt as to the misapplication—or lack of application—of our technology. Nor of the need for governmental regulation—at least in some areas, and to some degree. But I'm afraid that much of the blame lies in the lack of cooperation and understanding between areas of technology and science.

To use your own example, noise: We've had experimental data (on test animals) since about 1935, showing that permanent hearing impairment results from too high a noise level for too long a time. Before World War II some of us were trying to sell the idea of noise and vibration (and strain) monitors to provide an inexpensive record of a noise history. Now, at last, we're getting somewhere, largely through labor organization pressure.

Another example—electrical safety: Again, a few of us have worried about this for years, while the need for better grounding procedures, better circuit protection and the like grew rapidly with the growth of electrical loads. In the last few years, largely because of insurance people and the Underwriters' Laboratories, we're making a good start.

In the general field of hospital and medical instrumentation, we've hardly started, though a rush to install supervisory and monitoring equipment has begun. I hope some good planning is being done.

I think we've failed to educate our own groups—technological, scientific, and managerial—in these areas; we have not until very recently done much about educating the public or legislative bodies—and even now it appears that most of that is being done by lobbyists.

For years I worried about this and could do almost nothing, as a professor of engineering. Now as a private consultant, I'm doing something about both noise control and electrical safety—even a little in air pollution. But we've missed the boat, and catching up will require some mighty hard paddling. Wider understanding of the problem might give us a bigger paddle.

Howard C. Roberts
Industrial Physics—
Instrumentation
Urbana, Ill.

Clock that pulse; watch that gate

Sir:

Re: "Design flip-flops from LSI cells" (ED 12, June 6, 1968, pp. 82-86):

In line 3 of the sequence table (Fig. 1b), the author did not note a change in the output of gate 2.

When a Cp (clock pulse) occurs, it is seen at the inputs of gates 1 and 2. Gate 1 will remain in the "1" state, since gate 3 is in the "0" state. But gate 2 is fed by gate 4's "1", gate 1's "1", and the "1" of the Sd (the direct set).

Therefore, gate 2 will have an output "0", but this will not affect gates 4 or 6.

Also, when the clock pulse is lowered (line 4), gate 2 returns to its original state. This means that we will have another gate delay and another line has to be added.

The corrected and added lines should read as below.

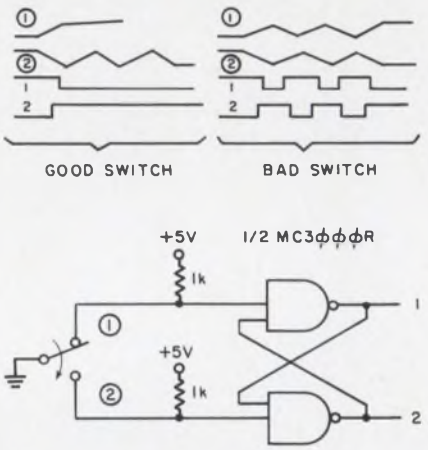
Dale R. Petran
Designer
McDonnell-Douglas Corp.
Long Beach, Calif. 90801

Line	Cp	D1	5(Q)	6(Q)	1	2	3	4	Remarks
3	1	0	0	1	1	0	0	1	Tpd-Stable
4	0	0	0	1	1	0	0	1	Clock-Lowered
4a	0	0	0	1	1	1	0	1	Tpd-Stable

Interested reader bounces back

Sir:

I read with interest the article entitled "Simple circuit eliminates switch contact bounce" in the Jan. 18, 1969, issue of ELECTRONIC DESIGN. We have used the circuit extensively to debounce control switches in the Raytheon Computer 703 and 706 IC computers. (The exact circuit is shown in the accompanying drawing.)



Unfortunately, the topic of excessive switch bounce was not covered in the above-mentioned article. Actually, the circuit produces bounce-free outputs only if the amplitude of the contact bounce is less than the distance between contacts 1 and 2. This case is shown as the "good switch" on the timing diagram (shown below). If the switch strikes both contacts 1 and 2 while bouncng, the output signals will not be bounce-free. This is shown in the diagram as the "bad switch." Therefore, debounce circuits should be selected with this characteristic in mind. And, if the simple dc latches cannot be used, RC networks or one shots must be employed.

J. L. Konsevich
Raytheon Computer
Santa Ana, Calif.

Acknowledgment

The National Radio Astronomy Observatory (see "New Aids For Radio Astronomy," ED 26, Dec. 19, 1968, pp. 25-33) is operated by Associated Universities, Inc., under contract with the National Science Foundation.

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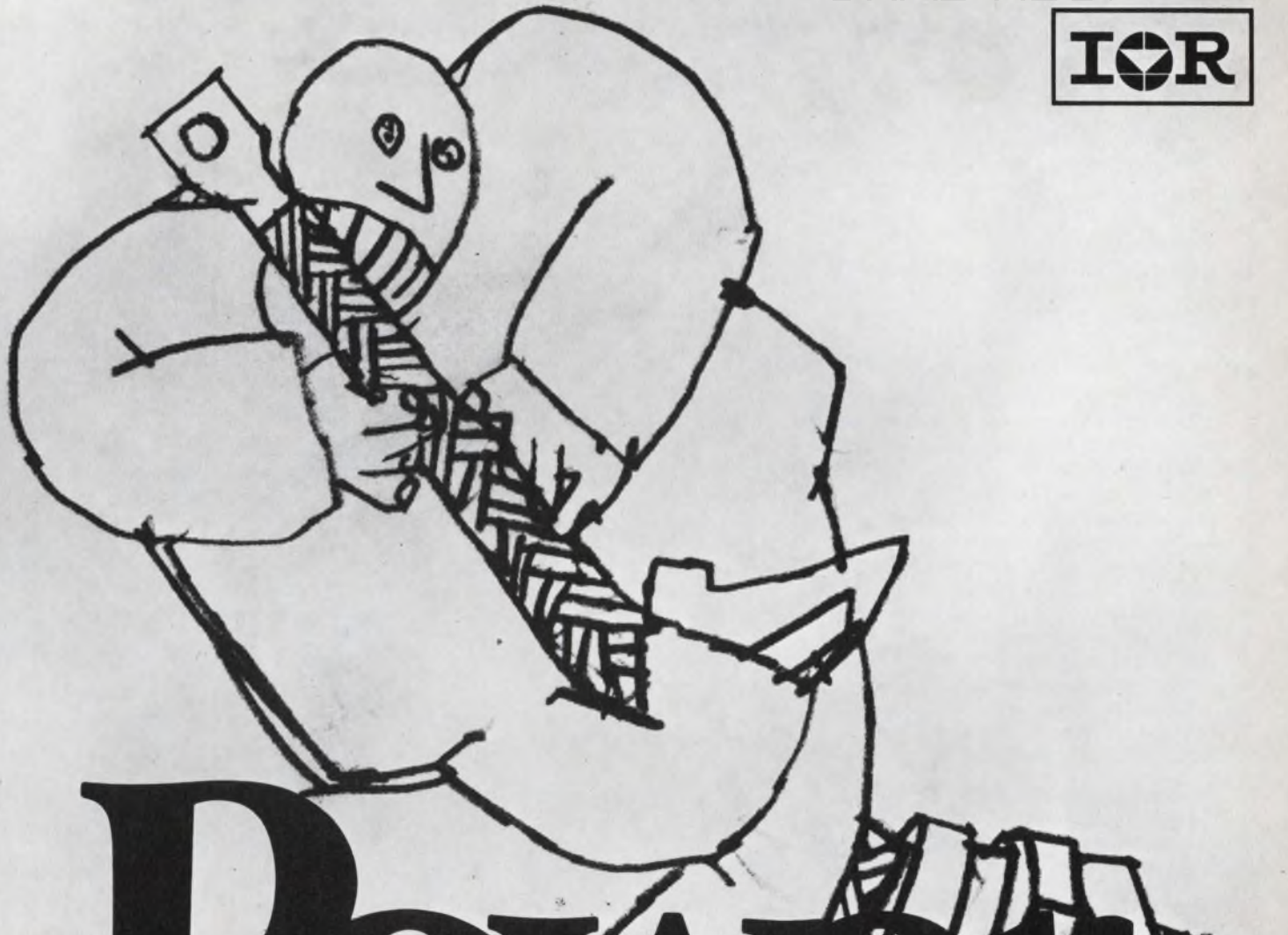

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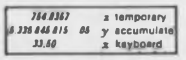

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INFORMATION RETRIEVAL NUMBER 27

098/22

IF x<y

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Covering Korea, a growing trouble spot

Long before the Pueblo was seized, Military Aerospace Editor John F. Mason was following the mounting tensions in Korea. He watched the growing number of border incidents reported without fanfare in the back pages of the daily press until, with the Pueblo, the unpopular subject moved to the front page. After this came more infiltrators from the north, an attempt on the life of President Park, the shooting of U.S. and South Korean guards at a U.N. post near the DMZ, and finally the downing of an EC-121. When the Defense Department invited John to go to Korea to cover Focus Retina, an airborne assault exercise, he jumped at the chance.

After interviewing officials in Seoul, he went to the forward area camp and lived in a tent in a sea of snow and mud. He photographed communications equipment and interviewed the men, watched the 1905-man airdrop and visited other bases in Korea, including the DMZ.

The trip back involved 40 hours without sleep—21 of them in a crowded C-141—and an overnight wait in Washington, D. C. Finally, unshaven, unshowered and wearing a flight jacket, slacks and a black business overcoat, he sank into a seat on a 7:30 A.M. plane for New York. So dazed was he, it took him several moments to catch the barb in the ingenuous-looking stewardess' "Are you going to a wedding, sir?"

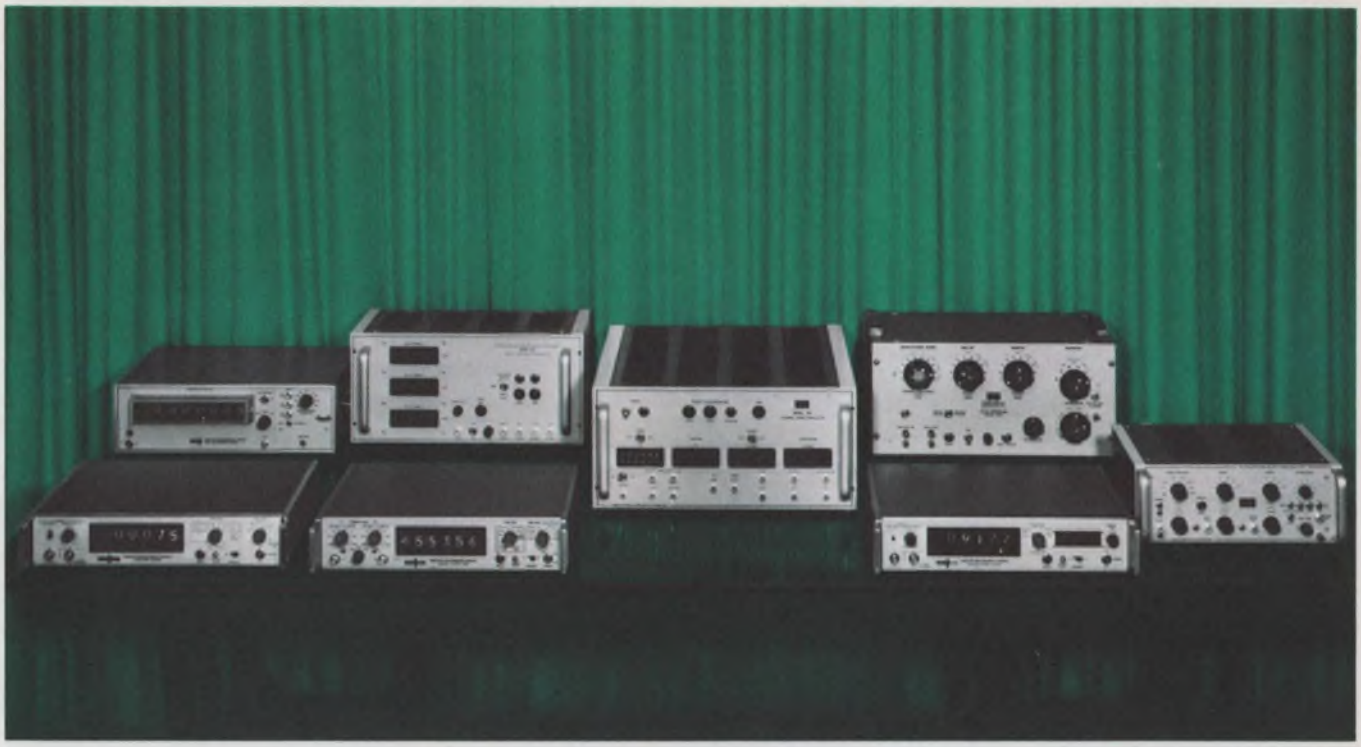
Now turn to Mason's story on p. 34.

Home in Korea for Military/Aerospace Editor John F. Mason (left) was this forward camp, which rain and snow turned to mud.

Pop art from MOS masks

The cover of our 1969 MOS IC Directory, (page 75), was prepared by Art Director Cliff Gardiner from a set of upsize MOS masks, very kindly provided by Motorola Semiconductor Products, Inc., Phoenix, Ariz.

What! Another 8 new counters and pulse generators from CMC?



NO! 8 GREAT CLASSICS

...that can't be beat for price and performance!

You've been hearing a lot about CMC's new state-of-the-art instruments, but maybe you've been overlooking some of our other high-quality precision products. These field-proved and reliable instruments have always been superior to the competition, and now we have improved the performance and reduced the prices of many of them. So before you order something new, check these eight classic instruments from CMC.

Our Model 607 Universal Counter-Timer was a winner at 5 MHz for $1195. Now—with a 20-MHz range for the same money—our new improved version, the Model 609, has got to be an even better buy! Or take a look at the updated version of our 603 counter—the Model 608. It, too, is the same in everything but performance. Now, for $740 you get a 15-MHz range instead of 2.5 MHz. And, if you're looking for a high-frequency instrument with a low-frequency price tag, you can't beat our combination Model 738/735. Here's a fine, field-proved, solid-state frequency meter with a range to 100 MHz that has been selling for $1775. Now we are offering it to you, complete with a $350 heterodyne converter plug-in, for less than the old price of the counter alone—just $1650! Where else can you get 500-MHz performance for such little cost?

So much for counters. But be sure to check our unique target simulator and our pulse and time delay generators. The CMC Model 301 Dynamic Target Simulator is a must for anyone concerned with the calibration or checkout of radar. It's a truly unique off-the-shelf product that may meet your requirements at a fraction of the cost of custom-made special-purpose equipment. And it's almost certain, too, that we have a pulse or time delay generator to meet your needs within your budget.

So for more information and prices on these eight classic instruments from CMC, please turn the page.

CMC — Counters ▪ Pulse Generators ▪ Time Delay Generators ▪ Target Simulators

Eight Classic CMC Instruments

ELECTRONIC COUNTERS
PULSE GENERATORS
TIME DELAY GENERATORS
TARGET SIMULATORS

Newly improved performance and reduced prices make many of these instruments extremely attractive "buys." For full product information, circle the appropriate reader service number.

MODEL 608 **Price: $740.**

15-MHz Electronic Counter—Measures frequency and period, determines frequency ratio and totalizes. Frequency range: 2 Hz to 15 MHz. Period and frequency ratio range: 2 Hz to 2.5 MHz. Period average and multiple ratio: 1, 10 and 100. In-line long-life biquinary display. Five decades are standard, a sixth is optional.

CIRCLE NO. 330

MODEL 609 **Price $1195.**

20-MHz Electronic Counter—Measures Frequency, period, multiple period average, frequency ratio, time interval, and totalizes. Frequency measurement range: 0 to 20 MHz. Period: 0 to 1 MHz. Multiple period average measurement from 0 to 2.5 MHz, from 10^0 to 10^7 periods in decade steps. 1 MHz crystal time base; stability ± 2 parts in 10^7 per month. Six decade in-line biquinary display, automatically positioned decimal point.

CIRCLE NO. 331

MODEL 614 **Price: $1300.**

Preset Multi-function Counter—Extends applications to normalizing and multiplication by any preselected constant. Gate time presets to any interval from 10μsec to 100 seconds. Gate time presets by remote selection. Direct displays as mph, rpm, ms, per N periods, etc. 614 also measures frequency and period and totalizes. Frequency range: 2Hz to 2.5 MHz. Period and frequency ratio ranges: 2 Hz to 500 kHz. Preset count circuitry operates dependably at frequencies through 300 kHz-up to three times as fast as other variable gate time counters. 100 kHz crystal time base; stability $\pm$ 2 parts in 10^6 per week. Standard five decade in-line biquinary display (sixth optional) with automatically positioned decimal point.

CIRCLE NO. 332

MODEL 738 **Price: (with 735) $1650.**

100-MHz Direct Reading, Frequency Meter Frequency from 10 Hz to 100 MHz measured directly. Seven decade in-line readout. Extends to 500 MHz in 50 MHz steps with Model 735 turret-type, positive switching heterodyne converter.

CIRCLE NO. 333

MODEL 301 **Price: $6330.**

Dynamic Target Simulator—Model 301 is a moving target simulator. It is applicable to tracking radars, weapons control systems, or sonar for calibration, production checkout, or operator training.

The standard Model 301 has a target Range from 0 to 1,000,000 feet in one foot increments with 0.1% of setting accuracy. It has a target Velocity from 0.0 to 100,000.0 feet/second in 0.1 foot/second increments with 0.005% of setting accuracy. Target Acceleration can be set from 0.00 to 10,000.00 feet/second/second in 0.01 foot/second/second increments with 0.005% of setting accuracy.

Special versions of the Digital Target Simulator are available with increased accuracies. 301's have also been built with remote-programming capabilities and ruggedized to meet MIL specifications.

CIRCLE NO. 334

MODELS A-10, A-11, A-12 **Prices: from $1070. to $3120.**

Solid-State Delay Generators—A-10 has time delays 0 to 1 sec in 100 nsec increments. Accuracy 0.001% of delay. Jitter less than 1 nsec. Amplitude 10V. Rise time 15 nsec.

A-11 has same features as A-10 with exception of amplitude, 6V and rise time 10 nsec.

A-12 was designed for fail-safe operation in explosives testing or other tests where premature triggering might destroy information. Amplitude, 70V; rise time, 100 nsec.

CIRCLE NO. 335

MODELS B-7B, B-7D, B-7F **Prices: from $695. to $825.**

Basic Pulse Generator—B-7B is a general purpose instrument with repetition rate to 2 MHz and 50V into 50 ohms. Variable rise/fall time control.

B-7D has all specifications of B-7B and simultaneous positive and negative output pulses; separate and independent rise/fall time controls.

B-7F has all B-7B features plus: 2 Hz repetition rate; separate rise/fall time controls; and double pulse output.

CIRCLE NO. 336

MODELS B-14, B-15, B-16 **Prices: from $340. to $595.**

Portable Pulse Generators—Model B-14 is a low cost, portable unit with repetition rate of 20 Hz to 2 MHz. Delay is 0 to 10 msec. Amplitude is 15V into 1k, 8V into 50 ohms. Pulse width of 60 nsec to 10 msec. Rise/fall time is less than 10 nsec fixed.

B-15 has same rise/fall time, delay, and pulse width. Also offers a repetition rate of 5 Hz to 5 MHz.

B-16 offers repetition rate of 20 Hz to 20 MHz. Variable rise/fall times of less than 5 nsec to greater than 200 nsec. Pulse width 15 nsec to 10 msec. Amplitude 10V. Single or pulse pair operation.

Rack mount available for B-14, -15, -16.

CIRCLE NO. 337

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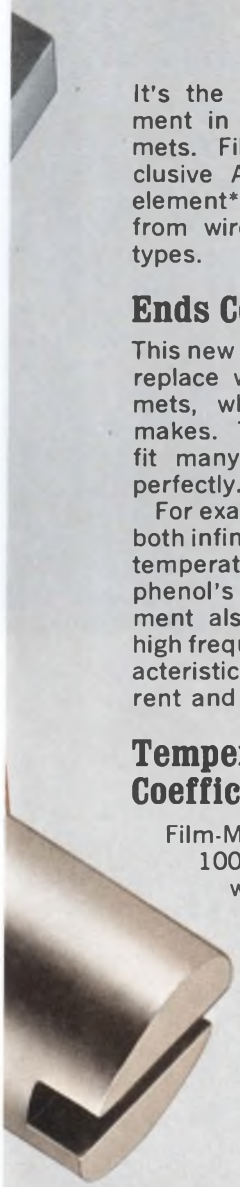
INFORMATION RETRIEVAL NUMBER 29

You know about wirewound trimmers.

You've heard about cermet.

This one's called Film-Met.



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Film-Met should also be your choice for high frequency and pulse applications because of its excellent performance characteristics in these areas. Due to its high frequency characteristics and infinite resolution, Film-Met can be used for exact impedance matching.

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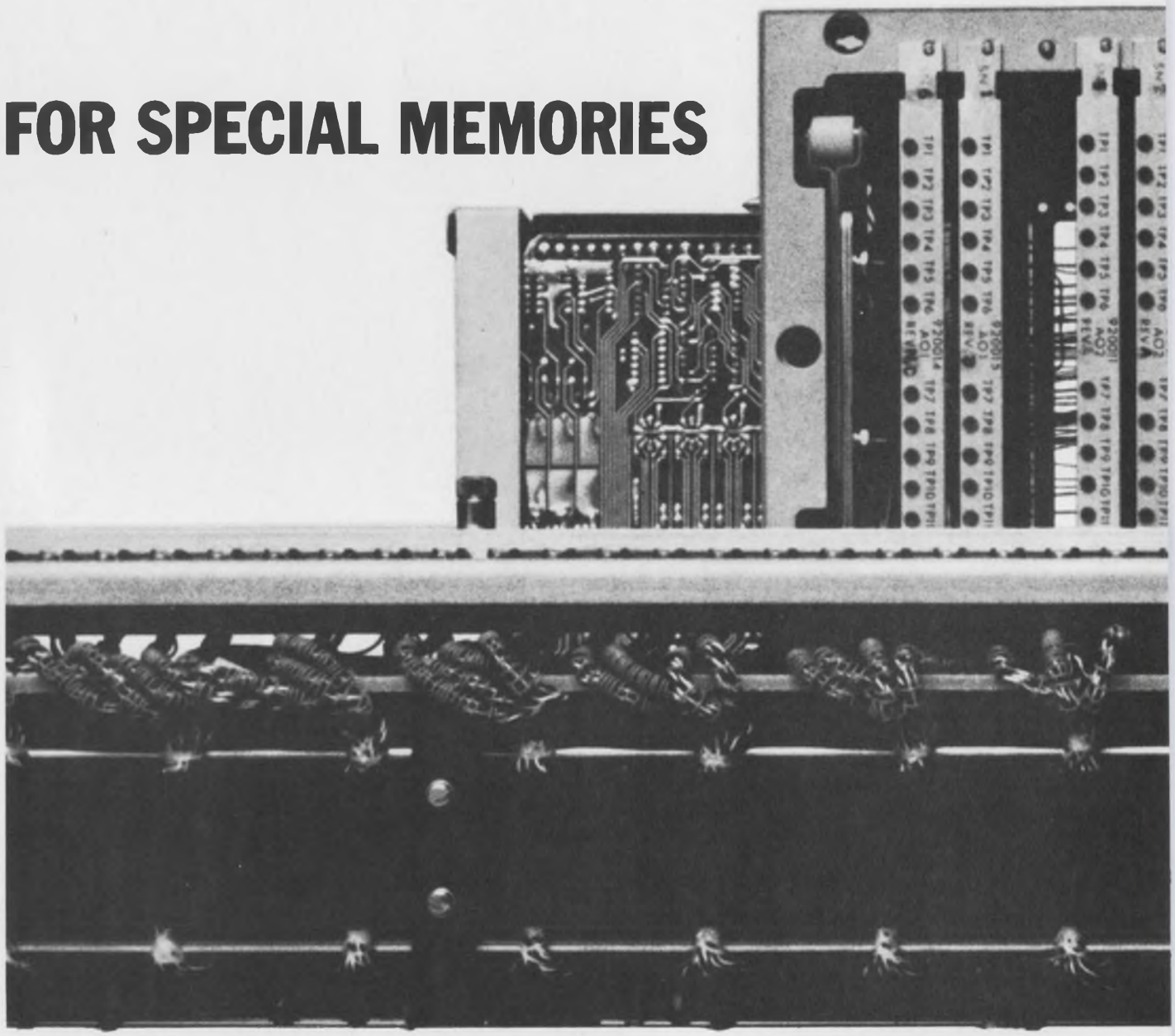
INFORMATION RETRIEVAL NUMBER 47

*U.S. Patent No. 3,353,134; also foreign patents.

FOR SPECIAL MEMORIES



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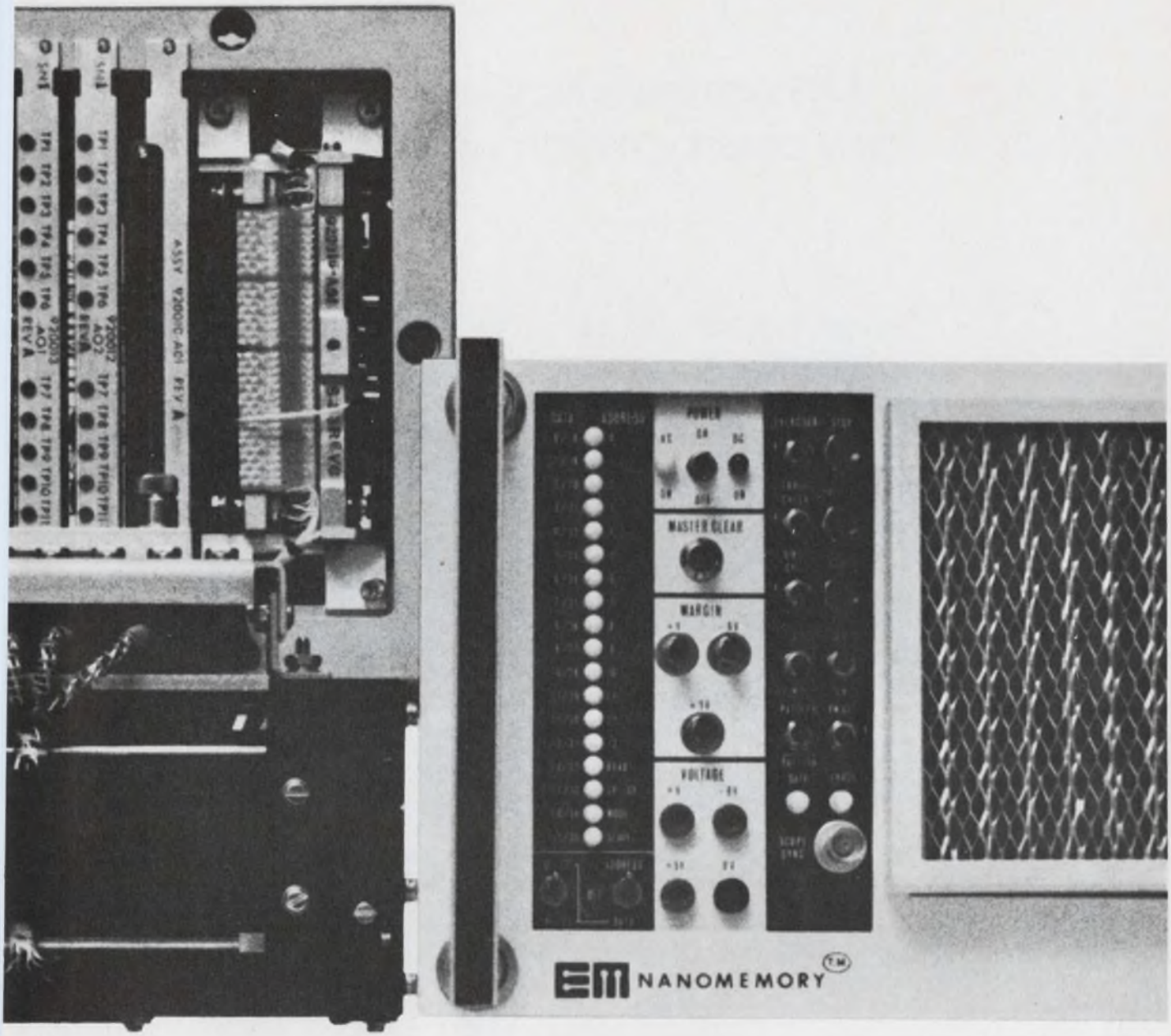
D. And for low cost systems, use our MICROMEMORY™ 1000. You get up to 32k bits of storage with a cycle time of 2.5μs occupying only 400 cubic inches and dissipating 35W. We use a special 3 D technique that both lowers the component count and increases the MTBF. The MICROMEMORY 1000 comes with no case so there are no special cooling requirements, while true random access and a simple I/O interface make for easy integration into your system.

E. If you're starting further back than that, pick one of our stacks. 2½ D or 3 D. Military or commercial. Miniaturized, heated, folded or split into modules. Whatever's exactly right for your application.



F. Or, if you're working right from scratch, we've got cores. 18 to 80 mil magnesium-manganese cores that operate from 0°C to +65°C, with cycle times that range down to less than 600ns. 18 to 30 mil lithium ferrite cores that operate over the full temperature range from −55°C to +125°C. We've made cores for all the major computer programs and most of the satellites. And we're building them for our own systems. Right now and in volume.

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THE MEMORY SQUAD

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ELECTRONIC MEMORIES INC.
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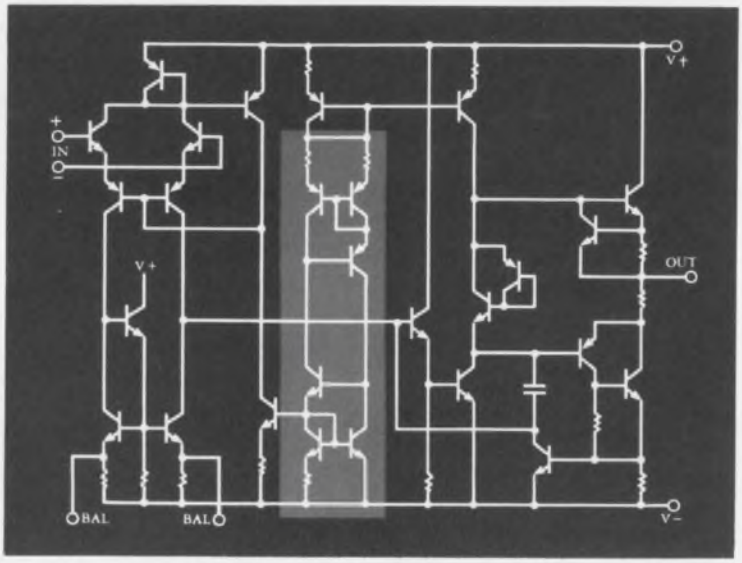
INFORMATION RETRIEVAL NUMBER 48

Op amps, like girls, are pretty much alike.

Now meet Miss Universe.



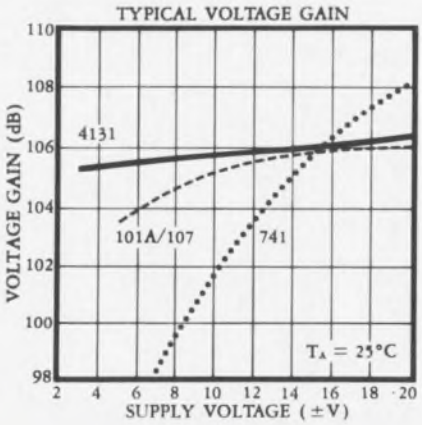
Now, we're not ones to thump the tub much. But this month we're unveiling our RM4131 fully compensated op amp, a pin-for-pin replacement for the good old 709, 101A, 107 and 741, and we felt you ought to know. It's not that the RM 4131 has anything the others don't have. It just has a potfull more of everything.

Figures don't lie.
Here are all the significant figures. Read 'em and weep, you other guys. And they don't even mention things like the RM4131 only needs a 10k ohm trim pot for balancing, not a 5 meg pot like some we could name.

Specification	741	107	4131
Slew rate (v/μs) 2k load	0.5	0.5	2.0
Min. voltage gain (dB) @ ±3 volts	80	80	94
Typ. bandwidth (MHz)	0.8	0.8	4.0
Max. power consumption (mW) @ ±20V, 25°C	120	120	64
Max. bias current (nA) @ 25°C	500	75	50
Max. offset current (nA) @ −55 to 125°C	500	20	20
Max. offset voltage (mV) @ −55 to 125°C	6.0	3.0	3.0

Take slew rate.
Compare our 2.0 v/μs typical slew rate to 0.5 v/μs for the others. And our slew rate is guaranteed 1.5 v/μs minimum across the whole ±3 to ±20-volt supply range, while the others peak sharply at ±15 volts.

And voltage gain.
Time now for a graph. Notice that the 107 shows specified gain only down to ±5 volts. At ±3 volts our RM4131 has 94 dB gain, compared to about 80 dB for the others.



Or bandwidth.
Naturally, frequency response jumps, too. At 25°C, the RM4131 is down 3 dB at 50 kHz, and hits unity gain at 4 MHz. Compare this to 8 kHz and 800 kHz respectively for 107s and 741s. Need we say more? Well, we will anyway.

How come?
Briefly stated, the RM4131 does all these neat things because of (1) that patent-pending current regulator in the gray patch above. It preserves gain at low voltages. And (2) our handy knack with small geometries, which gives frequency response a kick in the back porch. Plus (3) a winning way with latest process technologies, such as our new silicon nitride passivating layer for superb surface stabilities and high-beta transistors.

And how much.
Price for 100-999, full military version (−55°C to +125°C) is $20. Commercial versions are also available. So for evaluation quantities of our optimum op amp, see your Raytheon distributor. Or send for data from the company that's delivering the ideas in linear ICs. Raytheon Semiconductor, Mountain View, California. (415) 968-9211.

RAYTHEON

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EDITORIAL

Smart engineering, the European way

The so-called technology gap—the long lead that the American electronics industry has over the European—may be hurting European business, but it may also be creating outstanding designers. Tour some of Europe's big electronics plants and talk to their engineering chiefs—as I did recently—and this conclusion is inescapable.

Why?

B. J. Rechter, head of the industrial equipment division at Phillips-Eindhoven, cuts to the core of the matter when he says: "Limited R&D funds, a relatively small military space market, plus U.S. competition, force the European designer to be more cost-conscious and to design a component or instrument with greater sensitivity and refinements. He frequently must design his instrument for more general use."

The American engineer, Rechter indicates, isn't necessarily interested in broad market applications. He may, for example, design a specialized circuit for a heavily funded military program. An extra resistor here or a capacitor there doesn't matter; the circuit is strictly for the military, and economy isn't the overriding goal. The typical European engineer, on the other hand, thinks over carefully every circuit addition before incorporating it into his design. His "specialized" circuit, more often than not, must be adaptable to other applications.

Derek Roberts, head of Plessey Co.'s microelectronics division, notes: "We can't always afford to develop a new process. Rather, we concentrate on one bipolar or monolithic process, get to know it very well and then design around it for a wide variety of applications." This approach, he says, places more emphasis on the circuit designer.

Plessey has a rather unique approach to making sure that its potential customers get the exact microcircuit they want from the company's standard silicon processes.

It offers a three-to-four month course to outside engineers that trains them in the company's silicon technology and layout methods. On completion of the course, the engineer, with the help of Plessey's designers, will have completed a layout with Plessey's process. In effect, he has designed the exact circuit *he* wants to his *own* specs. This approach, says Roberts, gets over the "we-know-how-to-design-your-product problem" so frequently found in industry.

Siemens, Marconi and other European electronics giants have their own tricks for broad-market design. The apparent technology gap is caused more by money and aggressive American management and marketing methods than by differences in engineering know-how. The European designer is just as well-versed in the technology as his American counterpart—and frequently he's forced to be more innovative.

RALPH DOBRINER

New SONY®/TEKTRONIX® portable oscilloscope makes the going .... easier!

The SONY/TEKTRONIX Type 323 Portable Oscilloscope weighs 7 lbs, is 4 1/4 inches high, 8 1/2 inches wide and 10 5/8 inches deep. It operates from self-contained batteries for up to 8 hours. With this compact, lightweight instrument, a user may move from one remote application to another without concern for power connections.

The Type 323 is especially well suited for maintenance of remote microwave installations, mobile communications equipment, aircraft and marine instrumentation, production control equipment, etc.

Batteries are rechargeable overnight (16 hours) by simply plugging the instrument into an AC outlet. The built-in charger will provide a fresh power source for use the next day. The Type 323 may also be powered from DC, 6 V to 16 V, up to 4.5 watts, and 90 to 136 VAC or 180 to 272 VAC, 48 to 440 Hz, up to 14 watts.

This solid-state portable oscilloscope also provides performance!

Bandwidth is 4 MHz at 10 mV/div deflection factor. For low signal level applications, 1 mV/div at 2.75 MHz is provided. Sweep rates are 1 s/div to 5 μs/div, extending to 0.5 μs/div with the X10 magnifier. A single control knob permits automatic or manual level sweep triggering, positive or negative slope. With no input the automatic trigger mode provides a bright baseline reference at all sweep rates. A 6 X 10 (1/4-inch div) internal non-illuminated graticule permits parallax-free measurements.

The Type 323 is designed for severe environments. Performance specifications are maintained within an operating temperature range of —15° C to +55° C. It also passes shock, vibration and humidity tests which simulate environments "portable" instruments are likely to encounter.

Your Tektronix Field Engineer will demonstrate the performance of the Type 323 in your application at your convenience. Please call him or write: Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005.

Type 323 Portable Oscilloscope (including batteries) $925
U.S. Sales Price FOB Beaverton, Oregon

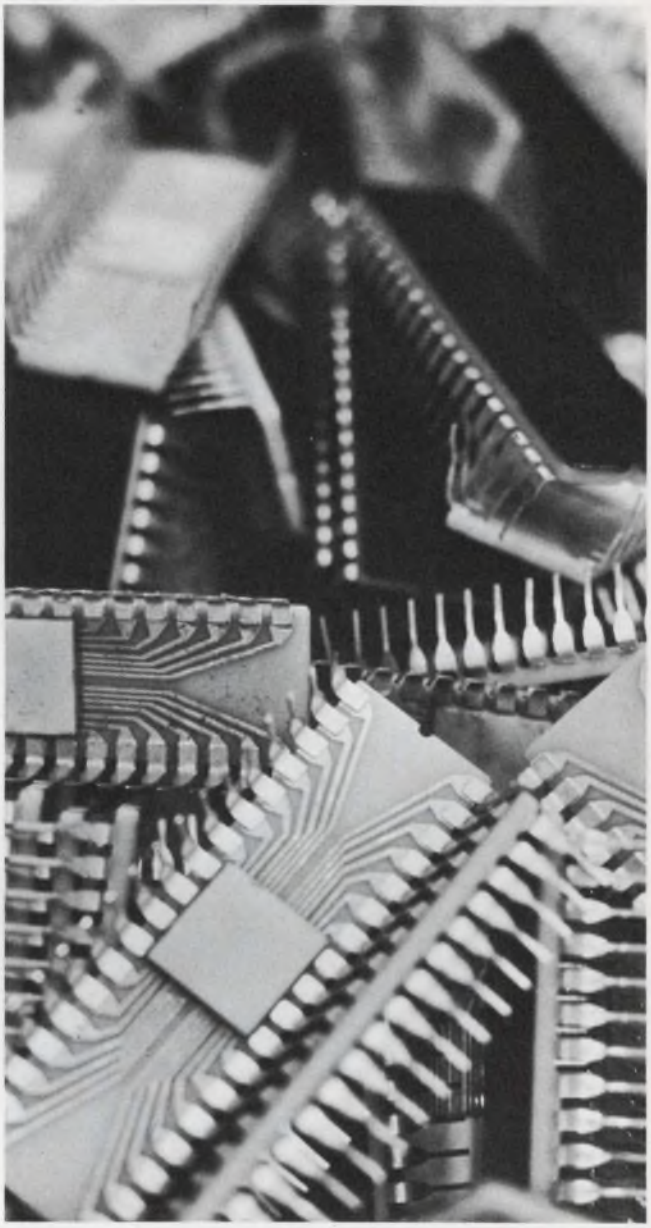
Tektronix, Inc.

committed to progress in waveform measurement

INFORMATION RETRIEVAL NUMBER 50

Technology

Over 200 short summer courses for design engineers or engineering managers. P. 120



Directory of MOS ICs includes all standard products and their manufacturers. P. 75

Also in this section:

The wreckless rechargeable.

Sonotone's Fastback™ battery won't wreck itself. Even under fast charging. Over and over and over again.

Sonotone's new nickel-cadmium sealed cell is called the Fastback because it gets back into action *fast.* In just five minutes, it gets enough charge to start a lawn mower or to operate a camera. So your product goes to work today . . . not tomorrow.

The Fastback's safe, too. In laboratory tests, it's been deliberately overcharged for months at the 3-hour rate. Without overheating or blowing its top. Even after that, it delivers full rated output under load.

And there's no need for expensive, bulky external charging apparatus. All the charging capability is built right into the Fastback. Already, the Fastback's found its place in many consumer products. Should it be in yours? Find out by writing for full specifications and performance charts. Sonotone Corporation, Battery Division, Elmsford, New York 10523.

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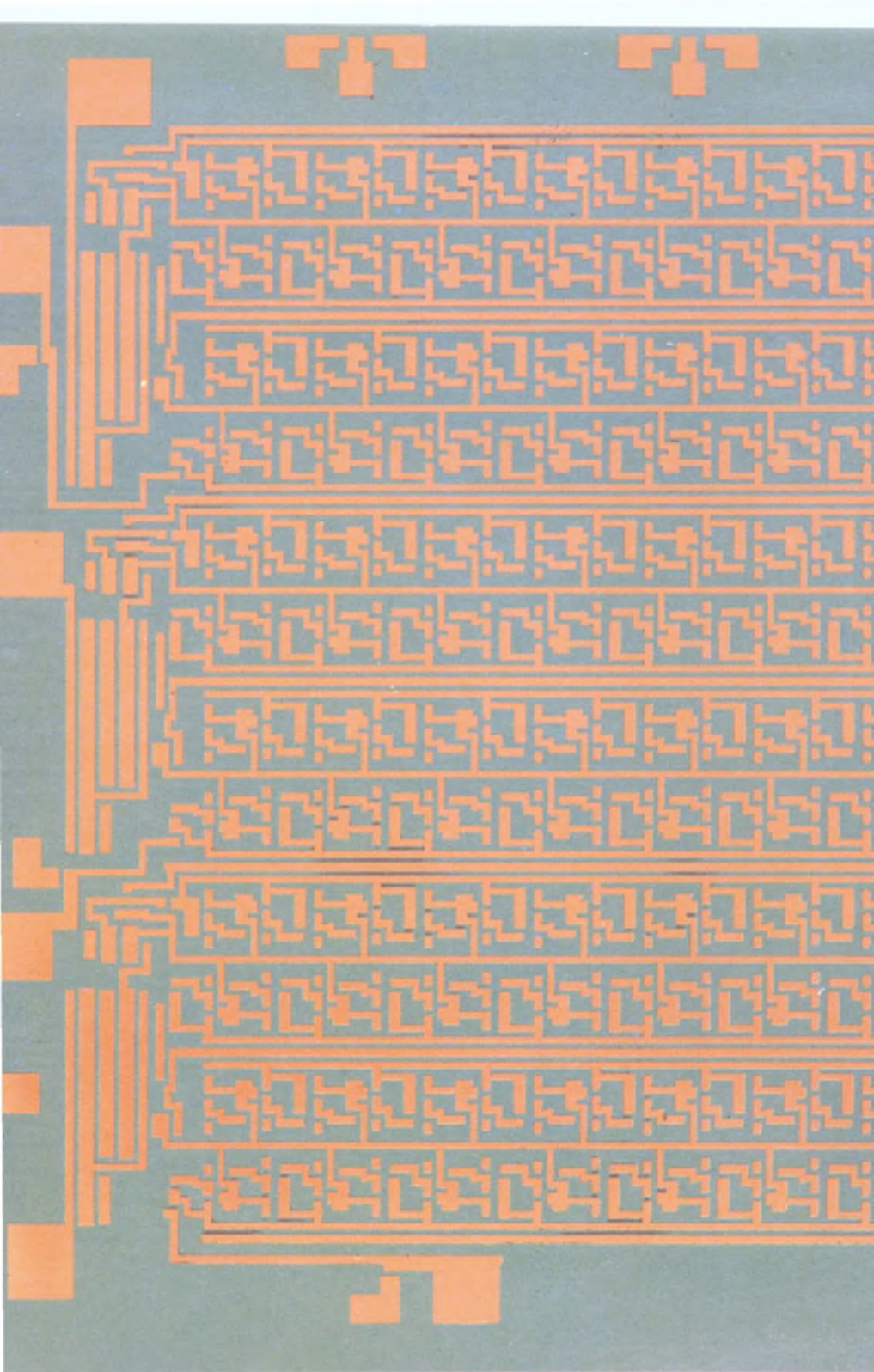

Electronic Design's MOS Integrated Circuit Directory

MOS Integrated Circuits

Raymond Daniel Speer, Microelectronics Editor

Accumulators

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
8-bit parallel	**FCH**	3800	0 to +70 −55 to +85	–	–	–	–	–	–
32-bit serial	**GI**	MEM3032-D2	−55 to +85	0.01 to 2.0	4	−2.0	−10	−2.0	−11
32-bit serial	GI	MEM3032-D5	−55 to +85	0.01 to 5.0	4	−2.0	−10	−2.0	−11
dual 64-bit	**NATL**	MM410	−55 to +125	to 4.0	2	−2.5	−4.5	−1.5	−8.0
dual 64-bit	NATL	MM510	−25 to +70	to 4.0	2	−2.5	−4.5	−1.5	−8.0
triple 60 +4-bit	NATL	MM415	−55 to +125	0.002 to 1.0	–	+4.0	+0.2	+5.0	−9.0
triple 60 +4-bit	NATL	MM515	−25 to +70	0.002 to 1.0	–	+4.0	+0.2	+5.0	−9.0

Adders

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
dual full	**GI**	MEM1000	−55 to +85	–	–	−2.0	−10	−0.5	−11
dual full	**TI**	TMS1A1700AA	−55 to +85	–	–	–	–	–	–

Converters, A/D and D/A

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Package
10-bit	**FCH**	3750	−55 to +85	36-lead DIP
12-bit	FCH	3751	−55 to +85	36-lead DIP
4-channel element	**GI**	MEM1051	−55 to +85	TO-87
10-bit element	GI	MEM5014	−55 to +85	40-lead plug-in
system	GI	S-C-100	0 to +70	–
system	GI	S-C-100A	−55 to +85	–
system	GI	S-C-101	0 to +70	–

See page 102 for key to manufacturer's code listing.

The following MOS ICs are standard products, fully characterized by their manufacturers. Data sheets have been prepared for all, and can be obtained by circling the appropriate reader service number (from the MOS manufacturers list, page 102) or by contacting the manufacturer directly.

Please use caution in applying the figures found in the tables to circuit design. We are not able to completely specify the test conditions under which these figures are obtained, and we suggest that you contact the manufacturers for more complete information. Use the handy information retrieval card!

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
–	–	–	–	–	36-lead DIP	6	8-bit slice of CPU
–	–	–	–27	–	l.p. 10-lead TO-74; TO-87	1-3	–
–	–	–	–27	–	l.p. 10-lead TO-74; TO-87	1-3	–
–	–18	0	–16	0.5 μW/bit	TO-5	3-4	TTL/DTL compatible
–	–18	0	–16	0.5 μW/bit	TO-5	1-2	TTL/DTL compatible
–	–10	+5	–	0.3 per bit	16-pin DIP	6	direct TTL interface
–	–10	+5	–	0.3 per bit	16-pin DIP	6	direct TTL interface

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
–13 ±1	–27 ±1	–	–	55	TO-87	1-3	–
–	–	–	–	–	14-lead flat pack	–	–

Delivery On 1000 Pcs (Weeks)	Description
6	serial or parallel data entry, 0.1% resolution
6	0.1% resolution
1-3	–
2-4	complete logic and analog switching for 10-bit successive approximation A/D converter
2-4	complete 10-bit A/D converter system
2-4	complete 10-bit A/D converter system
2-4	complete 10-bit D/A converter system

Converters, parallel/serial and serial/parallel

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
12-bit serial-in, parallel-out	**AMI**	SP01C	−55 to +125	dc to 2.0	–	−9	−3	−10	0
12-bit serial-in, parallel-out	AMI	SP51C	−25 to +75	dc to 2.0	–	−9	−3	−10	0
8-bit serial-in, parallel-out	**NATL**	MM408	−55 to +125	dc to 2.0	1	−2.5	−4.5	−1.5	−8.0
8-bit serial-in, parallel-out	NATL	MM508	−25 to +70	dc to 2.0	1	−2.5	−4.5	−1.5	−8.0
8-bit parallel-in, serial-out	NATL	MM409	−55 to +125	dc to 2.0	1	−2.5	−4.5	−1.5	−8.0
8-bit parallel-in, serial-out	NATL	MM509	−25 to +70	dc to 2.0	1	−2.5	−4.5	−1.5	−8.0
8-bit parallel-in, serial-out	**SIL**	D108	−55 to +125	0.5 max	1	V_R−0.25	V_R+0.25	–	–

Counters

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
4-stage binary up-down	**GI**	MEM1050	−55 to +85	dc to 0.16	–	−2.0	−10	−1.0	−11
4-stage binary up-down	GI	MEM1050B	−55 to +85	dc to 2.5	–	−2.0	−10	−0.5	−11
4-stage binary up-down with reset	GI	MEM1055	−55 to +85	dc to 2.5	–	−2.0	−10	−0.5	−11
frequency divider	**HUGH**	HRM F/2	0 to +85	0 to 1.0	none	−1 to −2	−6 to −27	0 to −1	−8 to −18
7-stage frequency divider	HUGH	HRM2034	−55 to +125	dc to 5	none	−1 to −2	−6 to −27	0 to −1	−8 to −18
decade to 7-bar display	HUGH	HRM3068	0 to +85	dc to 1	none	0 to +1.5	+4 to +6	0 to 0.5	+5
7-stage binary	**INTSL**	ICM7005	−25 to +70	1 kHz (typ)	–	–	–	0.1 max	1.8 min
BCD decade	**PHLCO**	pL4C01	−55 to +125	0.1	none	−3.0 max	−9.0 min	−2.0 max	−10.0 min
7-stage binary	**RCA**	CD4004	−55 to +125	2.5 (typ)	–	(1)	(1)	0.01 max	9.99 min
7-stage binary	RCA	CD4004T	−55 to +125	2.5 (typ)	–	(1)	(1)	0.01 max	9.99 min

Footnotes: (1) $V_{SS} \leq V_{IN}$, $V_{IN} \leq V_{DD}$ (2) +15 to −0.5 V max

Digital Differential Analyzers

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Package
digital differential analyzer	**AUTO**	DDA1736	−55 to +100	40-lead plug-in
digital differential analyzer	**HUGH**	HRM2032	−55 to +125	24-lead flat pack

See page 102 for key to manufacturer's code listing.

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
−27	–	–	−27	175	22-lead flat pack	4-6	series-shunt output
−27	–	–	−27	175	22-lead flat pack	4-6	series-shunt output
–	−16	0	−16	10 per bit	DIP	4-5	TTL/DTL compatible
–	−16	0	−16	10 per bit	DIP	3-4	TTL/DTL compatible
–	−16	0	−16	6 per bit	DIP	4-5	TTL/DTL compatible
–	−16	0	−16	6 per bit	DIP	3-4	TTL/DTL compatible
15	–	–	–	750	24-lead	4	MOS-bipolar monolithic construction

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
−27 ±1	–	–	–	300	16-lead flat pack	1-3	–
−27 ±1	–	–	–	300	16-lead flat pack	1-3	–
−27 ±1	–	–	–	300	24-lead flat pack	1-3	–
−9 to −27	–	0	none	12	4-lead TO-18	1	–
−6 to −24	−9 to −27	0	none	150	14-lead DIP	4	–
0 to −12	−6 to −24	+5	none	150	24-lead DIP epoxy	4	output switches will standoff 45 V
−4.5 to −5.5	–	–	–	50 μW/stage	TO-78	11	fanout of 10
−12.0 ±2.0	−24.0 ±4.0	–	–	100	24-lead flat pack	4	–
(2)	–	(2)	–	5 μW/pkg	14-lead flat pack	3	former developmental number TA5385
(2)	–	(2)	–	5 μW/pkg	12-lead TO-5 style	stock	–

Delivery On 1000 Pcs (Weeks)	Description
6	contains 310 gates using a low-power four-phase clocking scheme
4	pin compatible & electrically similar to GI MEM5021

Drivers

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
single-phase MOS clock driver	**NATL**	NH0007	−55 to +125	–	–	–	–	–	–
single-phase MOS clock driver	NATL	NH0007C	0 to +70	–	–	–	–	–	–
two-phase MOS clock driver	NATL	NH0009	−55 to +125	–	–	–	–	–	–
two-phase MOS clock driver	NATL	NH0009C	0 to +70	–	–	–	–	–	–
BCD nixie driver	**UNCB**	NN1X1	0 to +85	0.1	none	0 to +1 max	+10 max	–	–

Interface Circuits

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Package
MOS-to-bipolar interface	**AMI**	MX04C	−55 to +125	22-lead flat pack
MOS-to-bipolar interface	AMI	UL03C	−55 to +125	22-lead flat pack

Linear Circuits

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Package
dual differential-input amplifier	**SIL**	L120	−55 to +125	TO-100
RC - coupled audio amplifier	**TI**	TMS7A7000LA	−55 to +85	TO-18

Logic Elements

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
Flip-Flops									
binary	**AMI**	LP54A	−25 to +75	dc to 1.0	–	−3.5	−9.0	−3.0	−9.5
binary	AMI	LP04A	−55 to +125	dc to 1.0	–	−3.5	−9.0	−2.5	−10
dual J-K	**FCH**	3101	−55 to +85	0.25	1	−2.0	−9.0	−1.0	−10
dual J-K	**GI**	MEM1015	−55 to +85	dc to 1.0	–	−2.0	−10	−0.5	−11
$\overline{R}$-$\overline{S}$-T	GI	MEM1005	−55 to +85	dc to 0.5	–	−2.0	−10	−0.5	−11
R-S-T binary	**HUGH**	HRM8047	−55 to +125	dc to 1.0	none	−1 to −2	−6 to −27	0 to −1	−8 to −18
dual J-K	HUGH	HRM2306	−55 to +125	dc to 1.0	1	−1 to −2	−6 to −27	0 to −1	−8 to −18
gated binary	HUGH	HRM2307	−55 to +125	dc to 1.0	none	−1 to −2	−6 to −27	0 to −1	−8 to −18

See page 102 for key to manufacturer's code listing.

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
–	–	–	–	–	TO-5	5	TTL to MOS power translator
–	–	–	–	–	TO-5	4-5	TTL to MOS power translator
–	–	–	–	–	TO-8	5	TTL to MOS power translator
–	–	–	–	–	TO-8	4-5	TTL to MOS power translator
+10	+20	–	none	50	22-lead flat pack	8	directly drives Nixie tubes

Delivery On 1000 Pcs (Weeks)	Description
4-6	–
4-6	–

Delivery On 1000 Pcs (Weeks)	Description
4	monolithic MOS-bipolar, unity gain stable; 20 V/μs slew rate; 20 pA leakage
–	–

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
–10	–	–	–	0.0001 to 15	8-lead TO-5	4-6	low power, R_L is ext.
–10	–	–	–	0.0001 to 15	8-lead TO-5	4-6	low power, R_L is ext.
–	–27	gnd	–	75.0	16-lead DIP	6	–
–13 ±1	–27 ±1	–	–	82 per flip-flop	24-lead flat pack	1-3	–
–27 ±1	–	–	–	70	L.P. 10-lead TO-74	1-3	–
–6 to –24	–6 to –27	0	none	12	8-lead TO	2	–
–6 to –24	–9 to –27	0	–9 to –27	25	22-lead flat pack	4	–
–6 to –24	–9 to –27	0	none	25	14-lead DIP	4	–

Logic Elements (continued)

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
Flip-Flops (continued)									
J-K	**NATL**	MM483	−55 to +125	dc to 2.0	–	−1.5	−7	−1	−8
J-K	NATL	MM583	−25 to +70	dc to 2.0	–	−1.5	−7	−1	−8
dual J-K	**PHLCO**	pL4M01	−55 to +85	.5	none	−3.0 max	−9.0 min	−2.0 max	−10.0 min
binary	PHLCO	pL4M02	−55 to +85	0.4 (typ)	none	−3.0 max	−9.0 min	−2.0 max	−10.0 min
dual D-type	**RCA**	CD4003	−55 to +125	4 (typ)	1	(1)	(1)	0.01 max	9.99 min
dual D-type	RCA	CD4003D	−55 to +125	4 (typ)	1	(1)	(1)	0.01 max	9.99 min
Gates									
quad NAND	**AMI**	UL02C	−55 to +125	dc to 1.0	–	−3.5	−9.0	−2.5	−10
expandable NOR	AMI	UL03C	−55 to +125	dc to 1.0	–	−3.5	−9.0	−2.5	−10
gating and storage element	AMI	UL04C	−55 to +125	.001 to 1.0	2	−3.5	−9.0	−2.5	−10
3-input NOR	AMI	LP55A	−25 to +75	dc to 1.0	–	−3.5	−9.0	−3.0	−9.5
3-input NAND	AMI	LP56A	−25 to +75	dc to 1.0	–	−3.5	−9.0	−3.0	−9.5
3-input NOR	AMI	LP05A	−55 to +125	dc to 1.0	–	−3.5	−9.0	−2.5	−10
3-input NAND	AMI	LP06A	−55 to +125	dc to 1.0	–	−3.5	−9.0	−2.5	−10
quad NAND	AMI	UL52C	−25 to +75	dc to 1.0	–	−3.5	−9.0	−3.0	−9.5
expandable NOR	AMI	UL53C	−25 to +75	dc to 1.0	–	−3.5	−9.0	−3.0	−9.5
gating and storage element	AMI	UL54C	−25 to +75	0.01 to 1.0	2	−3.0	−9.0	−2.5	−9.5
dual 5-input	**FCH**	3100	−55 to +85	0.25	–	−2.0	−9.0	−1.0	−10
dual 3-input	FCH	3102	−55 to +85	0.25	–	−2.0	−9.0	−1.0	−10
dual 3-input NOR	**GI**	MEM1002	−55 to +85	–	–	−2.0	−10	−0.5	−11
dual exclusive OR/NOT	GI	MEM1008	−55 to +85	–	–	−2.0	−10	−0.5	−11
quad 2-input NOR	GI	MEM1013	−55 to +85	–	–	−2.0	−10	−0.5	−11
quad 2-input AND	GI	MEM1014	−55 to +85	–	–	−2.0	−10	−0.5	−11
triple NOR	**HUGH**	HRM8036	−55 to +125	dc to 2	none	−2.0	−10	−0.5	−11
triple 3, dual 2 NOR	HUGH	HRM2304	−55 to +125	dc to 2	none	−2.0	−10	−0.5	−11
dual 3-input NOR	**NATL**	MM480	−55 to +125	dc to 3	–	−1.5	−7	−1	−8
dual 3-input NOR	NATL	MM580	−25 to +70	dc to 3	–	−1.5	−7	−1	−8
dual exclusive OR	NATL	MM481	−55 to +125	dc to 2	–	−1.5	−7	−1	−8
dual exclusive OR	NATL	MM581	−25 to +70	dc to 2	–	−1.5	−7	−1	−8
hex 2-input and dual inverter	**PHLCO**	pL4G10AC pL4G10C	0 to +70	C=300 ns (3) AC=125 ns	none	−3.0 max	−9.0 min	−2.0 max	−10.0 min

Footnotes: (1) $V_{SS} \leq V_{IN}, V_{IN} \leq V_{DD}$ (2) +15 to −0.5 V max (3) propagation delay

See page 102 for key to manufacturer's code listing.

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
−10	–	gnd	–	13	TO-5	3-4	
−10	–	gnd	–	13	TO-5	2-3	–
−12.0 ±2.0	−24.0 ±2.0	–	–	125	22-lead flat pack 24-lead DIP	4	–
−12.0 ±2.0	–	–	–	1	TO-5 14-lead flat pack	6	low power
(2)	–	(2)	–	50 nW/pkg	14-lead flat pack	3	former developmental number TA5362
(2)	–	(2)	–	50 nW/pkg	14-lead dual in line ceramic	stock	–
−15	−27	–	–	40	22-lead flat pack	4-6	expandable
−15	−27	–	–	120	22-lead flat pack	4-6	4 inverters plus 4 expanders
−15	–	–	−27	60 @ 1MHz	22-lead flat pack	4-6	precharge outputs
−10	–	–	–	0.0001 to 15	8-lead TO-5	4-6	low power, R_L is ext
−10	–	–	–	0.0001 to 15	8-lead TO-5	4-6	low power, R_L is ext
−10	–	–	–	0.0001 to 15	8-lead TO-5	4-6	low power, R_L is ext
−10	–	–	–	0.0001 to 15	8-lead TO-5	4-6	low power, R_L is ext
−15	−27	–	–	40	22-lead flat pack	4-6	expandable
−15	−27	–	–	120	22-lead flat pack	4-6	4 inverters plus 4 expanders
−15	–	–	−27	60 @ 1MHz	22-lead flat pack	4-6	precharge outputs
–	−27	gnd	–	60.0	16-lead DIP	6	–
–	−27	gnd	–	6.0	10-lead TO-5 16-lead DIP	6	–
−27 ±1	–	–	–	35 per gate	l.p. 10-lead TO-74	1-3	–
−27 ±1	–	–	–	60 per gate	l.p. 10-lead TO-74	1-3	–
−13 ±1	−27 ±1	–	–	13 per gate	16-lead flat pack	1-3	–
−13 ±1	−27 ±1	–	–	14 (cir. 1,2,3) 42 (cir. 4)	16-lead flat pack	1-3	–
−13 ±1	−6 to −27	0	–	10 per gate	14-lead flat pack	4	DTL, TTL compatible
−13 ±1	−6 to −27	0	–	10 per gate	22-lead flat pack	3	DTL to MOS level translators
−10	–	gnd	–	10	TO-5	3-4	–
−10	–	gnd	–	10	TO-5	2-3	–
−10	–	gnd	–	10	TO-5	3-4	–
−10	–	gnd	–	10	TO-5	2-3	–
−25.0 ±1.0	–	–	–	50	24-lead flat pack 24-lead DIP	4	2-MHz operation

Logic Elements (continued)

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
Gates (continued)									
dual 4 plus dual 5-input	PHLCO	pL4G11AC pL4G11C	0 to +70	C=300 ns (3) AC=125 ns	none	−3.0 max	−9.0 min	−2.0 max	−10.0 min
dual 9-input	PHLCO	pL4G12C pL4G12AC	0 to +70	C=300 ns (3) AC=125 ns	none	−3.0 max	−9.0 min	−2.0 max	−10.0 min
dual 3-input NOR plus inverter	**RCA**	CD4000	−55 to +125	–	–	(1)	(1)	0.01 max	9.99 min
dual 3-input NOR plus inverter	RCA	CD4000D	−55 to +125	–	–	(1)	(1)	0.01 max	9.99 min
quad 2-input NOR	RCA	CD4001	−55 to +125	–	–	(1)	(1)	0.01 max.	9.99 min
quad 2-input NOR	RCA	CD4001D	−55 to +125	–	–	(1)	(1)	0.01 max.	9.99 min
dual 4-input NOR	RCA	CD4002	−55 to +125	–	–	(1)	(1)	0.01 max	9.99 min
dual 4-input NOR	RCA	CD4002D	−55 to +125	–	–	(1)	(1)	0.01 max	9.99 min
quad 2-input NOR	**SSS**	SCL5101	−55 to +125	dc to 1	–	−0.3 to +3	+7 to +10	.05	9.95
quad 2-input NAND	SSS	SCL5102	−55 to +125	dc to 1	–	−0.3 to +3	+7 to +10	.05	9.95
dual 3-input NOR	SSS	SCL5103	−55 to +125	dc to 1	–	−0.3 to +3	+7 to +10	.05	9.95
dual 3-input NAND	SSS	SCL5104	−55 to +125	dc to 1	–	−0.3 to +3	+7 to +10	.05	9.95
dual 4-input NOR	SSS	SCL5105	−55 to +125	dc to 1	–	−0.3 to +3	+7 to +10	.05	9.95
dual 4-input NAND	SSS	SCL5106	−55 to +125	dc to 1	–	−0.3 to +3	+7 to +10	.05	9.95
dual 3-input NOR	**TI**	TMS1A1702LA	−55 to +85	–	–	–	–	–	–

Footnote: (1) $V_{SS} \leqslant V_{IN}, V_{IN} \leqslant V_{DD}$ (2) +15 to −0.5 V max (3) propagation delay

Miscellaneous

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Package
dual matched devices	**AMI**	DM01B	−55 to +125	6-lead TO-5
dual matched devices	AMI	DM02B	−55 to +125	6-lead TO-5
dual matched devices	AMI	DM03B	−55 to +125	6-lead TO-5
input/output synchronizer	**AUTO**	IOS1706	−55 to +100	40-lead plug-in
counter timer	AUTO	CT1711	−55 to +100	40-lead plug-in
selector	AUTO	SEL1716	−55 to +100	40-lead plug-in
clock generator	AUTO	CG1726	−55 to +100	40-lead plug-in
CRT numeric character generator	**FCH**	3250	−55 to +85	24-lead DIP
10-bit serial/parallel - parallel/serial converter	FCH	3801	0 to +70 −55 to +85	36-lead DIP

See page 102 for key to manufacturer's code listing.

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
−25.0 ±1.0	–	–	–	50	24-lead flat pack 24-lead DIP	4	2-MHz operation
−25.0 ±1.0	–	–	–	50	24-lead flat pack 24-lead DIP	4	2-MHz operation
(2)	–	(2)	–	10 nW/pkg	14-lead flat pack	3	former developmental number TA5361
(2)	–	(2)	–	10 nW/pkg	14-lead dual in line ceramic	stock	–
(2)	–	(2)	–	10 nW/pkg	14-lead flat pack	3	former developmental number TA5455
(2)	–	(2)	–	10 nW/pkg	14-lead dual in line ceramic	stock	–
(2)	–	(2)	–	10 nW/pkg	14-lead flat pack	3	former developmental number TA5456
(2)	–	(2)	–	10 nW/pkg	14-lead dual in line ceramic	stock	–
+10	–	–	–	50 nW	TO-86	–	Zener protected inputs
+10	–	–	–	50 nW	TO-86	–	Zener protected inputs
+10	–	–	–	50 nW	TO-86	–	Zener protected inputs
+10	–	–	–	50 nW	TO-86	–	Zener protected inputs
+10	–	–	–	50 nW	TO-86	–	Zener protected inputs
+10	–	–	–	50 nW	TO-86	–	Zener protected inputs
–	–	–	–	–	10-lead TO	–	–

Delivery On 1000 Pcs (Weeks)	Description
4-6	V_{GST_1}-V_{GST_2} <50 MV for op-amp buffer, source follower applic.
4-6	V_{GST_1}-V_{GST_2} <100 MV for op-amp buffer, source follower applic.
4-6	V_{GST_1}-V_{GST_2} <150 MV for op-amp buffer, source follower applic.
6	support for DDA 1736
6	support for DDA 1736
6	support for DDA 1736
6	support for DDA 1736
6	7 segment CRT display - BCD input decode & char. matrix, serializer, on chip
8	25 MHz in serial mode

Miscellaneous (continued)

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Package
9-bit parallel parity detector	**GI**	MEM1022	–55 to +85	TO-87
digital differential adder element	GI	MEM5021	–55 to +85	24-lead flat pack
servo adder	GI	MEM5031	–55 to +85	TO-87
2-input ΔY adder	GI	MEM5035	–55 to +85	TO-87
variable modulus counter	GI	MEM5048	–55 to +85	24-lead flat pack
BCD to decimal decoder	**HUGH**	HRM2061	–55 to +125	22-lead flat pack
frequency divider	**MOTO**	MC1124	0 to +75	14-lead dual in line ceramic
dual voltage translator	**NATL**	DM7800	–55 to +125	TO-5
dual voltage translator	NATL	DM8800	0 to +70	TO-5
BCD to decimal decoder	**PHLCO**	pL4G02	–55 to +85	22-lead flat pack 24-lead DIP
2^7 frequency divider	PHLCO	pL4C07AC pL4C07C	0 to +70	14-lead flat pack 14-lead DIP
2^7 frequency divider	PHLCO	pL4C06AC pL4C06C	0 to +70	14-lead flat pack 14-lead DIP
dual complementary pair plus inverter	**RCA**	CD4007	–55 to +125	14-lead flat pack
dual complementary pair plus inverter	RCA	CD4007D	–55 to +125	14-lead dual in line ceramic

Multiplex Switches

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	On Resistance Maximum (Ω)	Input Leakage Maximum (nA)	Signal Levels			
							Input		Output	
							"0" (V)	"1" (V)	"0" (V)	"1" (V)
6-channel	**AMI**	MX02D	–55 to +125	5	150	1.5	–	–	–	–
10-channel	AMI	MX03C	–55 to +125	5	150	1.5	–	–	–	–
4-channel, 50 ohm	AMI	MX04C	–55 to +125	3	50	10	–9	–3	–	–
6-channel	AMI	MX52D	–25 to +75	5	150	1.5	–	–	–	–
10-channel	AMI	MX53C	–25 to +75	5	150	1.5	–	–	–	–
4-channel, 50 ohm	AMI	MX54C	–25 to +75	3	50	10	–9	–3	–	–
dual	AMI	DM01B	–55 to +125	150	1250	1.5	–	–	–	–
dual	AMI	DM02B	–55 to +125	150	1250	1.5	–	–	–	–
dual	AMI	DM03B	–55 to +125	150	1250	1.5	–	–	–	–
dual w/protective diode	AMI	DM05A	–55 to +125	187	250	1.0	–	–	–	–
dual w/o protective diode	AMI	DM06A	–55 to +125	187	250	1.0	–	–	–	–
single w/protective diode	AMI	DD07K	–55 to +125	187	125	1.0	–	–	–	–

See page 102 for key to manufacturer's code listing.

Delivery On 1000 Pcs (Weeks)	Description
1-3	–
2-4	ternary type DDA performing rectangular integration
2-4	shift register content decision unit used in conjunction with the MEM5021
2-4	2-input delta "Y" summer
2-4	binary counter that counts to the base six, ten, or sixteen
4	output switches ⩽500 Ω
–	field-plate diode protection
4-5	TTL to hi-voltage MOS logic levels
4-5	TTL to hi-voltage MOS logic levels
4	used with pL4C01 for decimal indicator
4	3-2-1-1 configuration, 7 parallel outputs
4	serial output only
3	former developmental number TA5388
stock	–

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
–	–	–	–	–	14-lead flat pack	4-6	common source
–	–	–	–	–	22-lead flat pack	4-6	common source
–	–	–	–	–	22-lead flat pack	4-6	series-shunt output
–	–	–	–	–	14-lead flat pack	4-6	common source
–	–	–	–	–	22-lead flat pack	4-6	common source
–25	–	–	–	150	22-lead flat pack	4-6	series-shunt output
–	–	–	–	–	6L - TO-5	2-4	common source
–	–	–	–	–	6L - TO-5	2-4	common source
–	–	–	–	–	6L - TO-5	2-4	common source
–	–	–	–	–	8L - TO-77	2-4	separate sources
–	–	–	–	–	8L - TO-77	2-4	separate sources
–	–	–	–	–	4L - TO-72	2-4	single MUV

Multiplex Switches (continued)

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	On Resistance Maximum (Ω)	Input Leakage Maximum (nA)	Signal Levels			
							Input		Output	
							"0" (V)	"1" (V)	"0" (V)	"1" (V)
single w/o protective diode	AMI	DD08K	−55 to +125	187	125	1.0	–	–	–	–
single w/protective diode	AMI	DD09K	−55 to +125	187	250	1.0	–	–	–	–
low V_T single w/protective diode	AMI	DD10K	−55 to +125	200	125	1.0	–	–	–	–
single w/protective diode	AMI	DD11K	−55 to +125	187	700	1.0	–	–	–	–
Hi g_m single w/protective diode	AMI	DD12J	−55 to +125	248	32	1.0	–	–	–	–
Hi g_m single w/protective diode	AMI	DD13K	−55 to +125	248	32	1.0	–	–	–	–
4-channel	**FCH**	3700	0 to +70 −55 to +125	1.0	270	2.0	+8.0	0	N/A	N/A
6-channel	FCH	3701	0 to +70 −55 to +125	2.0	500	1.0	−20	0	N/A	N/A
8-channel	FCH	3705	−55 to +85	1.0	400	1.0	+5.0	0	N/A	N/A
5-channel (4-channels-common drain)	**GI**	MEM2002	−65 to +125	–	200 typ	−4.0	<−3	>−6	–	–
4-channel (protective diodes)	GI	MEM2003	−65 to +125	–	200 typ	−4.0	<−3	>−6	–	–
4-channel (no diodes)	GI	MEM2004	−65 to +125	–	200 typ	−5.0	<−3	>−6	–	–
4-channel (dual 2-channels)	GI	MEM2005	−65 to +125	–	200 typ	−4.0	<−3	>−6	–	–
3-channel (2-channels-common drain)	GI	MEM2006	−65 to +125	–	200 typ	−4.0	<−3	>−6	–	–
6-channel	GI	MEM2009	−50 to +125	–	400	−1.0	<−2.5	>−6	–	–
6-channel	GI	MEM2017	−50 to +125	–	1000	−0.5	<−3	>−6	–	–
16-channel random access	GI	MEM5015	−55 to +85	–	–	–	–	–	–	–
16-channel random sequential	GI	MEM5116	−55 to +85	–	–	–	–	–	–	–
4-channel	**HUGH**	HRM8014D HRM8114D	−55 to +125	0-1	400	10	–	–	–	–
4-channel−common source	HUGH	HRM8052D	−55 to +125	0-1	400	10	–	–	–	–
5-channel with pull down	HUGH	HRM3210	−55 to +125	0-1	300	10	–	–	–	–
6-channel (5 + 1)	HUGH	HRM3211	−55 to +125	0-1	300	10	–	–	–	–
6-channel	HUGH	HRM3212	−55 to +125	0-1	300	10	–	–	–	–
3-pairs with pull down resistors	HUGH	HRM3213	−55 to +125	0-1	300	10	–	–	–	–
6-channel	HUGH	HRM3203	−55 to +125	0-1	300	10	–	–	–	–
quad dpdt	HUGH	HRM2206	−55 to +125	0-1	300	10	–	–	–	–
4-channel commutator	HUGH	HRM8013	−55 to +125	0-1	600	10	+1.0	+5	N/A	N/A
dual 2-channel commutator	HUGH	HRM8068	−55 to +125	0-1	600	10	+1.0	+5	N/A	N/A
8-channel	**MOTO**	MC1150	0 to +75	0 to 1	500	1000	−2	−10	–	–
dual 4-channel	MOTO	MC1151	0 to +75	0 to 1	500	1000	−2	−10	–	–
4-channel commutator	**NATL**	MM454F	−25 to +70	N/A	250	40	±10	±10	±10	±10

See page 102 for key to manufacturer's code listing.

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
–	–	–	–	–	4L - TO-72	2-4	single MUX
–	–	–	–	–	4L - TO-72	2-4	single MUX
–	–	–	–	–	4L - TO-72	2-4	low voltage drive
–	–	–	–	–	4L - TO-72	2-4	single MUX
–	–	–	–	–	3L - TO-5	2-4	5-ns turn-on
–	–	–	–	–	4L - TO-33	2-4	5-ns turn-on
–35	–35	+8.0	–	75	14-lead flat pack	2	digital or analog MUX available
N/A	N/A	N/A	–	–	14-lead flat pack	2	digital or analog MUX available
–20	–	+5.0	–	200	16-lead DIP	6	digital or analog MUX available
–	–	–	–	–	TO-87	1-3	–
–	–	–	–	–	TO-74	1-3	–
–	–	–	–	–	TO-74	1-3	–
–	–	–	–	–	TO-87	1-3	–
–	–	–	–	–	TO-74	1-3	–
–	–	–	–	900	TO-87	1-3	–
–	–	–	–	300	TO-87	1-3	high drain, source, gate breakdown voltage
–	–	–	–	–	40-lead plug-in	2-4	with address storage and decoding
–	–	–	–	–	40-lead plug-in	2-4	parallel access counter and decoding
–	–	–	–	200	14-lead flat pack 14-lead DIP	1	–
–	–	–	–	200	14-lead flat pack	3	–
–	–	–	–	200	14-lead flat pack	3	–
–	–	–	–	200	14-lead flat pack	3	–
–	–	–	–	200	14-lead flat pack	3	–
–	–	–	–	200	14-lead flat pack	3	–
–	–	–	–	200	14-lead flat pack	3	–
–	–	–	–	200	22-lead flat pack	3	–
–20	–25	+6	none	80	14-lead flat pack	3	inputs DTL, TTL compatible
–20	–25	+6	none	80	14-lead flat pack	3	inputs DTL, TTL compatible
–10	–20	0	–	100	16-pin dual in line ceramic	4	–
–10	–20	0	–	100	16-pin dual in line ceramic	4	–
0	–24	+12	–	–	flat pack	4	hi speed commutation

Multiplex Switches (continued)

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	On Resistance Maximum (Ω)	Input Leakage Maximum (nA)	Signal Levels			
							Input		Output	
							"0" (V)	"1" (V)	"0" (V)	"1" (V)
dual diff MOS	NATL	MM450	−55 to +125	N/A	250	40	±10	±10	±10	±10
4-channel MOS	NATL	MM451	−55 to +125	N/A	250	40	±10	±10	±10	±10
4 MOS xistor pkg	NATL	MM452	−55 to +125	N/A	250	40	±10	±10	±10	±10
dual diff MOS	NATL	MM550	−25 to +70	N/A	250	40	±10	±10	±10	±10
4-channel MOS	NATL	MM551	−25 to +70	N/A	250	40	±10	±10	±10	±10
4 MOS xistor pkg	NATL	MM552	−25 to +70	N/A	250	40	±10	±10	±10	±10
dual DTL/TTL compatible	NATL	MM453	−55 to +125	N/A	250	40	±10	±10	±10	±10
dual DTL/TTL compatible	NATL	MM553F	−25 to +70	N/A	250	40	±5	±5	±5	±5
dual digital multiplex	NATL	MM482	−55 to +125	dc to 2	–	–	−1.5	−7	−1	−8
dual digital multiplex	NATL	MM582	−25 to +70	dc to 2	–	–	−1.5	−7	−1	−8
4-channel analog	**PHLCO**	pL4S01	−55 to +125	–	–	–	+2.0 max	+8.0 max	–	–
10-channel analog	PHLCO	pL4S10	−55 to +125	–	–	–	−6.5 max	–	–	–
16-channel	PHLCO	pL4S16	−55 to +125	–	–	–	−3.0 max	−9.0 max	–	–
4-channel	**RCA**	TA5460	0 to 100	dc to 1	750	–	−5	+5	10 p-p or +5, −5	10 p-p or +5, −5
5-channel	**SIL**	G114L G414L	−55 to +125 0 to 70	>1	1000 1000	0.075 0.075	>V_{GS} −2	<V_{GS} −6	0	±10
5-channel	SIL	G116L G416L	−55 to +125 0 to 70	>1	100 125	0.5 1.0	>V_{GS} −2	<V_{GS} −6	0	±10
6-channel	SIL	G117L G417L	−55 to +125 0 to 70	>1	100 125	0.5 1.0	>V_{GS} −2	<V_{GS} −6	0	±10
6-channel	SIL	G118L G418L	−55 to +125 0 to 70	>1	100 125	0.5 1.0	>V_{GS} −2	<V_{GS} −6	0	±10
6-channel	SIL	G119L G419L	−55 to +125 0 to 70	>1	100 125	0.5 1.0	>V_{GS} −2	<V_{GS} −6	0	±10
4-channel	SIL	G122L G422L	−55 to +125 0 to 70	>1	125	0.5	>V_{GS} −2	<V_{GS} −6	0	±10
4-channel	SIL	G123L G423L	−55 to +125 0 to 70	>1	125	0.5	>V_{GS} −2	<V_{GS} −6	0	±10
4-channel	SIL	G124L G424L	−55 to +125 0 to 70	>1	125	0.5	>V_{GS} −2	<V_{GS} −6	0	±10
2-channel driver/switch	SIL	DG110L DG410L	−55 to +125 0 to 70	>1	125	$I_{D(OFF)}$	0.5	1.3	0	±10
2-channel driver/switch	SIL	DG111L DG411L	−55 to +125 0 to 70	>1	125	1	4.6	1	0	±10
2-channel driver/switch	SIL	DG112L DG412L	−55 to +125 0 to 70	>1	125	1	0.5	1.3	0	±10
4-channel driver/switch	SIL	DG116L DG416L	−55 to +125 0 to 70	>1	125	4	0.5	1.3	0	±10
4-channel driver/switch	SIL	DG118L DG418L	−55 to +125 0 to 70	>1	125	4	4.6	1	0	±10
5-channel driver/switch	SIL	DG123L DG423L	−55 to +125 0 to 70	>1	125	4	0.5	1.3	0	±10
5-channel driver/switch	SIL	DG125L DG425L	−55 to +125 0 to 70	>1	125	4	4.6	1	0	±10
3-channel driver/switch	SIL	DG120L DG420L	−55 to +125 0 to 70	>1	125	3	0.5	1.3	0	±10
3-channel driver/switch	SIL	DG121L DG421L	−55 to +125 0 to 70	>1	125	3	4.6	1	0	±10

See page 102 for key to manufacturer's code listing.

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
–	–22	+12	–	–	TO, flat pack	2-3	commutator or sample & hold applications
–	–22	+12	–	–	TO, flat pack	3-4	commutator or sample & hold applications
–	–22	+12	–	–	flat pack	2-3	commutator or sample & hold applications
–	–22	+12	–	–	TO, flat pack	1-2	commutator or sample & hold applications
–	–22	+12	–	–	TO, flat pack	1-2	hi speed commutation
–	–22	+12	–	–	flat pack	2-3	hi speed commutation
–	–22	+12	–	–	flat pack	6	hi speed commutation
–	–20	+10	–	–	flat pack	6	–
–10	–	gnd	–	13	TO-5	3-4	–
–10	–	gnd	–	13	TO-5	2-3	–
–15	–30	+10	–	50	14-lead flat pack 14-lead DIP	4	500 Ω on resistance
–	–	–	–	250/channel	22-lead flat pack 24-lead DIP	4	250 Ω on resistance
–28.0 ±1.0	–	–	–28.0 ±2.0	150	34-lead flat pack	6	sequential or random
+8	–	–8	–	0.001	TO-116	2	–
–	–	–	–	750	TO-86	4	common drains, separate sources, Zener protection
–	–	–	–	750	TO-86	4	common drains, separate sources, with pull ups
–	–	–	–	750	TO-86	4	common drains, 5 input channels, 1 output channel, pull ups
–	–	–	–	750	TO-86	4	common drains, separate sources, no pull ups
–	–	–	–	750	TO-86	4	3-channel differential
–	–	–	–	750	TO-86	4	2-channel differential with pull ups
–	–	–	–	750	TO-86	4	4-channel multiplexer with pull ups
–	–	–	–	750	TO-86	4	4-channel multiplexer, common drain, pull ups
–	–	–	–	750	TO-86	4	dual spst switch with drivers - pull ups
–	–	–	–	750	TO-86	4	dual spst switch with drivers - pull ups
–	–	–	–	750	TO-86	4	dual spst switch with drivers - pull ups
–	–	–	–	750	TO-86	4	4-channel spst switch with drivers - pull ups
–	–	–	–	750	TO-86	4	4-channel spst switch with drivers - pull ups
–	–	–	–	750	TO-86	4	5-channel spst switch with drivers - pull ups
–	–	–	–	750	TO-86	4	5-channel spst switch with drivers - pull ups
–	–	–	–	750	TO-86	4	3-channel dpst switch with drivers - pull ups
–	–	–	–	750	TO-86	4	3-channel dpst switch with drivers - pull ups

Multiplex Switches (continued)

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	On Resistance Maximum (Ω)	Input Leakage Maximum (nA)	Signal Levels			
							Input		Output	
							"0" (V)	"1" (V)	"0" (V)	"1" (V)
2-channel driver/switch	SIL	DG122L DG422L	–55 to +125 0 to 70	>1	125	3	0.5	1.3	0	±10
1-channel driver/switch	SIL	DG136L DG436L	–55 to +125 0 to 70	>1	125	–	–	–	0	±10
2-channel driver/switch	SIL	DG147L DG447L	–	>1	125	–	–	–	0	±10
2-channel driver/switch	SIL	DG148L DG448L	–	>1	–	–	–	–	0	±10
1-channel driver/switch	SIL	SI3001	–	>1	500	1	–	–	0	±10
1-channel driver/switch	SIL	SI3002 SI3002A	–55 to +125 –55 to +125	>1	200	2	V_R –1	V_R +1	0	±10
6-channel switch	**TI**	TMS1A6009	–55 to +85	–	250	6 (source)	<2.5	>–6	–	–
6-channel multiplexer	**UNCB**	MULT-6	–55 to +125	–	300	0.4 mA	0	–20	–	–

Random-Access Memory

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
dual 64-word–1-bit/word	**ELEC**	EA1400	–55 to +85	1	1 phase	–2	–9	–.5	–10
64-bit static	**FCH**	3530	–55 to +85	0.30	–	–2.0	–9.0	–1.0	–10
32-bit cell	**GI**	MEM5132	–55 to +85	–	–	–	–	–	–
64-bit	**MOTO**	MC1170	0 to +75	0 to 1	0	–2	–11	–1	–12
16-bit (NDRO)	**RCA**	CD4005	–55 to +125	–	–	(1)	(1)	(3)	(4)
16-bit (NDRO)	RCA	CD4005D	–55 to +125	–	–	(1)	(1)	(3)	(4)
256-bit R/W	**TI**	TMS7A4003MC	–55 to +85	–	–	–	–	–	–

Footnotes: (1) $V_{SS} \leq V_{IN}, V_{IN} \leq V_{DD}$ (2) +15 to –0.5 V max (3) "0" dc sense current 20 μA max (4) "1" dc sense current 500 μA min

Read-Only Memory

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
256 by 10	**AMI**	MA01M	–55 to +125	dc to 1.5	–	0.4	4.0	0.4	4.5
2048 by 1	AMI	MB01M	–55 to +125	0.01 to 1.1	2	–	–	–	–
1024-bit	**AUTO**	ROM2206	–55 to +125	–	–	–	–	–	–
256-word–9-bits/word	**ELEC**	EA3000	–55 to +85	1	2	–2	–9	–0.5	–10
1024-bit static	**FCH**	3501	0 to +70 –55 to +85	0.25	–	–2.0	–9.0	–1.0	–10
2048-bit	**NATL**	MM423	–55 to +125	dc to 2	none	+9.3	+3	+10	+1
2048-bit	NATL	MM523	–25 to +70	dc to 2	none	+9.3	+3	+10	+1

See page 102 for key to manufacturer's code listing.

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
–	–	–	–	750	TO-86	4	2-channel dpst switch with drivers & pull ups
–	–	–	–	750	TO-86	4	1-channel spdt switch with driver
–	–	–	–	750	TO-86	4	2-channel spst with drivers & pull ups
–	–	–	–	750	TO-86	4	2-channel spst with drivers & pull ups
–	–	–	–	500	TO-100	–	special function
–	–	–	–	500	TO-100	–	spdt switch with driver
–	–	–	–	900	14-lead flat pack	–	6 sources common
–30	–30	–	–	900 μW	TO-87; flat pack	8	C_{rss} = 1.6 pf C_{iss} = 5.0 pf

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
0 to –28	–24	gnd	–24	120 total	16-lead DIP	8	address may be dc; faster units available
–13	–27	gnd	–	225	16-pin DIP	6	decode & buffering included
–	–27	–	–	–	14-lead flat pack	2-4	–
–15	–30	0	–	250 typ	14-pin dual in line ceramic	4	includes decoding & sensing
(2)	–	(2)	–	100 nW/pkg	14-lead flat pack	3	former developmental number TA5406
(2)	–	(2)	–	100 nW/pkg	14-lead DIP ceramic	stock	–
–	–	–	–	–	40-lead DIP	12	200-ns access time

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
–12	–	+5	–	250	40-lead DIP	4-12	TTL, DTL interface expandable
–	–	–	–	–	–	–	expandable
–	–	–	–	–	40-lead flat pack	6	silicon on sapphire diode array
0 to –28	–	gnd	–24	80 total	24–lead DIP	10-12	address may be dc; faster units available
–13	–27	gnd	–	120	24-lead DIP	8	–
+12	–12	+12	–	250	24-pin DIP	6	256 by 8 or 512 by 4
+12	–12	+12	–	250	24-pin DIP	6	256 by 8 or 512 by 4

Read-Only Memory (continued)

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
256-bit	NATL	MM420	−55 to +125	dc to 1	1	+9.3	+3	+10	+1
256-bit	NATL	MM520	−25 to +70	dc to 1	1	+9.3	+3	+10	+1
1024-bit	NATL	MM421	−55 to +125	dc to 2	none	+9.3	+3	+10	+1
1024-bit	NATL	MM521	−25 to +70	dc to 2	none	+9.3	+3	+10	+1
1024-bit	NATL	MM422	−55 to +125	dc to 2	none	+9.3	+3	+10	+1
1024-bit	NATL	MM522	−25 to +70	dc to 2	none	+9.3	+3	+10	+1
1024-bit	**PHLCO**	PM1024A PM1024	−55 to +125	1 μs 2 μs	A/R only	−3.0 max	−9.0 min	−2.0 max	−10.0 min
1024-bit	**TI**	TMS1A4800MB	−55 to +85	–	–	–	–	–	–
2240-bit	TI	TMS2A4842MH	−55 to +85	–	–	–	–	–	–
2660-bit	TI	TMS2A4880MH	−55 to +85	–	–	–	–	–	–
1024-bit	**UNCB**	ROMIK	−55 to +125	–	none	0 to −2.0 max	−9 min	−1.0 max	−10 min

Shift Registers

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
dual 20-bit	**AMI**	RD02C	−55 to +125	.001 to 1.0	2	−3.5	−9	−2.5	−10
dual 50-bit	AMI	RD05G	−55 to +125	.001 to 1.0	2	−3.5	−9	−2.5	−10
dual 50-bit	AMI	RD05D	−55 to +125	.001 to 1.0	2	−3.5	−9	−2.5	−10
dual 50-bit	AMI	RD07C	−55 to +125	.001 to 5.0	2	−3.5	−9	−2.5	−10
dual 50-bit	AMI	RD07F	−55 to +125	.001 to 5.0	2	−3.5	−9	−2.5	−10
dual 50-bit w/stream select	AMI	RD08D	−55 to +125	.001 to 5.0	2	−3.5	−9	−2.5	−10
dual 50-bit w/stream select	AMI	RD08F	−55 to +125	.001 to 5.0	2	−3.5	−9	−2.5	−10
dual 50-bit	AMI	RD10C	−55 to +125	.001 to 10.0	2	−3.5	−9	−2.5	−10
dual 50-bit	AMI	RD10F	−55 to +125	.001 to 10.0	2	−3.5	−9	−2.5	−10
low V_T dual 50-bit	AMI	RD12C	−55 to +125	.01 to 1.0	2	1.3	3.3	.5	4.0
low V_T dual 50-bit	AMI	RD12F	−55 to +125	.01 to 1.0	2	1.3	3.3	.5	4.0
low V_T dual 50-bit	AMI	RD12H	−55 to +125	.01 to 1.0	2	1.3	3.3	.5	4.0
triple 66-bit	AMI	RD13G	−55 to +125	.001 to 1.0	2	−3.5	−9	−3.0	−10
low V_T 426-bit	AMI	RD15G	−55 to +125	.002 to 2.0	2	1.3	3.3	.5	4.0
low V_T 426-bit	AMI	RD15D	−55 to +125	.002 to 2.0	2	1.3	3.3	.5	4.0

See page 102 for key to manufacturer's code listing.

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
+12	−12	+12	–	250	TO-5	6	–
+12	−12	+12	–	250	TO-5	6	–
+12	−12	+12	–	250	16-pin DIP	6	256 by 4
+12	−12	+12	–	250	16-pin DIP	6	256 by 4
+12	−12	+12	–	250	24-pin DIP	6	256 by 4 or 128 by 8
+12	−12	+12	–	250	24-pin DIP	6	256 by 4 or 128 by 8
−13.0 ±2.0	−25.0 ±3.0	–	A/R −25 ±3	250	24-lead flat pack 24-lead DIP	8	output drives bipolar
–	–	–	–	–	24-lead C-DIP	–	–
–	–	–	–	–	28-lead C-DIP	10	5 by 7 bit character generator
–	–	–	–	–	50-lead C-DIP	–	35 bit character generator
−12	−26	−12	none	170	24-lead flat pack 24-DIP	8	3 dimensional decoding offers 4 organizations

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
−15	–	–	−27	48 @ 1 MHz	22-lead flat pack	4-6	precharge out
−15	–	–	−27	50 @ 1 MHz	10-lead TO-5	4-6	PL5R100 equiv.
−15	–	–	−27	50 @ 1 MHz	14-lead flat pack	4-6	PL5R100 equiv.
−15	–	–	−27	50 @ 1 MHz	22-lead flat pack	4-6	precharge out
−15	–	–	−27	50 @ 1 MHz	12-lead TO-5	4-6	precharge out
−15	–	–	−27	50 @ 1 MHz	14-lead flat pack	4-6	precharge out
−15	–	–	−27	50 @ 1 MHz	12-lead TO-5	4-6	precharge out
−15	–	–	−27	50 @ 1 MHz	22-lead flat pack	4-6	precharge out
−15	–	–	−27	50 @ 1 MHz	12-lead TO-5	4-6	precharge out
gnd	–	+5	−5	10 @ 1 MHz	22-lead flat pack	4-6	–
gnd	–	+5	−5	10 @ 1 MHz	12-lead TO-5	4-6	–
gnd	–	+5	−5	10 @ 1 MHz	16-lead DIP	4-6	–
−15	–	–	−27	100 @ 1 MHz	10-lead TO-100	2-4	inverter out
gnd	–	+5	−10	100 @ 1 MHz	10-lead TO-5	4-8	drives LP TTL directly
gnd	–	+5	−10	100 @ 1 MHz	14-lead flat pack	4-8	drives LP TTL directly

Shift Registers (continued)

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
dual 20-bit	AMI	RD52C	−25 to +75	1.0	2	−3.5	−9	−3.0	−9.5
dual 50-bit	AMI	RD55G	−25 to +75	1.0	2	−3.5	−9	−3.0	−9.5
dual 50-bit	AMI	RD55D	−25 to +75	1.0	2	−3.5	−9	−3.0	−9.5
dual 50-bit	AMI	RD57C	−25 to +75	1.0	2	−3.5	−9	−3.0	−9.5
dual 50-bit	AMI	RD57F	−25 to +75	1.0	2	−3.5	−9	−3.0	−9.5
dual 50-bit stream select	AMI	RD58D	−25 to +75	2.0	2	−3.5	−9	−3.0	−9.5
dual 50-bit stream select	AMI	RD58F	−25 to +75	2.0	2	−3.5	−9	−3.0	−9.5
dual 50-bit	AMI	RD60C	−25 to +75	3.0	2	−3.5	−9	−3.0	−9.5
dual 50-bit	AMI	RD60F	−25 to +75	3.0	2	−3.5	−9	−3.0	−9.5
dual 50-bit low V_T	AMI	RD62C	−25 to +75	.01 to 1.0	2	1.2	3.6	.7	4.0
dual 50-bit low V_T	AMI	RD62F	−25 to +75	.01 to 1.0	2	1.2	3.6	.7	4.0
dual 50-bit low V_T	AMI	RD62H	−25 to +75	.01 to 1.0	2	1.2	3.6	.7	4.0
triple 66-bit	AMI	RD63G	−25 to +75	1.0	2	−3.5	−9.0	−3.0	−9.5
426-bit low V_T	AMI	RD65G	−25 to +75	1.0	2	1.2	3.6	.7	4.0
426-bit low V_T	AMI	RD65D	−25 to +75	1.0	2	1.2	3.6	.7	4.0
12-bit serial/parallel conv.	AMI	SP01C	−55 to +125	dc to 2.0	2	−3.5	−9.0	−3.0	−9.5
dual 40-bit	AMI	RS03G	−55 to +125	dc to 1.0	2	−3.5	−9.0	−3.0	−9.5
12-bit serial/parallel conv.	AMI	SP51C	−25 to +75	dc to 1.0	2	−3.5	−9.0	−3.0	−9.5
dual 40-bit	AMI	RS53G	−25 to +75	dc to 1.0	2	−3.5	−9.0	−3.0	−9.5
1024-bit dynamic	**AUTO**	QSR2131	−50 to +100	1.0	4	−1	−10	−1	−15
variable length 1-64 bit	**ELEC**	EA1202	−55 to +85	0.010 to 3	2	−1.5	−9	−.5	−10
variable length 1-64 bit	ELEC	EA1203	−55 to +85	0.01 to 1	1	−1.5	−9	−.5	−10
quad 32-bit dynamic	ELEC	EA1200	−55 to +85	0.01 to 3	2	−1.5	−9	−.5	−10
quad 32-bit dynamic	ELEC	EA1201	−55 to +85	0.01 to 1	1	−1.5	−9	−.5	−10
256-bit dynamic	ELEC	EA1204	−55 to +85	0.01 to 5	2	−2	−9	−.5	−10
256-bit dynamic	ELEC	EA1205	−55 to +85	0.01 to 1	1	−2	−9	−.5	−10
quad 32-bit static	ELEC	EA1000	−55 to +85	–	1	−2	−9	−.5	−10
25-bit static	**FCH**	3300	0 to +70 −85 to +85	0.25	1	−2.0	−9.0	−1.0	−10
dual 25-bit dynamic	FCH	3303	0 to +70 −55 to +85	0.500	2	−2.0	−9.0	−1.0	−10
dual 16-bit static	FCH	3304	0 to +70 −55 to +85	1.0	2	−2.0	−9.0	−1.0	−10
64-bit static	FCH	3305/6	0 to +70 −55 to +85	1.0	1	−2.0	−9.0	−1.0	−10

See page 102 for key to manufacturer's code listing.

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
−15	–	–	−27	48 @ 1 MHz	22-lead flat pack	4-6	precharge out
−15	–	–	−27	50 @ 1 MHz	10-lead TO-5	4-6	PL5R100 equiv.
−15	–	–	−27	50 @ 1 MHz	14-lead flat pack	4-6	PL5R100 equiv.
−15	–	–	−27	50 @ 1 MHz	22-lead flat pack	4-6	precharge out
−15	–	–	−27	50 @ 1 MHz	12-lead TO-5	4-6	precharge out
−15	–	–	−27	50 @ 1 MHz	14-lead flat pack	4-6	precharge out
−15	–	–	−27	50 @ 1 MHz	12-lead TO-5	4-6	precharge out
−15	–	–	−27	50 @ 1 MHz	14-lead flat pack	4-6	precharge out
−15	–	–	−27	50 @ 1 MHz	12-lead TO-5	4-6	precharge out
gnd	–	+5	−5	10 @ 1 MHz	22-lead flat pack	4-6	DTL - TTL voltage comp.
gnd	–	+5	−5	10 @ 1 MHz	12-lead TO-5	4-6	DTL - TTL voltage comp.
gnd	–	+5	−5	10 @ 1 MHz	16-lead DIP	4-6	DTL - TTL voltage comp.
−15	–	–	−27	260 @ 1 MHz	10-lead TO-100	4-6	inverter out
−6	–	–	−15	100 @ 1 MHz	10-lead TO-5	4-6	drives LP TTL - DTL
−6	–	–	−15	100 @ 1 MHz	14-lead flat pack	4-6	drives LP TTL - DTL
−27	–	–	−27	150 @ 1 MHz	22-lead flat pack	4-6	push-pull outputs
−12	−27	–	−27	80 @ 1 MHz	10-lead TO-5	4-6	common clocks
−27	–	–	−27	150 @ 1 MHz	22-lead flat pack	4-6	push-pull outputs
−12	−27	–	−27	80 @ 1 MHz	10-lead TO-5	4-6	common clocks
−15	−27	0	−27	15	42-lead flat pack	6	–
0 to −28	−24	gnd	−24	1.0/bit	14-lead DIP	4	may be biased to drive TTL directly
0 to −28	−24	gnd	−9	1.2/bit	14-lead DIP	4	may be biased to drive TTL directly
0 to −28	−24	gnd	−24	0.6/bit	14-lead DIP	4	may be biased to drive TTL directly
0 to −28	−24	gnd	−9	1.0/bit	14-lead DIP	4	may be biased to drive TTL directly
0 to −28	–	gnd	−24	0.2/bit	10-lead TO	4	may be biased to drive TTL directly
0 to −28	−24	gnd	−9	0.4/bit	10-lead TO	4	may be biased to drive TTL directly
0 to −28	−24	gnd	−9	1.5/bit	14-lead DIP	4	data shift rates to 1 MHz
−13	−27	gnd	−9.0	50	10-lead TO-5	6	–
–	–	gnd	−27	0.2/bit	10-lead TO-5	6	–
−13	−27	gnd	−27	100	10-lead TO-5	6	–
−13	−27	gnd	−9.0	200	10-lead TO-5 16-lead DIP	6	–

Shift Registers (continued)

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
single 64-bit dynamic	FCH	3320	0 to +70 −55 to +85	2.0	4	−2.0	−10.24	−2.0	−10
5-bit parallel in/parallel out	**GI**	MEM3005PP	−55 to +85	dc to 1.0	2	−2.0	−10	−1.0	−11
5-bit serial in/parallel out	GI	MEM3005SP	−55 to +85	dc to 1.0	2	−2.0	−10	−1.0	−11
8-bit parallel in/serial out	GI	MEM3008PS	−55 to +85	dc to 1.0	2	−2.0	−10	−1.0	−11
12-bit serial in/parallel out	GI	MEM3012SP	−55 to +85	dc to 0.1	1	−2.0	−10	−1.0	−11
dual 16-bit	GI	MEM3016-2	−55 to +85	dc to 1.0	2	−2.0	−10	−1.0	−11
20-bit	GI	MEM3020	−55 to +85	dc to 1.0	2	−2.0	−10	−1.0	−11
21-bit	GI	MEM3021	−55 to +85	dc to 0.5	1	−2.0	−10	−1.0	−11
21-bit	GI	MEM3021B	−55 to +85	dc to 0.250	1	−2.0	−10	−1.0	−11
6-1ϕ binary weighted	GI	MEM3032	−55 to +85	dc to 1.0	1	−2.0	−9	−1.0	−11
dual 25-bit	GI	MEM3050	−55 to +85	0.010 to 0.500	2	−2.0	−10	−1.0	−14
64-bit serial accumulator	GI	MEM3064	−55 to +85	0.010 to 5.0	4	−2.0	−10	−2.0	−11
64-bit serial accumulator	GI	MEM3064B	−55 to +85	0.010 to 2.0	4	−2.0	−10	−2.0	−11
dual 64-bit serial accumulator	GI	MEM3064-2B	−55 to +85	0.010 to 2.0	4	−2.0	−10	−2.0	−11
dual 50-bit	GI	MEM3100	−55 to +85	0.010 to 2.0	2	−2.0	−10	−1.0	−11
dual 50-bit	GI	MEM3100A	−55 to +85	0.010 to 2.0	2	−2.0	−10	−1.0	−11
128-bit	GI	MEM3128	−55 to +85	0.010 to 2.0	2	−2.0	−10	−1.0	−11
dual 25-bit	**HUGH**	HRM2026	−55 to +125	0.010 to 1.0	2	−1 to −2	−6 to −27	0 to −1	−8 to −18
dual 50-bit	HUGH	HRM2027	−55 to +125	0.010 to 1.0	2	−1 to −2	−6 to −27	0 to −1	−8 to −18
dual 16-bit	HUGH	HRM2031	−55 to +125	dc to 2	2	−1 to −2	−6 to −27	0 to −1	−8 to −18
20-bit	**INTSL**	ICM7000	−55 to +125	1 (max)	2	–	–	–	–
dual 100-bit	INTSL	ICM7002	−55 to +125	1 (max)	2	–	–	–	–
100-bit	INTSL	ICM7003	−55 to +125	1 (max)	2	–	–	–	–
dual 16-bit dynamic	**ITT**	ITT-216D	−55 to +125	0.010 to 1.0	2	−4.0	−9.0	−3.0	−10.0
dual 100-bit dynamic	ITT	ITT-2100D	−55 to +125	0.010 to 1.0	2	−4.0	−9.0	−3.0	−10.0
dual 16-bit static	ITT	ITT-216S	−55 to +125	dc to 1.0	1 or 2	+1.0	+4.0	1 kΩ to gnd	1 kΩ to +5.0
dual 25-bit	**NATL**	MM400,401	−55 to +125	0.01 to 1.0	2	−2.5	−4.5	−1.5	−8.0
dual 25-bit	NATL	MM500,501	−25 to +70	0.01 to 1.0	2	−2.5	−4.5	−1.5	−8.0
dual 50-bit	NATL	MM402,403	−55 to +125	0.01 to 1.0	2	−2.5	−4.5	−1.5	−8.0
dual 50-bit	NATL	MM502,MM503	−25 to +70	0.01 to 1.0	2	−2.5	−4.5	−1.5	−8.0
dual 16-bit static	NATL	MM404	−55 to +125	dc to 1.0	1	−2.5	−4.5	−1.5	−8.0

See page 102 for key to manufacturer's code listing.

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
–	–	gnd	–27	.2/bit	10-lead TO-5	6	–
–13 ±1	–	–	–27	65	16-lead flat pack	1-3	–
–13 ±1	–27 ±1	–	–27	53	TO-87	1-3	–
–13 ±1	–27 ±1	–	–27	40	16-lead flat pack	1-3	–
–27 ±1	–	–	–27	216	16-lead flat pack	1-3	–
–13 ±1	–27 ±1	–	–27	184	l.p. 10-lead TO-74	1-3	–
–13 ±1	–27 ±1	–	–27	132	TO-78	1-3	–
–27 ±1	–	–	–27	146	l.p. 10-lead TO-74	1-3	–
–27 ±1	–	–	–27	146	l.p. 10-lead TO-74	1-3	–
–13 ±1	–27 ±1	–	–27	238	16-lead flat pack	1-3	–
–	–	–27 ±1	–27	10	l.p. 10-lead TO-74	1-3	–
–	–	–	–27	–	l.p. 10-lead TO-74, TO-87	1-3	–
–	–	–	–27	–	l.p. 10-lead TO-74, TO-87	1-3	–
–	–	–	–27	–	24-lead flat pack	1-3	–
–27 ±1	–	–	–27	162	l.p. TO-74 14-lead DIP	1-3	–
–27 ±1	–	–	–27	162	l.p. TO-73 14-lead DIP	1-3	–
–27 ±1	–	–	–27	108	l.p. TO-74 14-lead DIP	1-3	–
–6 to –24	–	0	–9 to –27	0.8/bit	8-lead TO 14-lead DIP	3	DTL, TTL compatible
–6 to –24	–	0	–9 to –27	0.8/bit	8-lead TO 14-lead DIP	4	DTL, TTL compatible
–6 to –24	–9 to –27	0	–9 to –27	2.0/bit	14-lead flat pack	4	DTL, TTL compatible
–5	–15	–	–	1/bit	TO-78	4	–
–5	–15	–	–	0.25/bit	TO-100	4	–
–5	–15	–	–	0.50/bit	TO-100	4	–
20.0	–	–	–27.0	150 at –55°C	10-lead TO-5	8	–
12.0	–	–	–27.0	660 at –55°C	12-lead TO-5	8	gated input to allow the unit to be commutated
–	–7.0	+5.0	+5/–7	85 at –55°C	10-lead TO-5	8	can be used with TTL or DTL
–10	–	0	16	0.8/bit	TO-5	3-4	TTL/DTL compatible
–10	–	0	–16	0.8/bit	TO-5	1-2	TTL/DTL compatible
–10	–	0	–16	0.8/bit	TO-5	3-4	TTL/DTL compatible
–10	–	0	–16	0.8/bit	TO-5	1-2	TTL/DTL compatible
–10	–16	0	–16	1.2/bit	TO-5	3-4	TTL/DTL compatible

Shift Registers (continued)

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
dual 32-bit static	NATL	MM405	−55 to +125	dc to 1.0	1	−2.5	−4.5	−1.5	−8.0
dual 16-bit static	NATL	MM504	−25 to +70	dc to 1.0	1	−2.5	−4.5	−1.5	−8.0
dual 32-bit static	NATL	MM505	−25 to +70	dc to 1.0	1	−2.5	−4.5	−1.5	−8.0
dual 100-bit	NATL	MM406,407	−55 to +125	0.01 to 1.0	2	−2.5	−4.5	−1.5	−8.0
dual 100-bit	NATL	MM506,507	−25 to +70	–	2	−2.5	−4.5	−1.5	−8.0
dual 25-bit	**NPC**	MOS400	−55 to +125	0.010 to 1.0	2	−2.5	−7.0	−1.5	−8.0
dual 25-bit	NPC	MOS500	0 to +70	0.010 to 1.0	2	−2.5	−7.0	−1.5	−8.0
dual 16-bit static	NPC	MOS404	−55 to +125	dc to 1.0	1	−2.5	−7.0	−1.5	−8.0
dual 16-bit static	NPC	MOS504	0 to +70	dc to 1.0	1	−2.5	−7.0	−1.5	−8.0
dual 100-bit	NPC	MOS406	−55 to +125	0.010 to 1.0	2	−2.5	−7.0	−1.5	−8.0
dual 100-bit	NPC	MOS506	0 to +70	0.010 to 1.0	2	−2.5	−7.0	−1.5	−8.0
dual 8/16-bit	**PHLCO**	pL5R32	−55 to +125	0.01 to 1.0	2	−4.0 max	−9.0 min	−3.0 max	−10.0 min
dual 20-bit	PHLCO	pL5R40	−55 to +125	0.01 to 1.0	2	−4.0 max	−9.0 min	−3.0 max	−10.0 min
dual 50-bit	PHLCO	pL5R100	−55 to +125	0.01 to 1.0	2	−4.0 max	−9.0 min	−3.0 max	−10.0 min
dual 64-bit	PHLCO	pL5R128A pL5R128	−55 to +125	0.01 to 5.0 0.01 to 2.0	2	−3.0 max	−9.0 min	−2.0 max	−10.0 min
250-bit dynamic	PHLCO	pL5R250A pL5R250	−55 to +125	0.01 to 5.0 0.01 to 2.0	2	−3.0 max	−9.0 min	−2.0 max	−10.0 min
256-bit dynamic	PHLCO	pL5R256A pL5R256	−55 to +125	0.01 to 5.0 0.01 to 2.0	2	−3.0 max	−9.0 min	−2.0 max	−10.0 min
18-bit	**RCA**	TA5459	−55 to +125	–	1	(1)	(1)	0.01 max	9.99 min
single 64-bit dynamic	**SSS**	CDL5300P	−55 to +125	0.001 to 5	2	4	9	0	20
dual 64-bit	SSS	CDL5301P	−55 to +125	0.001 to 5.0	2	4	9	0	20
single 64-bit	SSS	CDL5302P	−55 to +125	0.001 to 10	2	4	9	0	20
dual 64-bit	SSS	CDL5303P	−55 to +125	0.001 to 10	2	4	9	0	20
single 50-bit	SSS	CDL5305P	−55 to +125	0.001 to 5.0	2	4	9	0	20
dual 50-bit	SSS	CDL5306P	−55 to +125	0.001 to 5.0	2	4	9	0	20
single 50-bit	SSS	CDL5307P	−55 to +125	0.001 to 10	2	4	9	0	20
dual 50-bit	SSS	CDL5308P	−55 to +125	0.001 to 10	2	4	9	0	20
single 50-bit	SSS	CDL5300N	−55 to +125	0.001 to 5.0	2	4	9	0	20
dual 50-bit	SSS	CDL5301N	−55 to +125	0.001 to 5.0	2	4	9	0	20
single 64-bit	SSS	CDL5302N	−55 to +125	0.001 to 10	2	4	9	0	20
dual 64-bit	SSS	CDL5303N	−55 to +125	0.001 to 10	2	4	9	0	20
single 50-bit	SSS	CDL5305N	−55 to +125	0.001 to 5.0	2	4	9	0	20

Footnotes: (1) $V_{SS} \leq V_{IN}, V_{IN} \leq V_{DD}$ (2) +15 V to −0.5 V max

See page 102 for key to manufacturer's code listing.

Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
−10	−16	0	−16	1.2/bit	TO-5	3-4	TTL/DTL compatible
−10	−16	0	−16	1.2/bit	TO-5	1-2	TTL/DTL compatible
−10	−16	0	−16	1.2/bit	TO-5	1-2	TTL/DTL compatible
−10	–	0	−16	0.8/bit	TO-5	3-4	TTL/DTL compatible
−10	–	0	−16	0.8/bit	TO-5	1-2	TTL/DTL compatible
+0.5 −25	–	–	+0.5 −25	300	TO-5 l.p.	6	–
+0.5 −25	–	–	+0.5 −25	300	TO-5 l.p.	6	–
+0.5 −25	+0.5 −25	–	+0.5 −25	300	TO-5 l.p.	6	–
+0.5 −25	+0.5 −25	–	+0.5 −25	300	TO-5 l.p.	6	–
+0.5 −25	+0.5 −25	–	+0.5 −25	0.8/bit	TO-5 l.p.	6	–
+0.5 −25	+0.5 −25	–	+0.5 −25	0.8/bit	TO-5 l.p.	6	–
−20.0	–	–	−27.0	3.5/bit	TO-5 14-lead DIP	4	dynamic
−20.0	–	–	−27.0	3.5/bit	TO-5 14-lead DIP	4	dynamic
−20.0	–	–	−27.0	3.5/bit	TO-5 14-lead DIP	4	dynamic
−25.0 ±5.0	–	–	−25.0 ±3.0	.2/bit	TO-5 14-lead DIP	6	dynamic
−25.0 ±5.0	–	–	−25.0 ±3.0	.2/bit	TO-5 14-lead DIP	6	output drives bipolar
−25.0 ±5.0	–	–	−25.0 ±3.0	.2/bit	TO-5 14-lead DIP	6	output drives bipolar
(2)	–	(2)	–	100 nW/pkg	14-lead DIP ceramic	2	–
12 to 18	–	–	20	400 μW/bit	TO-5	6	other packages available
12 to 18	–	–	20	400 μW/bit	TO-5	6	other packages available
12 to 18	–	–	20	–	TO-5	6	other packages available
12 to 18	–	–	20	–	TO-5	6	other packages available
12 to 18	–	–	20	–	TO-5	6	other packages available
12 to 18	–	–	20	–	TO-5	6	other packages available
12 to 18	–	–	20	–	TO-5	6	other packages available
12 to 18	–	–	20	–	TO-5	6	other packages available
12 to 18	–	–	20	–	TO-5	6	other packages available
12 to 18	–	–	20	–	TO-5	6	other packages available
12 to 18	–	–	20	–	TO-5	6	other packages available
12 to 18	–	–	20	–	TO-5	6	other packages available
12 to 18	–	–	20	–	TO-5	6	other packages available

Shift Registers (continued)

Circuit	Mfr.	Part Number	Operating Temperature (°C)	Frequency Range (MHz)	Clocks Required	Signal Levels			
						Input		Output	
						"0" (V)	"1" (V)	"0" (V)	"1" (V)
dual 50-bit	SSS	CDL5306N	−55 to +125	0.001 to 5.0	2	4	9	0	20
single 50-bit	SSS	CDL5307N	−55 to +125	0.001 to 10	2	4	9	0	20
dual 50-bit	SSS	CDL5308N	−55 to +125	0.001 to 10	2	4	9	0	20
–	SSS	SCL5120	−55 to +125	dc to 2.0	1	3	7	.05	9.95
dual 16-bit	**TI**	TMS1B3016LA	−55 to +85	dc to 1.0	2	> −2	< −10	> −2	−13
dual 32-bit	TI	TMS7B3001LA	−55 to +85	dc to 2.0	2	> −2	< −10	> −2	−13
dual 25-bit	TI	TMS7B3000LA	−55 to +85	dc to 1.0	2	> −2	< −10	> −2	−13
dual 50-bit	TI	TMS7C3002LA	−55 to +85	dc to 1.0	2	> −2	< −10	> −2	−13
dual 100-bit	TI	TMS7C3003LA	−55 to +85	dc to 1.0	2	> −2	< −10	> −2	−13
dynamic dual 25-bit	**UNCB**	SRD25	0 to +85	0.01 to 1.0	2	0 to −2.5 max	−7 min	−1.5 max	−8.0 min

MOS Integrated Circuit Manufacturers

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Supply Voltages				Power Dissipation (mW)	Package	Delivery On 1000 Pcs (Weeks)	Comments
V_{DD} (V)	V_{GG} (V)	V_{SS} (V)	Clock (V)				
12 to 18	–	–	20	–	TO-5	6	other packages available
12 to 18	–	–	20	–	TO-5	6	other packages available
12 to 18	–	–	20	–	TO-5	6	other packages available
7 to 13	–	–	7	75 nW typ	TO-5	6	other packages available
–13	–27	0	–2 to –26	147 typ	10-lead TO	4	third-phase generated on chip
–14	–28	0	–2 to –26	280 typ	10-lead TO	4	third-phase generated on chip
–14	–28	0	–2 to –26	252 typ	10-lead TO	5	third-phase generated on chip
–14	–28	0	–2 to –28	1.6/bit typ	10-lead TO	6	third-phase generated on chip
–14	–28	0	–2 to –27	1.6/bit typ	10-lead TO	8	third-phase generated on chip
–10	–	–	–16	50	TO-99 (8 pin)	8	–

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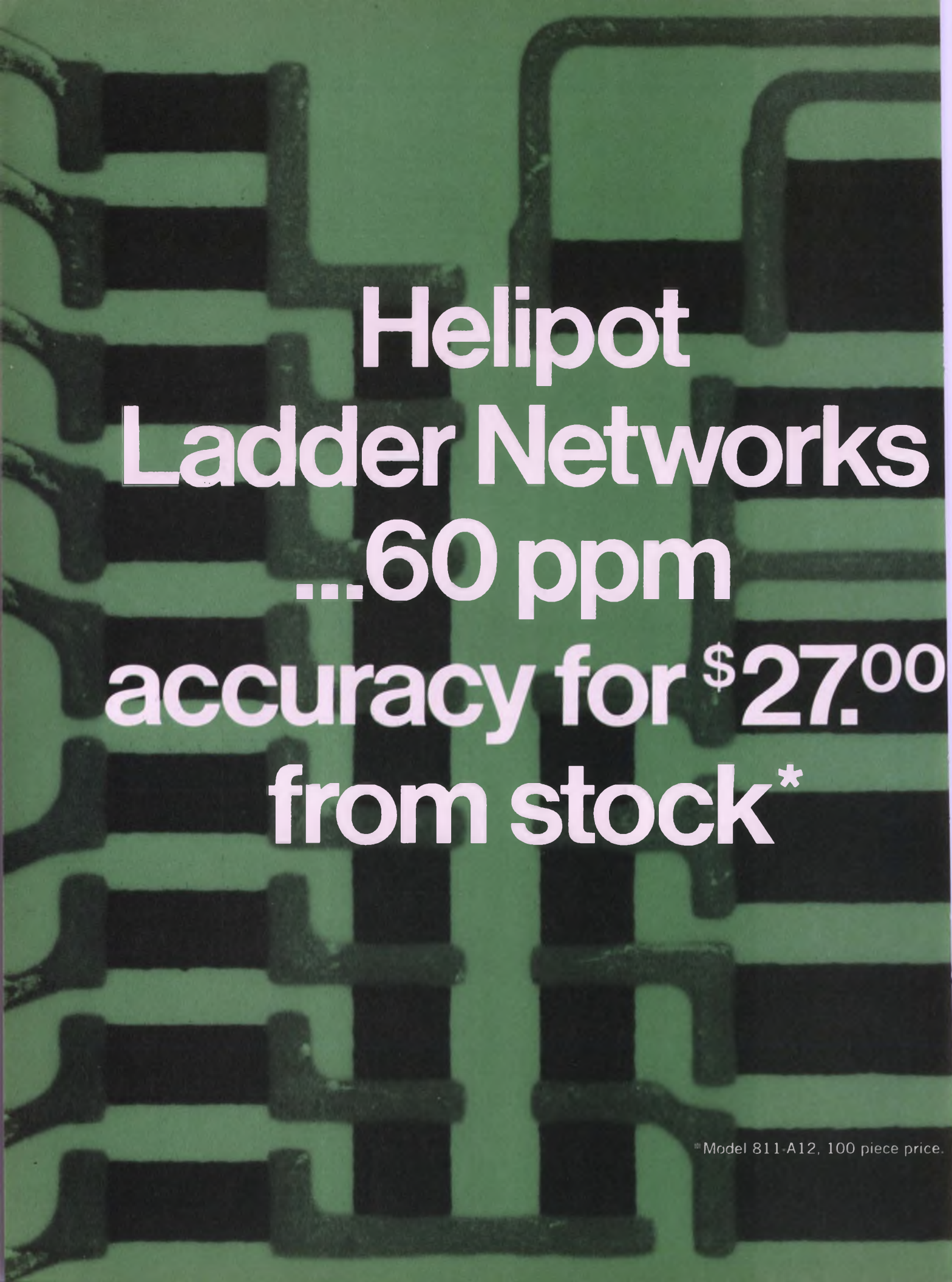

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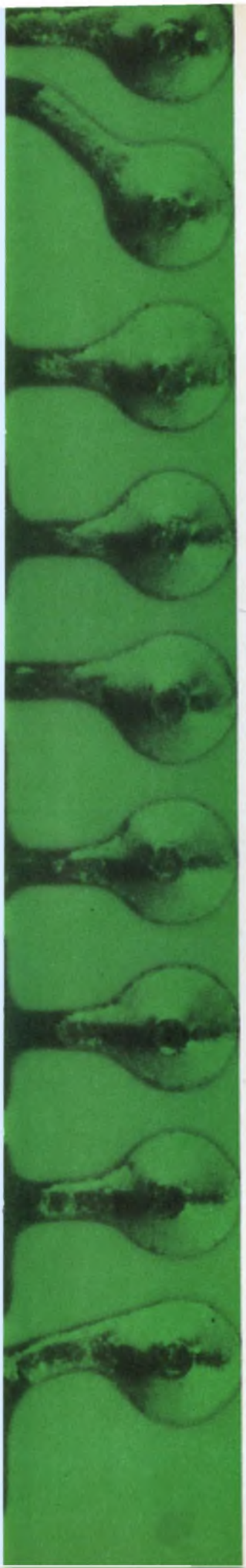

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Design and match rf amplifiers

using these two QUIKTRAN programs to simplify device analysis and selection of matching network.

The design of transistor rf amplifiers can be made easier by using two QUIKTRAN computer programs for device and matching network analysis. QUIKTRAN,† which is based on the FORTRAN language, was used to develop the following design programs:

- RFAMP (Table 1), which analyzes a two-port device in terms of its y-parameters for a given stability factor. The analysis of the device provides optimum source and load admittance, resulting transducer gain, unilateralized gain, stability, sensitivity, and both input and output impedances. Other types of parameters require the writing of an auxiliary program to convert them to y-parameters. If s-parameters are used, the auxiliary program can easily be made to accept measured values A, $B < \phi$ directly.
- ZMATCH, which selects, identifies and determines the components of 28 possible matching networks for given source and load impedances, frequency and required Q. The networks consist of all possible combinations of either two capacitances and a single inductance, or two inductances and a single capacitance.

RFAMP highlights trade-off

To demonstrate the operation of RFAMP, let's use it to solve a typical device analysis problem.

Assume we want to use a 3N128 MOSFET in an rf amplifier. If, during the computer run, the device is found to be potentially unstable, the program will find the optimum terminating impedances for this transistor by using the Stern[1,2] equations (see box). Using less-than-optimum impedances may, however, provide a simpler matching network design. Let's assume that in this particular application, a straight source-resistance of 300 Ω and a 2-kΩ load resistance would simplify the necessary matching network. We can now use RFAMP to evaluate the loss in gain resulting from our less-than-optimum terminations.

† For a description of the QUIKTRAN program see "Fundamentals of QUIKTRAN." Copies of this publication are available through IBM Information Marketing branch offices.

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The program, normally stored in the computer library, is loaded and started by the simple statements shown in Fig. 1. The program then requests the necessary input data in the order shown. All entries made by the engineer are shown boxed in Fig. 1. The type designation 3N128 isn't required, but may be added at the user's discretion to identify his run; this entry is ignored by the computer.

As shown in Fig. 1 the computer then prints out the results of the programed computations. Linvill stability criteria are used to determine potential stability. In this case the device is potentially unstable, and the source and load admittances (GS, BS, GL, BL) listed are the Stern solution for the given stability factor of 10. The transducer gain printout is the output power delivered to the load divided by maximum input power available from the source; the unilaterized

Table 1. RFAMP program statements

```
101. =      CF    PROGRAM RFAMP
102. =      C     ANALYSIS OF A DEVICE EXPRESSED BY ITS Y PARAMETERS
103. =            J=0
104. =         11 FORMAT(F12.4)
105. =            PRINT 3
106. =          30FORMAT(58H ENTER G11, B11, G12, B12, G21, B21, G22, B22, (IN MMHOS
                  1),/64H DESIRED STABILITY FACTOR (STERN'S), FREQUENCY (IN MHZ), (NA
                  4ME):)
107. =        112 CONTINUE
108. =      CF    READ 0,G11,B11,G12,B12,G21,B21,G22,B22,XK,FREQ
109. =            GO TO 111
110. =        101 READ 11,G11
111. =            GO TO 100
112. =        102 READ 11,B11
113. =            GO TO 100
114. =        103 READ 11,G12
115. =            GO TO 100
116. =        104 READ 11,B12
117. =            GO TO 100
118. =        105 READ 11,G21
119. =            GO TO 100
120. =        106 READ 11,B21
121. =            GO TO 100
122. =        107 READ 11,G22
123. =            GO TO 100
124. =        108 READ 11,B22
125. =            GO TO 100
126. =        109 READ 11,XK
127. =            GO TO 100
128. =        110 READ 11,FREQ
129. =            GO TO 100
130. =        111 K=0
131. =            YR=G12*G21-B12*B21
132. =            YM=G12*B21+B12*G21
133. =            YMAG=YR**2+YM**2
134. =            YMSQ=G21**2+B21**2
135. =            C=YMAG**.5/(2.*G11*G22-YR)
136. =            IF(C-1.)10,20,20
137. =         10 DS=((2.*G11*G22-YR)**2-YMAG)**.5
138. =            GS=DS/2./G22
139. =            BS=-B11+YM/2./G22
140. =            GL=DS/2./G11
141. =            BL=-B22+YM/2./G11
142. =            PRINT 4,C
143. =          4OFORMAT(/29H LINVILL'S STABILITY FACTOR =,F5.2,34H: DEVICE IS UNCON
                  4DITIONALLY STABLE)
144. =            GO TO 30
145. =         20 PRINT 5,C
146. =          5OFORMAT(/29H LINVILL'S STABILITY FACTOR =,F5.2,32H: DEVICE IS POTEN
                  4TIALLY UNSTABLE)
147. =            GO TO 22
148. =         21 K=1
149. =            XK=2.*(G11+GS)*(G22+GL)/(YMAG**.5+YR)
150. =         22 A=(YMAG**.5+YR)*XK
```

Amplifier stability

As noted in the reference a major factor in the over-all design of an amplifier is the potential stability of the transistor. This may be determined by computing the Linvill stability factor C, using the following expression:

$$C = |y_{12}y_{21}|/[2g_{11}\ g_{22} - \text{Re}\ (y_{12}\ y_{21})],$$

where

Re $(y_{12}\ y_{21})$ = Real part of $(y_{12}\ y_{21})$.

When C is less than 1, the transistor is unconditionally stable. When C is greater than 1, the transistor is potentially unstable.

The C factor is a test for stability under a hypothetical worst-case condition; that is, with both input and output transistor terminals open-circuited. With no external feedback, an unconditionally stable transistor will not oscillate with any combination of source and load. If a transistor is potentially unstable, certain source and load combinations will produce oscillations.

Although the C factor may be used to determine the potential stability of a transistor, the conditions of open-circuited source and load which are assumed in the C factor test are not applicable to a practical amplifier. Consequently it is also desirable to compute the relative stability of actual amplifier circuits, and Stern has defined a stability factor K for this purpose. The K factor is similar to the C factor, except that it also takes into account finite source and load admittances connected to the transistor. The expression for K is:

$$K = [2\ (g_{11} + G_s)\ (g_{22}+G_L]/[|y_{12}y_{21}| + \text{Re}\ (y_{12}y_{21})]$$

If K is greater than one, the circuit will be stable. If K is less than one, the circuit will be unstable.

```
151. =            E=A+2.*YR
152. =            F=-(2.*YM*A**.5)
153. =            H=F**2/4.+E**3/27.
154. =            IF(H)40,50,60
155. =         40 Q=(-(E/3.))**.5
156. =            PHI=ARCOS(F/2./E**3./Q)/3.
157. =            Z1=2.*Q*COS(PHI)
158. =            Z2=-(2.*Q*COS(1.047198-PHI))
159. =            Z3=-(2.*Q*COS(1.047198+PHI))
160. =            D1=Z1**4/4.+E*Z1**2/2.-2.*YM*Z1*A**.5+A/2.-YR+YM**2
161. =            D2=Z2**4/4.+E*Z2**2/2.-2.*YM*Z2*A**.5+A/2.-YR+YM**2
162. =            D3=Z3**4/4.+E*Z3**2/2.-2.*YM*Z3*A**.5+A/2.-YR+YM**2
163. =            IF(D2-D1)41,42,42
164. =         41 IF(D2-D3)43,44,44
165. =         42 IF(D1-D3)45,44,44
166. =         43 ZO=Z2
167. =            GO TO 90
168. =         44 ZO=Z3
169. =            GO TO 90
170. =         45 ZO=Z1
171. =            GO TO 90
172. =         50 Z1=(F/2.)**(1./3.)
173. =            Z2=-(2.*Z1)
174. =            D1=Z1**4/4.+E*Z1**2/2.-2.*YM*Z1*A**.5+A/2.-YR+YM**2
175. =            D2=Z2**4/4.+E*Z2**2/2.-2.*YM*Z2*A**.5+A/2.-YR+YM**2
176. =            IF(D2-D1)51,52,52
177. =         51 ZO=Z2
178. =            GO TO 90
179. =         52 ZO=Z1
180. =            GO TO 90
181. =         60 P=-(F/2.)+H**.5
182. =            Q=-(F/2.)-H**.5
183. =            IF(P)61,62,62
184. =         61 P=-((P**2)**(1./6.))
185. =            GO TO 63
186. =         62 P=P**(1./3.)
187. =         63 IF(Q)64,65,65
188. =         64 Q=-((Q**2)**(1./6.))
189. =            GO TO 66
190. =         65 Q=Q**(1./3.)
191. =         66 ZO=P+Q
192. =         90 QK=XK*(YMAG**.5+YR)
193. =            IF(K)91,161
194. =         91 GS=(QK*G11/2./G22)**.5-G11
195. =            GL=(QK*G22/2./G11)**.5-G22
196. =            GO TO 161
197. =        151 READ 11,GS
198. =            GO TO 100
199. =        152 READ 11,GL
200. =            GO TO 100
201. =        162 IF(C-1.)30,21,21
202. =        161 BS=(GS+G11)*ZO/QK**.5-B11
203. =            BL=(GL+G22)*ZO/QK**.5-B22
204. =         30 T=G11+GS
205. =            U=B11+BS
206. =            V=G22+GL
207. =            W=B22+BL
208. =            ZK=2.*T*V/(YMAG**.5+YR)
209. =            RS=1000./GS
210. =            CS=-(BS*500./3.14159/FREQ)
211. =            RL=1000./GL
212. =            CL=-(BL*500./3.14159/FREQ)
213. =            GT=4.*GS*GL*YMSQ/((T*V-U*W-YR)**2+(U*V+T*W-YM)**2)
214. =            GT=10.*ALOG10(GT)
215. =            GU=(G21-G12)**2+(B21-B12)**2
216. =            GU=GU/4./(G11+G12)/(G22+G12)
217. =            GU=10.*ALOG10(GU)
218. =            S=(V*GL+W*BL)**2+(V*BL-W*GL)**2
219. =            S=S*(G11**4+(G11*B11)**2)
220. =            YK=YMAG**.5/G11*G22
221. =            S=S**.5*YK/(V**2+W**2)/(G11**2+B11**2)
222. =            THETA=ATAN(-(YM/YR))*57.29578
223. =            S1=YK*(G11**2*COS(THETA)+G11*B11*SIN(THETA))/(G11**2+B11**2)
224. =            S2=YK*(G11**2*SIN(THETA)+G11*B11*COS(THETA))/(G11**2+B11**2)
225. =            S=S/((V/G22+S1)**2+(W/G22+S2)**2)**.5
226. =            S=S*100.
227. =            GIN=G11-(YR*V+YM*W)/(V**2+W**2)
228. =            BIN=B11-(YM*V-YR*W)/(V**2+W**2)
229. =            RIN=1000./GIN
230. =            CIN=BIN/2./3.14159/FREQ*1000.
231. =            GOUT=G22-(YR*T+YM*U)/(T**2+U**2)
232. =            BOUT=B22-(YM*T-YR*U)/(T**2+U**2)
233. =            ROUT=1000./GOUT
234. =            COUT=BOUT/2./3.14159/FREQ*1000.
235. =            PRINT 6,ZK,S,GT,GU
236. =         60FORMAT(27H STERN'S STABILITY FACTOR =,F6.2,14X,14H SENSITIVITY =,F
                 46.2/18H TRANSDUCER GAIN =,F7.3,13X,22H UNILATERALIZED GAIN =,F7.3)
237. =            PRINT 7,GS,BS,GL,BL
238. =          7 FORMAT(4H GS=,F10.3,5X,4H BS=,F7.2,5X,4H GL=,F10.3,5X,4H BL=,F7.2)
239. =            PRINT 8,RS,CS,RL,CL
240. =          8 FORMAT(4H RS=,F10.1,5X,4H CS=,F7.2,5X,4H RL=,F10.1,5X,4H CL=,F7.2)
241. =            PRINT 9,RIN,CIN,ROUT,COUT
242. =          9 FORMAT(4H RI=,F10.1,5X,4H CI=,F7.2,5X,4H RO=,F10.1,5X,4H CO=,F7.2)
243. =            IF(J)113,114,100
244. =        100 READ 13,M
245. =         13 FORMAT(I2)
246. =            GGO TO (101,102,103,104,105,106,107,108,109,110,151,152,111,113,112
                  4,162),M
247. =        114 PRINT 12
248. =         12GFORMAT(/70H CHANGE PARAMETER BY ENTERING M: M=01 FOR G11, 02 B11,
                 103 G12, 04 B12,/62H 05 G21, 06 B21, 07 G22, 08 B22, 09 XK, 10 FREQ
                 2, 11 GS, 12 GL,/52H 13 RESTART, 14 EXIT, 15 READ G11-FREQ, 16 CONT
                 4INUE:)
249. =            J=1
250. =            GO TO 100
251. =        113 PAUSE
252. =            END
253. +READY
```

gain is the gain obtainable when *Y12* is made zero by feedback, and *YL* is conjugately matched to *YOUT*. In addition, sensitivity (defined as percentage change in *YIN* divided by the percentage change in *YL* times 100) is included.

Values shown for *RS*, *CS*, *RL* and *CL* (used with the ZMATCH program) represent the effective input and output impedances that the device should see, looking into the matching networks. *R1*, *C1*, *R0* and *C0* values are the actual input and output impedances of the device.

The RFAMP program has built-in instructions for modifying, which are subsequently printed out. For example, in order to change *GS*, the number 11 is entered followed by the value 3.3333, which corresponds to the reciprocal of 300 Ω; *GL* is changed to 1/2 kΩ by using the address number 12. Finally, the number 16 is entered in order to start the program again.

The resulting stability factor differs from the original 10. The transducer gain, 17.176 dB, can be compared on the basis of the same stability factor. Since the new stability factor is now in the program that supersedes the original one, restarting the program by entering 13 will give optimum gain for this factor. The resulting gain, 17.634 dB, exceeds 17.176 by about 0.5 dB, which is the penalty we've been looking for.

The choice of stability factor (Stern) isn't too critical; it should be higher as the number of stages increase, or when the probability of stray feedback is great, etc. Table 3 shows how gain, input and output impedances change as a function of stability factor for the potentially unstable 2N4957. (2N4957 is unconditionally stable (common emitter configuration) beyond 600 MHz.

Note that the device is stable, although the input impedance goes through infinity at about 5.2 and then goes negative. The source and input resistance in parallel comes out positive, of course, increases to infinity near 1.0 and, as expected, goes negative below 1.0, which defines the region of actual instability.

One merit of the stability factor is the basis it provides for comparing gain between different types of devices.

RFAMP can also be used to examine effects on the stability factor and gain of variation in *y*-parameter values with fixed *GS* and *GL*. Table 4 shows the effects of varying each of the eight parameters by plus and minus 20%, and then

```
101. -READY          LOAD(RFAMP)
253. +READY          START(0)
105. =0 03    ENTER G11, B11, G12, B12, G21, B21, G22, B22, (IN MMHOS),
105. =    2   DESIRED STABILITY FACTOR (STERN'S), FREQUENCY (IN MHZ), (NAME):
108. =I 00    .27 5.5 0. -.12 7.1 -1.4 .21 1.3 10. 150.     3N128
145. =0 05
145. =    2   LINVILL'S STABILITY FACTOR = 3.09; DEVICE IS POTENTIALLY UNSTABLE
235. =0 06    STERN'S STABILITY FACTOR = 10.00              SENSITIVITY =  0.54
235. =    2   TRANSDUCER GAIN = 16.429              UNILATERALIZED GAIN = 23.608
237. =0 07    GS=     1.852      BS=  -6.01      GL=     1.440      BL=  -1.70
239. =0 08    RS=     540.0      CS=   6.38      RL=     694.3      CL=   1.80
241. =0 09    RI=    4021.2      CI=   6.38      RO=    5170.1      CO=   1.80
247. =0 12
247. =    2   CHANGE PARAMETER BY ENTERING M; M=01 FOR G11, 02 B11, 03 G12, 04 B12,
247. =    3   05 G21, 06 B21, 07 G22, 08 B22, 09 XX, 10 FREQ, 11 GS, 12 GL,
247. =    4   13 RESTART, 14 EXIT, 15 READ G11-FREQ, 16 CONTINUE:
244. =I 13    11
197. =I 11    3.3333
244. =I 13    12
199. =I 11    .5
244. =I 13    16
235. =0 06    STERN'S STABILITY FACTOR =  7.31              SENSITIVITY =  2.00
235. =    2   TRANSDUCER GAIN = 17.176              UNILATERALIZED GAIN = 23.608
237. =0 07    GS=     3.333      BS=  -6.66      GL=     0.500      BL=  -1.53
239. =0 08    RS=     300.0      CS=   7.06      RL=    2000.0      CL=   1.62
241. =0 09    RI=    7392.4      CI=   7.06      RO=    5451.0      CO=   1.62
244. =I 13    13
145. =0 05
145. =    2   LINVILL'S STABILITY FACTOR = 3.09 DEVICE IS POTENTIALLY UNSTABLE
235. =0 06    STERN'S STABILITY FACTOR =  7.31              SENSITIVITY =  0.67
235. =    2   TRANSDUCER GAIN = 17.637              UNILATERALIZED GAIN = 23.608
237. =0 07    GS=     1.544      BS=  -6.08      GL=     1.201      BL=  -1.75
239. =0 08    RS=     647.8      CS=   6.45      RL=     832.9      CL=   1.86
241. =0 09    RI=    9945.9      CI=   6.45      RO=    6359.0      CO=   1.86
244. =I 13    15
108. =I 00    17. 11. 0. -.92 22.8 -44.8 .29 1.91 10. 200.    2N3279
142. =0 04
142. =    2   LINVILL'S STABILITY FACTOR = 0.91; DEVICE IS UNCONDITIONALLY STABLE
235. =0 06    STERN'S STABILITY FACTOR = 20.05              SENSITIVITY = 40.11
235. =    2   TRANSDUCER GAIN = 15.407              UNILATERALIZED GAIN = 20.934
237. =0 07    GS=    37.379      BS= -47.17      GL=     0.638      BL=  -2.53
239. =0 08    RS=     26.8       CS=  37.53      RL=    1568.3      CL=   2.01
241. =0 09    RI=     26.8       CI=  37.53      RO=    1568.3      CO=   2.01
244. =I 13    05
118. =I 11    18.2
244. =I 13    13
142. =0 04
142. =    2   LINVILL'S STABILITY FACTOR = 0.87; DEVICE IS UNCONDITIONALLY STABLE
235. =0 06    STERN'S STABILITY FACTOR = 37.88              SENSITIVITY = 38.60
235. =    2   TRANSDUCER GAIN = 14.871              UNILATERALIZED GAIN = 20.586
237. =0 07    GS=    43.263      BS= -39.87      GL=     0.738      BL=  -2.40
239. =0 08    RS=     23.1       CS=  31.73      RL=    1355.0      CL=   1.91
241. =0 00    RI=     23.1       CI=  31.73      RO=    1355.0      CO=   1.91
244. =I 13    14
251. =PAUSE
253. +READY          COMMAND
```

1. **Sample run of RFAMP demonstrates** how the program is used to determine the loss in gain that will result from using other-than-optimum source and load terminations. Entries made by the user are shown boxed.

```
101. -READY          LOAD(ZMATCH)
370. +READY          START(0)
105. =0150    ENTER RO, CO (PF), RI, CI, FREQ (MHZ), Q:
109. =I 00    1000. 5. 80. 40. 150. 20.
339. =0152          K          C1,?          C3,9      L2,8,(4,6) (UH)
344. =0153         819         22.49         15.92         0.0531
344. =0153         192          9.79          4.51         0.1682
344. =0153         921         23.11          6.87         0.1682
344. =0153         941          3.59          6.87         0.0865
344. =0153         981         16.38          4.35         0.0531
344. =0153         961         16.38         70.85         0.0826
344. =0153         183         19.82         12.14         0.0833
344. =0153         729         11.63         17.40         0.0860
351. =0154          K      C1,9,(3,7)        L4,8          L2,6
356. =0155         821          6.17        0.0667         0.1137
356. =0155         823         24.13        0.0667         0.1452
356. =0155         982         13.02        0.1831         0.1194
356. =0155         782          0.13        8.4022         0.1194
356. =0155         928         13.02        0.0110         0.0450
356. =0155         281         10.91        0.2294         0.5123
356. =0155         128          1.35        0.0215         1.0100
356. =0155         328         15.06        0.0215         0.0522
356. =0155         128          1.35        0.0406         1.0946
356. =0155         328          7.96        0.0406         0.0914
356. =0155         289        162.76        0.0052         0.1731
356. =0155         287          0.01      130.8137         0.1731
356. =0155         289        162.76        0.0059         0.2578
356. =0155         287          0.00      270.4529         0.2578
356. =0155         294         21.59        0.0982         0.3803
356. =0155         618          8.22        0.0152         0.0736
364. =0157    MODIFY PROGRAM BY ENTERING M: M=1 FOR RO, 2 CO,
364. =    2   3 RI, 4 CI, 5 FREQ, 6 Q, 9 RO-Q, 7 RESTART, 8 EXIT.
334. =I151    6
333. =I 06    5.
334. =I151    7
351. =0154          K      C1,9,(3,7)        L4,8          L2,6
356. =0155        128          7.45        0.0215         0.3242
356. =0155        128          7.45        0.0406         0.4088
356. =0155        287          0.12        9.7878         0.1731
334. =I151    9
109. =I 00    430. 6. 7. 150. 150. 5.
361. =0156    SORRY, NO MATCH; CHANGE Q IF POSSIBLE OR USE TWO
361. =    2   NETWORKS MATCHED TO AN INTERMEDIATE, VIRTUAL RESISTANCE.
334. =I151    6
333. =I 06    10.
334. =I151    7
351. =0154          K      C1,9,(3,7)        L4,8          L2,6
356. =0155        821         26.22        0.0340         0.0054
356. =0155        928         16.23        0.0047         0.0468
356. =0155        928         16.23        0.0182         0.0532
356. =0155        281         45.60        0.0362         0.2609
356. =0155        281         45.60        0.0241         0.0601
356. =0155        294         28.21        0.0349         0.0466
356. =0155        294         60.03        0.0249         0.2220
334. =I151    8
368. =PAUSE
370. +READY          COMMAND
101. -READY
```

2. **Sample ZMATCH run provides** a number of possible matching circuits which will satisfy a particular circuit requirement. User's entries are shown in boxes. The entered inputs are shown in Fig. 3.

Table 2. ZMATCH program statements

```
      CF    PROGRAM ZMATCH
      C     MATCHING TWO PARALLEL RC NETWORKS WITH CCL OR CLL NETWORKS
      C     (OUT OF 28 POSSIBLE CONFIGURATIONS).
      C     K: CAP = ODD NUMBER. IND = EVEN. SHUNT = ABOVE 5. SERIES = BELOW 5
            PRINT 150
  150 FORMAT(42H ENTER RO. CO (PF). RI. CI. FREQ (MHZ). Q:)
            J=0
    9 CONTINUE
      CF    READ D,R,CO,P,CI,FQ,Q
    7 I=-1
            N=0
            D=6.28318531*FQ
            X=-(1000000./D/CO)
            Z=-(1000000./D/CI)
   10 A=R/X
            B=P/Z
            S=R/(1.+A**2)
            U=S*A
            T=P/(1.+B**2)
            V=T*B
            PS=P*S
            SS=S**2
            QT=Q*T
            QV=Q+V/T
            GO TO 1
   11 S=P
            P=R
            R=S
            S=Z
            Z=X
            X=S
            GO TO 1
   12 IF(P-S)13,13,1
   13 N=N+4
    1 N=N+1
      GGO TO (12,14,16,18,20,22,25,11,10,12,28,29,30,31,32,33,34,37,39,42
     1,44,46,49,51,53,54,56,58,60,61,65,67,71,11,10,44,74,75,76,77,78,79
     4,80,81,82,83,84,85,86,90,92,95,120),N
    2 IF(C)110,110,1
    3 IF(C)115,115,1
   14 K=129
   15 G=-((PS-SS)**.5)
            H=PS/G
            D=Z*H/(Z-H)
            W=Q*S
            C=-U-W-G
            GO TO 2
   16 K=140
   17 F=C+W
            W=(4.*S+(U+G)**2/S)/Q
            C=W*F/(W-F)
            GO TO 2
   18 K=189
   19 W=P/Q
            C=G-U
            D=-(1./(1./H+1./W+1./Z))
            GO TO 2
   20 K=169
   21 F=W*D/(W+D)
            W=Q*P/(4.+(B*(H+Z)/H)**2)
            D=F-W
            GO TO 2
   22 K=819
   23 W=R/Q
            F=R/(1.+(A*(X+W)/W)**2)
            IF(P-F)1,1,24
   24 G=-((F*(P-F))**.5)
            C=-G-F*(Q+A)
            D=P*F/(G-B*F)
            GO TO 2
   25 K=192
   26 W=QT
            F=T+(V+W)**2/T
            IF(F-S)1,1,27
   27 C=-((S*(F-S))**.5)-U
            D=-(F*S/(U+C+S*QV))
            GO TO 2
   28 K=921
            GO TO 15
   29 K=991
            GO TO 17
   30 K=981
            GO TO 19
   31 K=961
            GO TO 21
   32 K=918
            GO TO 23
   33 K=291
            GO TO 26
   34 K=183
            G=S*T*(2.+Q**2)-SS-T**2
            IF(G)1,35,35
   35 D=S*(QT+G**.5)/(S-T)-U
   36 C=-V-T*(Q+(U+D)/S)
            W=(S+(U+D)**2/S)/Q
            GO TO 2
   37 K=183
            IF(G)1,38,38
   38 D=S*(QT-G**.5)/(S-T)-U
            GO TO 36
   39 K=729
            G=R*P*Q**2-(R-P)**2
            IF(G)1,40,40
   40 H=(R-P)/(G**.5/R-Q)
   41 D=X*H/(X-H)
            C=-(P/(B+R/H+Q))
            W=Q*R/(1.+(R/H)**2)
            GO TO 2
   42 K=729
            IF(G)1,43,43
   43 H=(P-R)/(G**.5/R+Q)
            GO TO 41
   44 IF(P-S)45,45,1
   45 N=N+8
            GO TO 1
   46 K=821
   47 G=(PS-SS)**.5
            E=PS/Z
            H=B*S
   48 Y=PS/(G-E)
            W=Q*S-G-E
            C=-U-W-G
            GO TO 3
   49 K=823
   50 F=C+W
            W=(4.*SS+(U+G)**2)/(Q*S-G+E)
            C=W*F/(W-F)
            GO TO 3
   51 K=821
   52 G=-G
            GO TO 48
   53 K=823
            GO TO 50
   54 K=982
   55 W=G-U
            Y=PS/(S*Q-W)
            C=-(1./(G/PS+1./Y+1./Z))
            GO TO 3
   56 K=782
   57 F=Y*C/(Y+C)
            Y=PS/(4.+(B+G/S)**2)*(S*Q-W)
            C=F-Y
            GO TO 3
   58 K=982
   59 G=-G
            GO TO 55
   60 K=782
            GO TO 57
   61 K=928
   62 C=-(P/(A+B+Q))
            F=P/(1.+(A+Q)**2)
            IF(R-F)1,63,63
   63 H=(F*(R-F))**.5
   64 W=F*(A+Q)-H
            Y=R*F/(H-F*A)
            GO TO 3
   65 K=928
            IF(R-F)1,66,66
   66 H=-H
            GO TO 64
   67 K=281
   68 C=-(S*QV)-U
            F=S+(U+C)**2/S
            IF(F-T)1,69,69
   69 W=(T*(F-T))**.5-V
   70 Y=F/(Q-W/T)
            GO TO 3
   71 K=281
   72 IF(F-T)1,73,73
   73 W=-((T*(F-T))**.5+V)
            GO TO 70
   74 K=128
            GO TO 47
   75 K=328
            GO TO 50
   76 K=128
            GO TO 52
   77 K=328
            GO TO 50
   78 K=289
            GO TO 55
   79 K=287
            GO TO 57
   80 K=289
            GO TO 59
   81 K=287
            GO TO 57
   82 K=829
            GO TO 62
   83 K=829
            GO TO 66
   84 K=182
            GO TO 68
   85 K=182
            GO TO 72
   86 K=294
            E=1.-T/S
            F=U+V+QT
            G=SS+U**2-S*T*(1.+QV**2)
            H=F**2-E*G
            IF(H)1,88,88
   88 W=-((F+H**.5)/E)
   89 Y=T*(Q-W/S)
            C=-((S+(U+W)**2/S)/(QV+U/S))
            GO TO 3
   90 K=294
            IF(H)1,91,91
   91 W=(H**.5-F)/E
            GO TO 89
   92 K=618
            F=R*(Q+B)+P*A
            G=R-P+R*(Q+B)**2-P*A**2
            H=F**2+(P-R)*G
            IF(H)1,93,93
   93 E=(F+H**.5)/(R-P)
   94 W=R/E
            Y=P/(Q-E)
            C=(R*(Q+A+B)/(1.+(E+A)**2))
            GO TO 3
   95 K=618
            IF(H)1,96,96
   96 E=(F-H**.5)/(R-P)
            GO TO 94
    6 FORMAT(F12.4)
  101 READ 6,R
            GO TO 8
  102 READ 6,CO
            GO TO 8
  103 READ 6,P
            GO TO 8
  104 READ 6,CI
            GO TO 8
  105 READ 6,FQ
            GO TO 8
  106 READ 6,Q
    8 READ 151,M
```

(continued on page 110)

(continued from page 109)

```
335. =          151 FORMAT(I1)
336. =              GO TO (101,102,103,104,105,106,7,99,9),M
337. =          110 IF(D)111,111,1
338. =          111 IF(I)112,113,99
339. =          112 PRINT 152
340. =          152 FORMAT(5X,2H K,8X,5H C1,7,7X,5H C3,9,4X,16H L2,8,(4,6) (UH))
341. =          113 CC=-(1000000./O/C)
342. =              CF=-(1000000./O/D)
343. =              UL=W/O
344. =              PRINT 153,K,CC,CF,UL
345. =          153 FORMAT(5X,I3,2F12.2,F12.4)
346. =              I=0
347. =              GO TO 1
348. =          115 IF(Y)1,116,116
349. =          116 IF(W)1,117,117
350. =          117 IF(I)118,118,119
351. =          118 PRINT 154
352. =          154 FORMAT(5X,2H K,4X,11H C1,9,(3,7),4X,5H L4,8,7X,5H L2,6)
353. =          119 CC=-(1000000./O/C)
354. =              UH=Y/O
355. =              UL=W/O
356. =              PRINT 155,K,CC,UH,UL
357. =          155 FORMAT(5X,13,F12.2,2F12.4)
358. =              I=1
359. =              GO TO 1
360. =          120 IF(I)121,122,122
361. =          121 PRINT 156
362. =          156OFORMAT(49H SORRY, NO MATCH; CHANGE Q IF POSSIBLE OR USE TWO,/57H N
                   4ETWORKS MATCHED TO AN INTERMEDIATE, VIRTUAL RESISTANCE.)
363. =          122 IF(J)99,123,8
364. =          123 PRINT 157
365. =          157OFORMAT(48H MODIFY PROGRAM BY ENTERING M: M=1 FOR RO, 2 CO,/,52H 3
                   4RI, 4 CI, 5 FREQ, 6 Q, 9 RO-Q, 7 RESTART, 8 EXIT.)
366. =              J=1
367. =              GO TO 8
368. =           99 PAUSE
369. =              END
370. +READY
```

Table 3. Effects of varying stabiilty factor

K	G_T	RS	R1	RL	RO
1.0001	106.4	99	– 99	1976	– 1.976
1.2	41.8	89	– 111	1773	– 2.222
3	27.7	53	– 317	1051	– 6.346
4	26.0	45	– 706	900	– 14.112
5	24.8	40	– 4.974	797	– 99.488
5.20	24.6	39	–357.998	780	–7.160.140
5.21	24.6	39	+147.378	779	+2.947.953
5.3	24.6	39	10.915	772	218.317
6	24.0	36	1.482	722	29.643
7	23.3	33	759	665	15.187
10	21.9	28	412	550	8.233
20	19.1	19	301	383	6.026
50	15.4	12	308	239	6.161
100	12.5	8	336	168	6.720

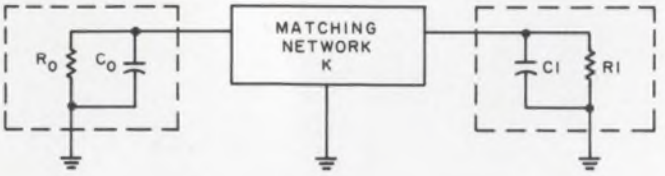
Gain and termination resistance as a function of stability factor for 2N4957 at 150 MHz.

Table 4. Results of y-parameter variation

	+20%		−20%	
	K	G_T	K	G_T
G11	6.59	23.52	6.40	23.78
B11	6.49	23.65	6.49	23.65
0%*	6.49	23.65	—	—
B12	5.41	23.73	8.11	23.61
G21	5.14	25.39	8.75	21.69
B21	6.90	23.62	6.10	23.71
G22	6.57	23.55	6.42	23.75
B22	6.49	23.65	6.49	23.65
20%**	3.96	26.00	12.08	21.61
10%**	5.01	24.78	8.68	22.59

* Nominal values ** Composite worst case

Stability and Gain as a function of parameter variation for 2N4957 at 150 MHz and GS=25.0, GL=1.6667.



3. **These are the variables** that the ZMATCH program considers in computing the various suitable combinations of L and C which will make up a suitable matching network, K.

shows the cumulative effect of varying all parameters ±20% and ±10% in the worst-case direction.

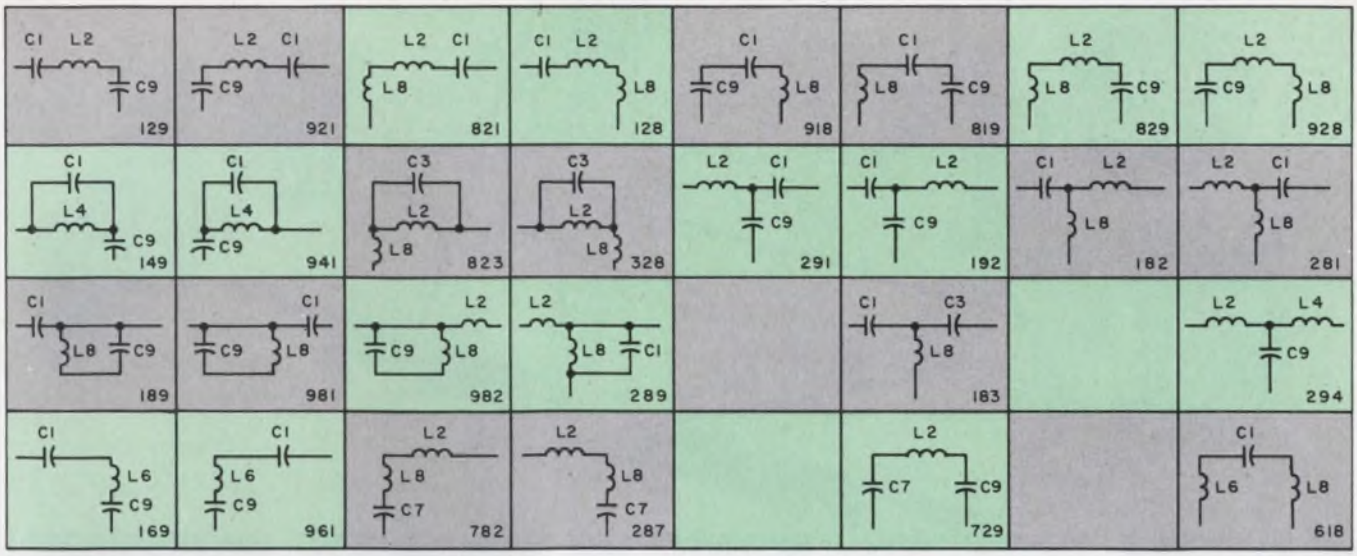
Select a matching network

When all effective device input and output impedances in a system have been established and system terminations are known, we're ready to start the design of matching networks. The control of tuning, loaded Q and conditions of maximum power transfer constitute three circuit conditions which must be satisfied; hence there are three variables and a minimum of three reactive components in the matching network.

ZMATCH examines all 28 possible combinations (Fig. 4), many of which have two solutions, infinity at about 5.2 and then goes negative. The for a total of 44 possible readouts. Each configuration is identified by a number, *K*, consisting of three digits. Capacitors are represented by odd digits, and coils by even digits. Components in series have values below 5, and components in shunt (usually to rf ground) have values above 5, making it easy to identify network type without a chart. Component Qs are assumed to be relatively high with respect to loaded network Q.

Figure 2 shows a sample run (entries by engineer are shown "boxed in"). The entered inputs are defined in Fig. 3, and consist of parallel output and input resistances and capacitances. No less than 24 solutions follow, but most of them have unsuitable component values.

Number 921 is a useful one. It has a series



4. **All possible combinations of L and C** are provided by ZMATCH to fit a specific matching speed.

capacitor (1) for dc blocking, and a series inductor (2). The inductor permits longer leads, including ground return paths, since these leads become natural parts of the network inductance and make the network more physically realizable. There are only two paths of reactive current: one right into the base of the next stage; the other through the shunt capacitor (9), which can be physically close to the first stage, so that this current is confined locally.

Number 618 has the dc blocking capability and saves two rf chokes; but there is a total of three current paths, and the collector coil current must also pass the collector supply bypass capacitor and associated paths back to the emitter.

The sample run shows next a modification in the form of changing Q from 20 to 5. Only three networks are possible. Next, a new set of data are entered, with no solutions, but with a suggestion to change Q. Increasing Q to 10 subsequently produces seven solutions.

The program can also be used to match a resistive load, say a 50-Ω transmission line. The requested capacitance input must then be entered as 0.01 pF, or less, but not zero (which will result in forbidden divisions by zero in the program).

As the sample run suggests, in difficult cases it is possible to use two matching networks matched to an intermediate virtual resistance to obtain the desired Q. The two networks may then have two or more components combined, resulting in a 4-5 component filter having the desirable characteristics. The Q used in each run should be such that the over-all Q is the desired one.

The ZMATCH program can be modified to work with only one desirable network type by simply inserting a statement of the type GO TO (14, 8), N, where statement 14—in this case—directs the action to filter number 129 and then straight back to read statement 8. The effects of parameter variation on component values for a particular network can then be checked for several runs without having to print out all the other network values. ■■

References:

1. J. C. Linvil and J. F. Gibbons, *Transistors and Active Circuits*, New York: McGraw-Hill Book Co., 1961.
2. "RF Small Signal Design Using Admittance Parameters," Motorola Semiconductor Products, Inc., Technical Information Note AN-215.

Test your retention

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

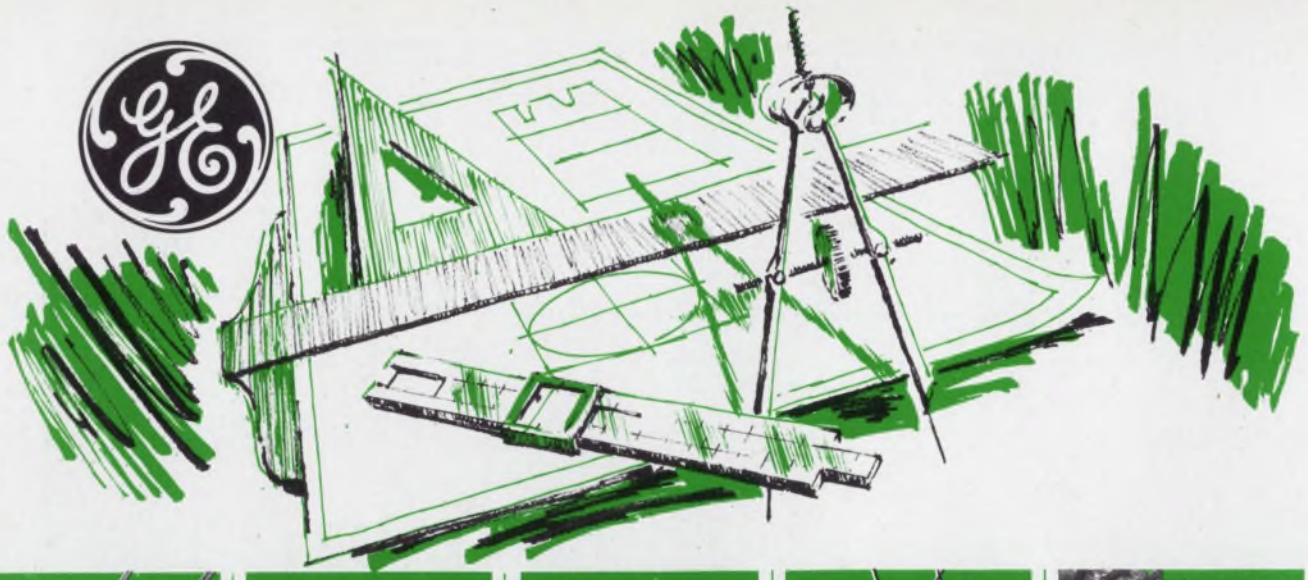
1. What type of parameters will the RFAMP program handle?

2. What was the advantage gained by using terminating resistances of less-than-ideal values?

3. What is one advantage to be gained in using the same stability factor in analyzing different transistors?

4. How many possible combinations of L/C matching networks are provided by ZMATCH?

5. In addition to amplifiers, what other types of circuitry can be matched using ZMATCH?



GE's 3 amp hermetic A15 replaces costlier rectifier diodes

GE offers a higher rated companion to its field-proved, 1 amp A14 rectifier at a significantly lower cost than stud or other lead mounted units (depending upon configuration). The A15 is rated 3 amps at 70 C and the 200 to 800 volt models are transient voltage protected up to 1000 watts for 20 μS in reverse direction.

A15's dual heat sink design means low thermal impedance and easy adaptation to PC board mounting . . . reduced installation cost.

Both the A15 and A14 are hermetically sealed in an all-diffused, glass passivated junction structure. No internal cavity means more resistance to environmental stresses . . . thus increased reliability.

High-power A15 is now available through GE distributors in quantities up to 9999 for applications including time delay circuits, battery chargers, TV damper diodes, communication equipment and small portable appliances. Circle number **784**.

Select your instruments from industry's most complete line

● **Panel meters.** Measure a-c, d-c volts and amps. 1½ to 4½-inch sizes in THE BIG LOOK® style. 2½ to 4½-inch sizes in HORIZON LINE® style.

● **Meter relays and pyrometers.** Indicate, monitor and control temperature or other variables directly or with transducers. BIG LOOK and HORIZON LINE style. 2½ to 4½-inch sizes. "Piggy-back" control module.

● **Edgewise meters.** Measure a-c and d-c volts and amps. Miniature type 185, 2¼ inch or large type 180, 6-inch. Both can be multi-stacked vertically or horizontally. Standard accuracy of 2%, 1% optional.

● **Switchboard instruments.** Measure volts, amps, speed, vars, power factor, frequency, phase angle, other variables. 4½ and 8½-inch sizes. Standard one percent accuracy. For full line information, circle **785**.

Reduce redesign cycles with reliable GE microwave circuit modules

GE microwave circuit modules (MCM) help reduce design cycles, provide retrofit and lead to improved system performance by optimum integration of active devices. And lower system cost results from circuit simplicity, easy application and longer life.

These rugged GE devices are built to deliver reliable performance in adverse environments of shock, vibration, high altitude and extreme temperatures. MCM's may be designed for use as oscillators, amplifiers, integrated isolators and circulators.

General Electric microwave modules encompass all planar triode and diode uses—from DC to X-band, from milliwatts to kilowatts. For details, circle number **786.**

GE wet slug capacitors . . . highest efficiency in half the size

GE 69F900 wet slugs meet high-density application needs with highest volumetric efficiency of any capacitor. We halved the military (CL64) wet slug size, and essentially kept its electrical and performance traits.

The 69F900 has excellent capacitance retention at low temps . . . can be stored to —65 C. Operating range is —55 C to +85 C. It's tough too—withstands vibration to 2000Hz; 15G acceleration!

GE's capacitor is fully insulated; has low, stable leakage current. Ratings are available from 6 to 60 volts; capacitance ranges from 0.5 to 450 μf. For more information, circle magazine reader card number **787.**

New 36 point one-piece Terminal Boards

General Electric has stretched its reliable line of one-piece terminal boards to 36 contact points. And they are available in eight configurations of solder, screw and quick-connect points.

The new expanded line of CR151, Type D1 or D7, is rated 15 amperes with breakdown voltage of 3600. Of course, other designs are still available in ratings up to 30 amperes and breakdown voltage to 7500.

No insulation is required between board and panel because the molded plastic base already provides the protection. Marking strips or stamped markings can be provided on top and/or bottom.

The expanded D1 and D7 boards add just another dimension to what is already the broadest terminal board line on the market. For more information, circle reader card number **788.**

10 more

electronic components tailored for designers

General Electric components are engineered for reliability and cost effectiveness. No other single manufacturer offers such a wide selection of quality electronic components as General Electric. Specify GE in your designs.

Complementary power transistors—up to 20W in audio applications

Complementary D27C/D27D silicone-encapsulated, planar, epitaxial power transistors have low collector saturation voltages and offer a dissipation of 8W total power with tab at 70 C. Their 0.5″ leads can be formed to fit TO-66 and TO-5 configurations.

Key Characteristics

Collector current
3 amps (continuous)
5 amps (peak)
Collector saturation voltage
D27C: 0.5V typ., 3.0A
D27D; -1.0V typ., -3.0A
Collector-to-emitter voltage
30 and 40 volts
Total power dissipation (with tab)
1.7W (free air at 50 C)
2.1W (free air at 25 C)
8.0W (tab at 70 C)
Forward current transfer ratio
120 max., 200 mA
Gain band width product
D27C: 50MHz typ.
D27D: 40MHz

Their small size and power handling capability offer a great variety of applications including drivers, voltage regulators, power switching, audio output for automobile or phono stereo, TV, radio. And they are color coded for identification. Circle number **789.**

Designing a radar? New GE 4-cell tetrode improves bandwidth 300%

Up go electronic bandwidths with GE's unique ZP-1081 "multicell" tetrode, a compact, air-cooled transmitting tube that incorporates four high-performance tetrode units in a single vacuum envelope. This innovation leads to very high transconductance and significantly low output capacitance, to provide high gain-bandwidth in amplifier circuits.

Electronic bandwidth of about 120 MHz has been demonstrated under RF power amplifier operation at 475 MHz. Related typical performances includes 70 KW of useful peak power output with a peak drive power of 15KW.

Output efficiency is close to 40%, and low operating voltages are used under RF grid-pulsed amplifier service. Bandwidth achieved is on the order of 200-300% of that available from previous tetrodes and associated circuitry operating at comparable power and frequency. For more information, circle number **790.**

GE's Economy Pack . . . proved thermistors at budget prices

Growing uses of printed circuit boards in new applications have demanded hermetically sealed temperature compensation units at lower cost. And in response to this need, GE has put its proven 1H-Series (negative temperature Coefficient) Thermistors in a new Economy Package.

As low as 16¢ each in OEM quantities, these high-quality units are available in 5%, 10%, 20% and 30% tolerances with Zero-Power Resistance Values from 18K to 56K ohms at 25 C.

1.125 inch gold-plated Dumet leads may be welded or soldered . . . ideal for PCB designs.

Proved quality at lower cost makes GE thermistors the answer to your PCB needs. For more facts on the GE Economy Package, circle number **791.**

Smallest 4-pole relay available anywhere . . . GE's 150 grid

The General Electric 150 grid sealed relay is now a better buy than ever. It's the smallest available. And three years of application experience rank it with the most reliable GE sealed relays ever designed.

Low in price, it is even less than GE's standard 4-pole relay which is 4 times larger.

It meets Mil Spec 5757E, rated 2 amps, 250 MW sensitivity, and has all welded construction. Ask for the best 4-pole sealed relay buy on the market—GE's Type 3-SBH 150 grid.

Circle number **792** for more information.

Instant response for driving computer peripherals

When your equipment calls for instant response—inertial time constants low as 1 millisecond—look to GE's new Hyper-Servo* motor. It can accelerate faster than any previous GE design.

The Hyper-Servo motor makes possible new performance capacity in motor-driven peripheral data processing equipment. It is available in 3.4-, 4.6-, 4.8- and 4.9-inch diameters. And look at these performances: torque-to-inertia ratios in excess of 350,000 rad/sec² and; cont torque ratings from 32 oz-in at 2700 rpm to 326 oz-in at 2800 rpm.

These and other high performance characteristics make the Hyper-Servo motor adaptable to nearly every computer peripheral drive application. Circle magazine inquiry card number **793.**

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Cut differential-amplifier design time.

Don't work out equations for each design — use handy tables, based on popular configurations.

The differential amplifier is a versatile circuit used in a variety of applications. Unfortunately, the equations used for design depend on the amplifier's configuration. Considerable design time can be saved if, instead of searching for the appropriate equations each time a differential amplifier is required, the designer uses a handy reference, like Tables 1 and 2. These are based on the following frequently used differential-amplifier configurations:

- One single-ended voltage input
- Two single-ended voltage inputs
- Two single-ended current inputs
- Differential input.

Differential-amplifier input resistance

Figure 1 shows the input circuit of a differential amplifier having one single-ended input. The other input has a resistance, R_s, to ground, so that both inputs see the same impedance. The impedance, Z_3, seen looking into the base of $Q2$ is obtained as follows:

$$Z_1 = h_{ib} + R_s/(\beta+1)$$

Where Z_1 is the input resistance of $Q1$:

Z_2 is the impedance seen at the constant bias source. It consists of R_e in parallel with the series combination of R_2 and Z_1. Since R_e is typically much greater than R_2+Z_1

$$Z_2 \simeq R_2 + h_{ib} + R_s/(\beta+1)$$

The impedance Z_3 seen by the external generator is

$$Z_3 = \beta(R_1+R_2+2r_e) + R_s$$

The input circuit, therefore, has the equivalent shown in Fig. 1b.

A voltage source at the other input can be handled in the same manner, with the first voltage source set equal to zero. The results can be combined by using superposition.

Single-ended voltage sources

Figure 2 shows a differential amplifier having two single-ended voltage sources, e_{s1} and e_{s2}. Base current i_{b1} causes collector currents i_a and i_b to flow. Base current i_{b2} causes collector currents i_c and i_d to flow. With e_{s2} set equal to zero, the input is exactly as shown in Fig. 1b. Therefore,

$$i_{b1} = e_{s1}/[2R_s+\beta(R_1+R_2+2r_e)]$$

The resulting collector currents are

$$i_a = i_b\,\beta e_{s1}/[2R_s+\beta(R_1+R_2+2r_e)]$$

Similarly, when e_{s1} is set equal to zero:

$$i_c = i_d = \beta e_{s2}/[2R_s+\beta(R_1+R_2+2r_e)]$$

Two different load conditions are possible and must be considered. These are:

- Z is an open circuit.
- Z has a finite value.

For Z open-circuited, the following results are obtained, using superposition:

$$e_1 = (i_d - i_a)R_3$$
$$e_1 = \beta R_3(e_{s2}-e_{s1})/[2R_s+\beta(R_1+R_2+2r_e)]$$
$$e_2 = (i_b - i_c)R_4$$
$$e_2 = \beta R_4(e_{s1}-e_{s2})/[2R_s+\beta(R_1+R_2+2r_e)]$$

Therefore,

$$e_2 - e_1 = \beta(R_3+R_4)(e_{s1}-e_{s2})/[2R_s+\beta(R_1+R_2+2r_e)]$$

Table 1 lists the design expressions for voltages e_2 and $(e_2 - e_1)$, along with simplifying expressions for two important cases. An expression for e_1 can be derived from e_2 by changing R_4 to R_3 and taking the negative of the expression.

For a finite value of Z, the following results are obtained using Fig. 2b:

$$i_1 = i_d - i_a = \beta(e_{s2}-e_{s1})/[2R_s+\beta(R_1+R_2+2r_e)]$$
$$i_2 = i_b - i_c = \beta(e_{s1}-e_{s2})/[2R_s+\beta(R_1+R_2+2r_e)]$$

and

$$e_1 = \frac{R_3(Z+R_4)}{R_3+Z+R_4} i_1 + \frac{R_3R_4}{R_3+Z+R_4} i_2$$

substituting for i_1 and i_2 and regrouping terms:

$$e_1 = \frac{R_3Z}{R_3+Z+R_4} \times \frac{\beta(e_{s2}-e_{s1})}{2R_s+\beta(R_1+R_2+2r_e)}$$

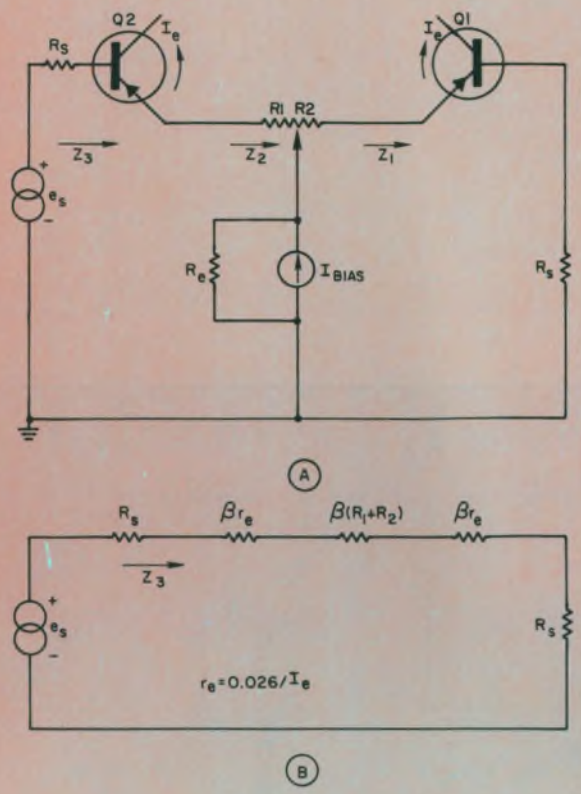
In a similar manner,

$$e_2 = \frac{R_4Z}{R_3+Z+R_4} \times \frac{\beta(e_{s1}-e_{s2})}{2R_s+\beta(R_1+R_2+2r_e)}$$

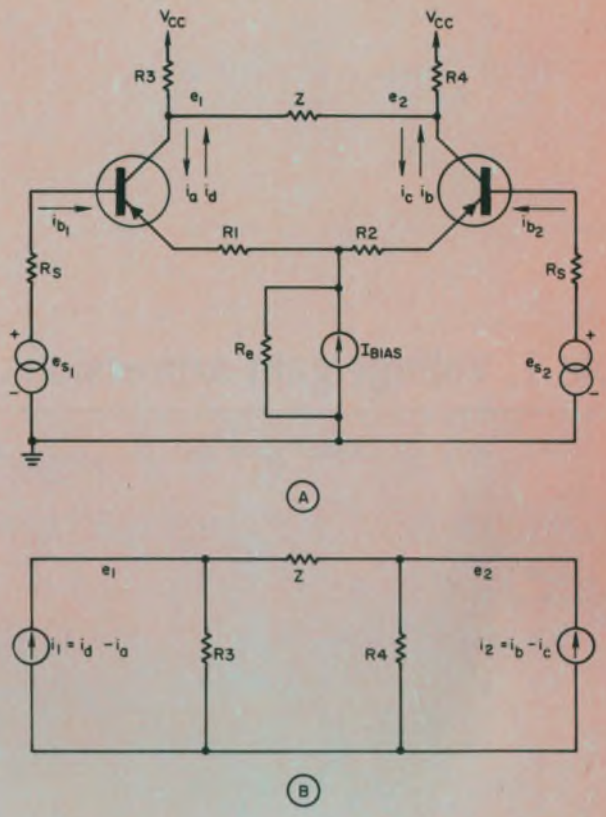
and, therefore,

$$e_2 - e_1 = \frac{(R_3+R_4)Z}{R_3+Z+R_4} \times \frac{\beta(e_{s2}-e_{s1})}{2R_s+\beta(R_1+R_2+2r_e)}$$

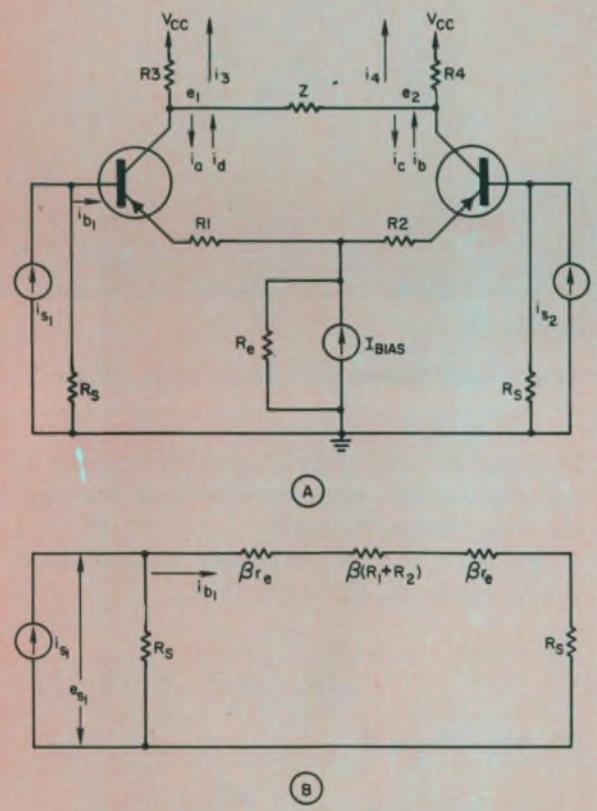
Sidney A. Friedman, Electronics Engineer, Cardion Electronics, Woodbury, N. Y.



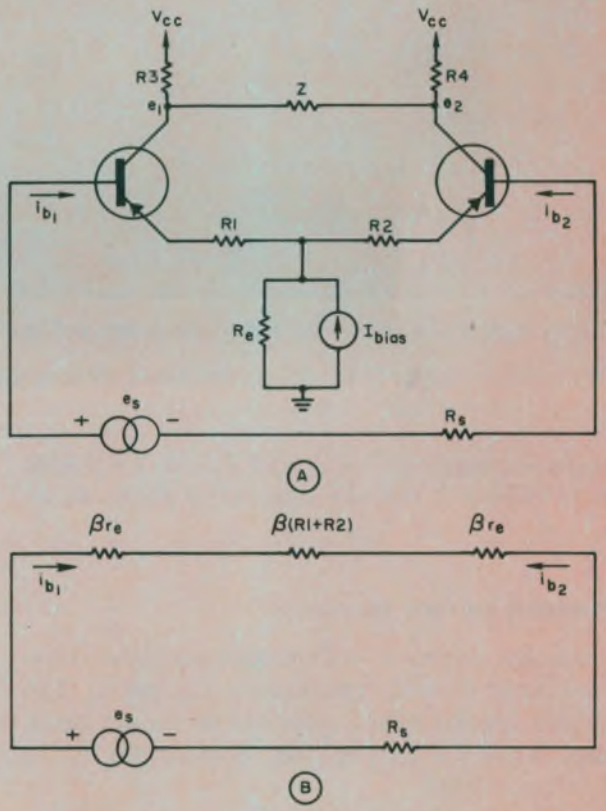
1. **Differential-amplifier input circuit** having a single input (A) has the equivalent circuit of (B).



2. **Differential amplifier with single-ended voltage sources** (A) has the equivalent circuit of (B).



3. **Differential amplifier with single-ended current sources** (A) has the equivalent circuit of (B) when $i_{s2} = 0$.



4. **Differential amplifier with floating input** (A) has the equivalent of (B). It can be handled with the equations of Table 1, using the appropriate D.

Table 1. Voltage-gain expressions

	Exact value	$r_e >> \frac{R_1 + R_2}{2} + \frac{R_s}{\beta}$	$R_1 + R_2 >> \frac{2R_s}{\beta} + 2r_e$
Z open circuited			
e	$\frac{\beta R_4}{D}(e_{s_1} - e_{s_2})$	$\frac{R_4}{2r_e}(e_{s_1} - e_{s_2})$	$\frac{R_4}{R_1 + R_2}(e_{s_1} - e_{s_2})$
$e_2 - e_1$	$\frac{\beta (R_3 + R_4)}{D}(e_{s_1} - e_{s_2})$	$\frac{R_3 + R_4}{2r_e}(e_{s_1} - e_{s_2})$	$\frac{R_3 + R_4}{R_1 + R_2}(e_{s_1} - e_{s_2})$
Finite Z			
e_2	$\frac{\frac{\beta R_4 Z}{R_3 + Z + R_4}}{D}(e_{s_1} - e_{s_2})$	$\frac{\frac{R_4 Z}{R_3 + Z + R_4}}{2r_e}(e_{s_1} - e_{s_2})$	$\frac{\frac{R_4 Z}{R_3 + Z + R_4}}{R_1 + R_2}(e_{s_1} - e_{s_2})$
$e_2 - e_1$	$\beta \cdot \frac{(R_3 + R_4) \mid\mid Z}{D}(e_{s_1} - e_{s_2})$	$\frac{(R_3 + R_4) \mid\mid Z}{2r_e}(e_{s_1} - e_{s_2})$	$\frac{(R_3 + R_4) \mid\mid Z}{R_1 + R_2}(e_{s_1} - e_{s_2})$

$D = 2(R_s + \beta r_e) + \beta (R_1 + R_2)$ for single-ended voltage inputs (Fig. 2).

$D = R_s + 2\beta r_e + \beta (R_1 + R_2)$ for single-ended current inputs (Fig. 3) and differential voltage input (Fig. 4).

Design expressions for e_2 and $(e_2—e_1)$ are also given in Table 2 for the case of a finite value of Z.

Single-ended current sources

Figure 3A shows a differential amplifier having two input current generators, i_{s1} and i_{s2}. The equivalent input circuit, with source i_{s2} set equal to zero, is shown in Fig. 3B. Solving for i_{b1} in terms of e_{s1} yields

$$i_{b1} = \frac{e_{s1}}{R_s + \beta(R_1 + R_2 + 2r_e)}$$

Observe that the denominator for a current source is almost the same as for a voltage source. The only difference is that $2R_s$ is replaced by R_s. This makes Table 1 hold equally for both voltage and current sources, provided that the appropriate denominator is used.

The current gain equations are obtained in a similar manner. For infinite Z:

$$i_2 = i_4 = i_b — i_c = \frac{\beta R_s (i_{s1} — i_{s2})}{[2R_s + \beta(R_1 + R_2 + 2r_{e2})]}$$

and for a finite Z:

$$i_3 = \frac{Z}{R_3 + Z + R_4} \times \frac{\beta R_s (i_{s2} — i_{s1})}{2R_s + \beta(R_1 + R_2 + 2r_e)}$$

$$i_4 = \frac{Z}{R_3 + Z + R_4} \times \frac{\beta R_s (i_{s1} — i_{s2})}{2R_s + \beta(R_1 + R_2 + 2r_e)}$$

The design expressions for the load current, i_3

Table 2. Current-gain expressions

	Exact value	$r_e >> \frac{R_1 + R_2}{2} + \frac{R_s}{\beta}$	$R_1 + R_2 >> \frac{2R_s}{\beta} + 2r_e$
Z open circuited			
$i_4 = -i_3$	$\frac{\beta R_s}{D}(i_{s_1} - i_{s_2})$	$\frac{R_s}{2r_e}(i_{s_1} - i_{s_2})$	$\frac{R_s}{R_1 + R_2}(i_{s_1} - i_{s_2})$
(For $i_{s_1} = -i_{s_2} = i_s$)			
$i_4 = -i_3$	$\frac{2\beta R_s}{D} i_s$	$\frac{R_s}{r_e} i_s$	$\frac{2R_s}{R_1 + R_2} i_s$
Finite Z			
$i_4 = -i_3$	$\frac{\beta R_s}{D} \cdot \frac{Z}{R_3 + Z + R_4}(i_{s_1} - i_{s_2})$	$\frac{R_s}{2r_e} \cdot \frac{Z}{R_3 + Z + R_4}(i_{s_1} - i_{s_2})$	$\frac{R_s}{R_1 + R_2} \cdot \frac{Z}{R_3 + Z + R_4}(i_{s_1} - i_{s_2})$
(For $i_{s_1} = -i_{s_2} = i_s$)			
$i_4 = -i_3$	$\frac{2\beta R_s}{D} \cdot \frac{Z}{R_3 + Z + R_4} i_s$	$\frac{R_s}{r_e} \cdot \frac{Z}{R_3 + Z + R_4} i_s$	$\frac{2R_s}{R_1 + R_2} \cdot \frac{Z}{R_3 + Z + R_4} i_s$

$D = 2(R_s + \beta r_e) + \beta(R_1 + R_2)$ for single-ended current inputs (Fig. 3)

and i_4, along with the forms for various simplifying cases, are listed in Table 2.

Differential voltage source

A differential (floating) voltage source applied between the two inputs is illustrated in Fig. 4a. The equivalent input circuit is shown in Fig. 4b. From the circuit,

$$i_{b1} = -i_{b2} = \frac{e_s}{R_s + \beta(R_1 + R_2 + 2r_e)}$$

Thus, the amplifier with a floating voltage source can be treated the same as for two single-ended voltage sources if the denominator, D, is changed to read $D = R_s + \beta(R_1 + R_2 + 2r_e)$. Table 1 can be used with the appropriate change in D. ■■

Test your retention

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

1. What are the important differential-amplifier input configurations?

2. What do the various configurations have in common?

3. What differences exist between the various configurations?

80 lines per second!

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Clevite 4800 is based on proprietary equipment and proprietary paper. There is nothing else quite like it. It's faster, more versatile, quieter and more dependable. Yet, the Clevite 4800 printer's low price will surprise you. Let's talk soon. Clevite Corporation, Graphics Group. 37th and Perkins, Cleveland, Ohio 44114.

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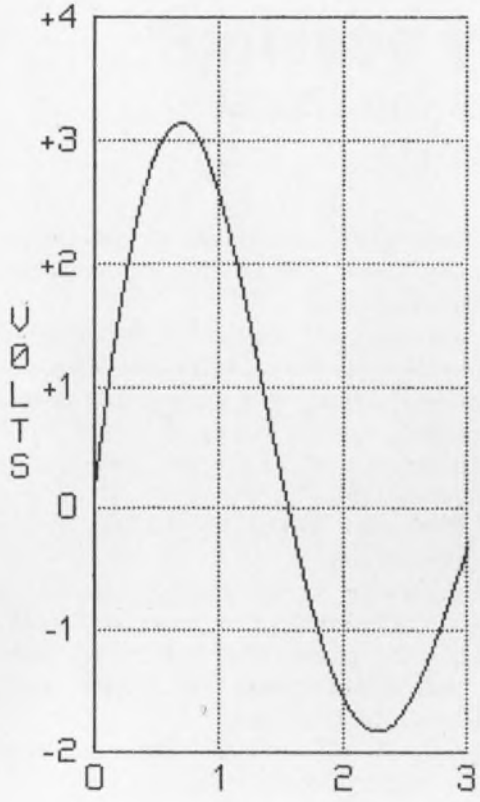
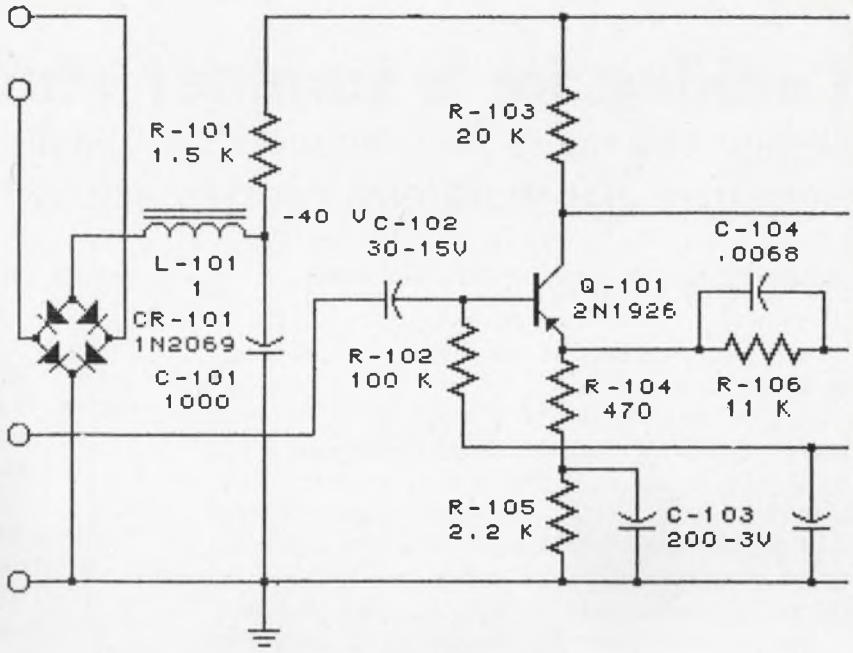
INFORMATION RETRIEVAL NUMBER 53

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

See Clevite 4800 at booth 805, Spring Joint Computer Conference in Boston.





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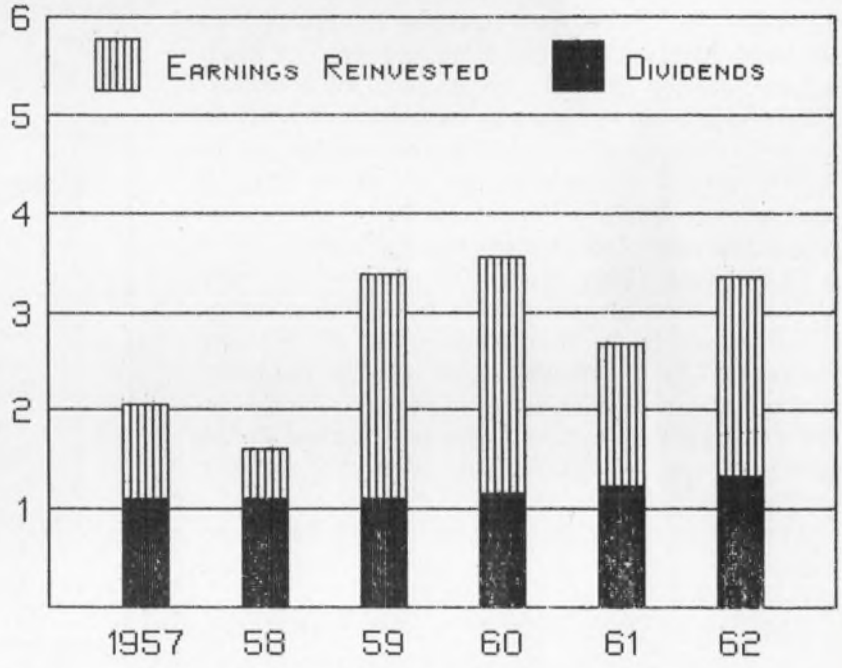

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Looking for a summer study session?

Design engineers and engineering managers can choose from over 200 short-term courses across the U.S.

Richard Turmail, Management & Careers Editor

Are you planning to do a little "short-term" studying this summer?

If so, this ELECTRONIC DESIGN guide to summer engineering courses, workshops and seminars will be helpful. The listing contains over 200 short-term (less than one month) courses that will be offered to design engineers and engineering managers in 22 states, the District of Columbia and Canada in June, July and August.

The courses are broken down into 12 categories (see box).

To help you determine what courses are available in your area of the country, the number or numbers that correspond to category numbers in the box have been placed at the end of each school address listing. (Example: **Ohio State**-Engineering Short Courses, Ohio State University, 2070 Neil Ave., Columbus, Ohio 43210 (1, 3, 6, 10), which means that the school is offering courses in Applied Mathematics, Communications, Infrared and Optics, and Systems.)

The schools listed may offer a wider category of courses than are designated here. The category numbers apply to this guide only. If you are interested in information on several summer courses at a school or schools, you may circle the Information Retrieval Number on the card in the back of the book that corresponds to the number on pages 120-121.

The courses are also listed by alphabetized categories. Dates of the courses are listed chronologically within each category.

The cost of most courses is given. However, you should check with the schools to determine whether or not these prices include housing, meals and other expenses.

The three management institutes listed offer courses at the following fees: American Management Association (AMA), for each 1-day meeting: members $55, non-members $65; for each 2-day meeting, $110 and $135; for each 3-day meeting, $165 and $190.

Industrial Education Institute (I.E.I.), 1-day seminar, $65 per person.

Management Center of Cambridge (MCC), 1 to 5 participants, $70 each; 6 or more, $65 each.

This listing is the result of a nationwide survey of more than 250 engineering colleges, universities and other institutions.

For a reprint of this course listing, circle No. **255** on the Information Retrieval Card.

Categories:

Where to write

(Or circle indicated numbers on the Information Retrieval Card for information.)

AMA—American Management Association, Course Register, 135 W. 50th St., New York, N.Y. 10020 (5) — **270**

Arizona—Electrical Engineering Department, University of Arizona, Tucson, Ariz. 85721 (7) — **271**

Automation Industries—Boulder, Colo. (6) — **272**

Cal Tech—Management Development Section, Industrial Relations Center, California Institute of Technology, Pasadena, Calif. 91109 (5) — **273**

C-E-I-R, Inc.—Institute for Advanced Technology, 5272 River Road, Washington, D.C. 20016 (2, 10) — **274**

Colorado—College of Engineering, University of Colorado, Boulder, Col. 80302 (3) — **275**

Connecticut—Box U-56, University of Connecticut, Storrs, Conn. 06268 (5, 8) — **276**

Cornell—Director of Continuing Education, College of Engineering, Cornell University, 251 Carpenter Hall, Ithaca, N.Y. 14850 (1, 4, 5, 6, 10, 11) — **277**

Dartmouth—Thayer School of Engineering, Dartmouth College, Hanover, N.H. 03755 (1, 5) 321

Geo. Washington—Short Course Program, Electrical Engineering Department, George Washington University, Washington, D.C. 20006 (3, 4, 8, 10, 12) 278

Georgia Tech—Department of Continuing Education, Georgia Institute of Technology, Atlanta, Ga. 30332 (5, 12) 279

IEI—Industrial Education Institute, 221 Columbus Avenue, Boston, Mass. 02116 (5) 280

Iowa State—Electrical Engineering Building, Iowa State University, Ames, Iowa 50010 (4, 12) 281

MCC—Management Center of Cambridge, P.O. Box 185, Harvard Square, Cambridge, Mass. 02138 (5) 282

Michigan—Engineering Summer Conferences, Chrysler Center, University of Michigan, North Campus, Ann Arbor, Mich. 48105 (1, 3, 4, 5, 6, 7, 9, 11, 12) 283

Mississippi State—EES, P. O. Box M, Mississippi State University, State College, Miss. 39762 (2) 284

M.I.T.—Summer Session, Room E19-356, Massachusetts Institute of Technology, Cambridge, Mass. 02139 (1, 3, 4, 5, 10) 285

N.C.U.I.H.—National Center of Urban & Industrial Health—Cincinnati, Ohio (1) 286

Nevada—Director, Continuing Education, University of Nevada, Reno, Nev. 89507 (6, 11, 12) 287

New Hampshire—Department of Electrical Engineering, Durham, N. H. (2) 288

Ohio State—Engineering Short Courses, Ohio State University, 2070 Neil Ave., Columbus Ohio 43210 (1, 3, 6, 10) 289

OPCS—Oyer Professional Computer Service, Inc., 369 Lexington Ave., New York, N.Y. 10017 (4) 322

Penn State—Seminars for Engineers, Pennsylvania State University, J. Orvis Keller Building, University Park, Pa. 16802 (5) 290

Purdue—Division of Conferences and Continuation Services, Purdue University, 116 Memorial Center, Lafayette, Ind. 47907 (1, 3, 5, 8, 10) 291

RCA—Institute for Professional Development, RCA Institutes, Inc., P. O. Box 962, Clark, N.J. 07066 (3, 4, 6, 7, 10) 292

Santa Clara-School of Engineering, Department of Electrical Engineering, The University of Santa Clara, Santa Clara, Calif. 95053 (4) 293

Texas—Engineering Institutes, College of Engineering, Division of Extension, University of Texas, Austin, Tex. 78712 (5, 7, 9, 10) 294

Texas A&M—Department of Electrical Engineering, Texas A&M University, College Station, Tex. 77843 (10) 295

UCLA—Program Promotion, University of California Extension, 6532 Boelter Hall, Los Angeles, Calif. 90024 (1, 2, 3, 4, 5, 6, 8, 9, 10, 12) 296

University College—Continuing Engineering Studies University College, 610 E. Fayette St., Syracuse, N.Y. 13202 (1, 3, 5, 6, 10) 297

USC—Noncredit Programs, University of Southern California, University College, University Park, Los Angeles, Calif. 90007 (1, 3, 4, 6, 10) 298

Utah—Summer School, University of Utah, Salt Lake City, Utah 84112 (1) 299

Washington—Institute for Continuing Education in Engineering and Applied Science, Washington University, St. Louis, Mo. 63130 (2, 5, 8) 267

Washington—Office of Short Courses and Conferences, University of Washington, 336 Lewis Hall, Seattle, Wash. 98105 (8) 268

Wisconsin—Institute Director, University of Wisconsin, 725 Extension Building, 432 N. Lake St., Madison, Wis. 53706 (1, 4, 12) 269

Applied Mathematics

Date	Course (and cost)	Location
June 2-6	Applied Statistics for Engineers ($175)	**Texas,** Austin
June 4-6	Introduction to the Design of Experiments ($250)	**C-E-I-R, Inc.** Wash., D.C.
June 9-11	Data Analysis ($250)	**C-E-I-R, Inc.** Wash., D.C.
June 9-13	Environmental Statistics—Sample Size Determination (no fee)	**N.C.U.I.H.,** Cincinnati
June 9-19	Statistical Methods and Advanced Quality Control ($300)	**Purdue,** Layfayette, Ind.
June 16-20	Introduction to Elec-Magnetic Theory ($200)	**Wisconsin,** Madison
June 16-27	Foundations of Information Systems Engineering ($400)	**Michigan,** Ann Arbor
June 16-27	Numerical Analysis ($400)	**Michigan**
June 16-27	Applications of Modern Mathematics ($375)	**UCLA,** Los Angeles
June 16-27	Recent Advances in Engineering Mathematics ($375)	**UCLA,** Los Angeles
June 18-20	Topics in Mathematic Programing and Optimization ($150)	**Cornell,** Ithaca, N.Y.
June 21-23	Quality Control by Statistical Methods ($300)	**Michigan,** Ann Arbor
June 30-July 11	Decision Analysis for Engineers and Scientists ($650)	**Dartmouth,** Hanover, N.H.
July 7-18	Statistical Method in Modern Experimentation ($450)	**M.I.T.,** Cambridge
July 7-18	Physiological Systems Analysis for Engineers ($350)	**Michigan,** Ann Arbor
July 7-18	Applied Probability and Statistics ($375)	**UCLA,** Los Angeles
July 8-10	Statistical Experimental Design for Engineering ($120)	**University College,** Syracuse

Date	Course (and cost)	Location
July 12	Numerical Methods Using Fortran	**Utah,** Salt Lake City
July 14-18	Numerical Analysis and Computer Methods in Engineering Systems ($275)	**UCLA,** Los Angeles
July 21-Aug. 1	Matrix Error Analysis ($375)	**UCLA,** Los Angeles
July 28-Aug. 1	Engineering Application of Modern Operational Mathematics ($200)	**Ohio State,** Columbus
July 28-Aug. 8	Mathematical Biosciences ($375)	**USC,** Los Angeles
Aug. 18-29	Applied Stochastic Processes ($375)	**UCLA,** Los Angeles

Automatic Controls

June 9-11	Nonlinear Programing ($250)	**C-E-I-R,** Inc., Wash., D.C.
June 16-21	Digital Control System Design ($225)	**New Hampshire,** Durham
July 14-18	Sampled-Data Short Course ($150)	**Mississippi St.,** State College
July 17-18	Guidance and Control of Missiles Aircraft, Helicopters and Space Vehicles ($375)	**UCLA,** Los Angeles
July 21-25	Guidance and Control of Tactical Missiles ($275)	**UCLA,** Los Angeles
Aug. 11-15	Introduction to Process Computer Control ($275)	**UCLA,** Los Angeles
Aug. 11-22	Optimal Control: Theory and Applications ($375)	**UCLA,** Los Angeles
Aug. 18-20	Digital Controls ($295)	**RCA,** Palo Alto, Calif.
Aug. 18-23	Current Trends in Automatic Control Theory	**Washington,** St. Louis

Communications

June 9-11	IEEE International Conference on Communications ($18-M, $23-NM)	**Colorado,** Boulder
June 9-13	Digital Communications ($390)	**RCA,** Minneapolis
June 16-20	Communications Systems ($275)	**George Washington,** Wash., D.C.
June 23-July 3	Speech Communication ($450)	**M.I.T.,** Cambridge
July 7-11	Application of Stripline Components to Microwave Signal Processing ($200)	**University College,** Syracuse
July 14-18	Digital Communications ($390)	**RCA,** Palo Alto, Calif.
July 14-25	Communications Systems ($375)	**UCLA,** Los Angeles
July 14-25	Introduction to Statistical and Digital Communication Theory ($275)	**Ohio State,** Columbus
July 14-25	Communication Systems: Theory and Applications ($375)	**UCLA,** Los Angeles
July 21-25	Digital Communications Systems ($225)	**Michigan,** Ann Arbor
July 21-25	Application of State-Variable Techniques to Communications Systems ($300)	**M.I.T.,** Cambridge
July 21-25	Digital Communications ($390)	**RCA,** Los Angeles
Aug. 4-15	Digital Communications ($375)	**USC,** Los Angeles
Aug. 25-29	Digital Communications $390)	**RCA,** Wash., D.C.

Computers, Computer-Aided Design

June 2-6	Logic Design ($390)	**RCA,** Wash., D.C.
June 9-10	Computer Programing for EES; Problem Solving for EES Using Time Shared Computers ($100 IEEE members; $110 non-members)	**OPCS** Chicago
June 9-20	Computer Graphics for Designers ($450)	**Michigan,** Ann Arbor
June 9-20	Computer Models and Simulation Techniques for Power System Engineering ($300)	**Wisconsin,** Madison
June 16-20	Computer-Aided Circuit Design ($300)	**George Washington,** Wash., D.C.
June 16-27	Computer and Program Organization ($375)	**Michigan,** Ann Arbor
June 23-27	Automatic Text and Picture Processing ($200)	**Cornell,** Ithaca, N.Y.
June 23-27	Computer Methods in Structural Dynamics ($275)	**USC,** Los Angeles
June 23-July 3	Advances in Digital Computer Systems Design ($375)	**UCLA,** Los Angeles
July 6-Aug. 1	Computer Fundamentals and Data Transmission ($800)	**Iowa State,** Ames
July 7-11	Matrix Computer Methods in Engineering Systems ($275)	**UCLA,** Los Angeles
July 7-18	Hybrid Computation ($375)	**UCLA,** Los Angeles
July 14-18	Logic Design ($390)	**RCA,** Boston
July 14-25	Computer Systems Analysis Methodology ($375)	**UCLA,** Los Angeles
July 21-25	Computer Oriented Techniques for Pattern Recognition ($275)	**USC,** Los Angeles
July 21-25	Introduction to Digital Logic ($200)	**Wisconsin,** Madison
July 21-Aug. 1	Modern Computer Systems ($375)	**UCLA,** Los Angeles
July 21-Aug. 8	Computer Methods for Power System Analysis ($400)	**Santa Clara,** Santa Clara
July 27-Aug. 1	Applications of Computers to Automated Design ($225)	**Michigan,** Ann Arbor
July 28-Aug. 1	Computer-Aided Mathematical Modeling ($250)	**University College,** Syracuse
July 28-Aug. 1	Fortran Programing & Engineering Applications of Numerical Methods ($225)	**Ohio State,** Columbus
July 28-Aug. 1	Computers and Modern Process Control ($150)	**Purdue,** Lafayette
July 28-Aug. 8	Computer Applications in Naval Architecture and Ocean Engineering ($450)	**M.I.T.,** Cambridge
Aug. 4-8	Logic Design ($390)	**RCA,** New York

Date	Course (and cost)	Location
Aug. 4-15	Digital Simulation of Avionic Systems ($375)	**UCLA,** Los Angeles
Aug. 11-15	Question Answering and Theorem Proving by Computer ($275)	**UCLA,** Los Angeles
Aug. 18-29	Computer Methods of Network Analysis ($375)	**UCLA,** Los Angeles
Aug. 18-29	Computer Applications with Linear/Nonlinear Programing Optimization Procedures ($375)	**UCLA,** Los Angeles

Engineering Management

June 2-4	Data Processing Management	**AMA,** Los Angeles
June 2-6	Management Dynamics and Effective Decision Making ($175)	**Georgia Tech.,** Atlanta
June 4	Information Retrieval Systems ($70)	**MCC,** Cleveland
June 4-6	Data Processing Management	**AMA,** Los Angeles
June 5	Information Retrieval Systems ($70)	**MCC,** Chicago
June 6	Information Retrieval Systems ($70)	**MCC,** Detroit
June 9	Planning and Administering Executive's Development $300)	**Cal Tech.,** Pasadena, Calif.
June 9	Managing Your Drafting and Design Function More Efficiently	**I.E.I.** Atlanta
June 9-13	Management for Engineers ($175)	**Georgia Tech.**
June 10	Managing Your Drafting and Design Function More Efficiently	**I.E.I.** Houston
June 11	Managing Your Drafting and Design Function More Efficiently	**I.E.I.** Dallas
June 15-20	The Twelfth Quality Control Management Institute ($350)	**Connecticut,** Storrs
June 15-20	R&D Management Seminar	**Pennsylvania State,** University
June 16	Managerial Aspects of Supervision ($300)	**Cal Tech.,** Pasadena
June 16	Coordinating Enigineering & Sales Relationships	**MCC,** Seattle
June 16-18	Data Automation	**AMA,** Chicago
June 16-18	Documentation	**AMA,** Chicago
June 16-27	Advanced Topics in Systems Programing ($375)	**Michigan,** Ann Arbor
June 16-27	Computer and Program Organization ($375)	**Michigan,** Ann Arbor
June 17	Coordinating Engineering and Sales Relationships	**MCC,** Portland, Ore.
June 17-27	Industrial Dynamics ($700)	**M.I.T.,** Cambridge
June 18	Coordinating Engineering and Sales Relationships	**MCC,** San Francisco
June 18-20	Computer Programing	**AMA,** Chicago
June 18-20	Simulation	**AMA,** Chicago
June 18-20	Real Time	**AMA,** Houston
June 19	Coordinating Engineering and Sales Relationships	**MCC,** Los Angeles
June 20	Coordinating Engineering and Sales Relationships	**MCC,** San Diego
June 23-25	Data Communication Systems	**AMA,** New York
June 23-28	Management Seminar in Reliability Engineering Operations ($425)	**UCLA,** Los Angeles
June 23-July 18	Modern Engineering Concepts for Technical Managers ($1600)	**Cornell,** Ithaca, N.Y.
June 23-July 3	Mathematical Programing ($550)	**M.I.T.,** Cambridge
July 7-9	Data Processing Management	**AMA,** Chicago
July 7-11	Management of Engineering, Scientific and Technical Personnel ($375)	**Nevada,** Reno
July 7-18	Frontiers in Investment Management and Analysis ($800)	**M.I.T.,** Cambridge
July 7-25	Engineering Management	**Nevada,** Reno
July 14-16	Data Processing Management	**AMA,** New York
July 14-18	Management of the Quality Function (no fee)	**Washington,** St. Louis
July 14-18	Selection of Development Projects to Yield Optimum Returns ($200)	**University College,** Syracuse
July 14-18	Managing Technical Personnel ($150)	**Cornell,** Ithaca, N.Y.
July 14-18	Material Handling Planning and Management Short Course ($300)	**Purdue,** Lafayette, Ind.
July 14-25	Management Science in Marketing ($700)	**M.I.T.,** Cambridge
July 14-25	Management Applications of Mathematical Programing ($300)	**Georgia Tech.,** Atlanta
July 16	Estimating and Controlling Engineering Costs	**MCC,** Toronto
July 16-18	Computer Programing	**AMA,** New York
July 17	Estimating and Controlling Engineering Costs	**MCC,** Montreal
July 21-23	Critical Path Method (CPM) ($120)	**University College,** Syracuse
July 21-Aug. 1	Models for Financial Management and Long-Range Financial Planning ($800)	**M.I.T.,** Cambridge
July 28-Aug. 1	Management and Improvement Symposium 1969 ($200)	**Georgia Tech.,** Atlanta
Aug. 4-6	Data Communication Systems	**AMA,** New York
Aug. 4-6	Data Processing Management	**AMA,** New York

Date	Course (and cost)	Location
Aug. 4-6	Data Processing Management	**AMA,** Chicago
Aug. 4-9	Engineering Design ($350)	**Dartmouth,** Hanover, N.H.
Aug. 4-15	Foundation and Tools for Operations Research and Management Sciences ($400)	**Michigan,** Ann Arbor
Aug. 6-8	Data Automation	**AMA,** Chicago
Aug. 6-8	Audits and Control	**AMA,** New York
Aug. 11-13	Interpersonal Relations for Engineering Managers ($150)	**Texas,** Austin
Aug. 11-22	Management Information Systems ($800)	**M.I.T.,** Cambridge
Aug. 18-29	Computer Applications with Linear/Nonlinear Programming Optimization Procedures ($375)	**UCLA,** Los Angeles

Infrared and Optics

June 2-6	Fundamentals of Infrared Technology ($225)	**Michigan,** Ann Arbor
June 2-6	Electron Microscopy—Theory and Applications in Solid State Science ($400)	**University College,** Syracuse
June 9-13	Advanced Infrared Technology ($225)	**Michigan,** Ann Arbor
June 9-13	Modern Optics ($390)	**RCA,** Dallas
June 16-20	Infrared Radiometry—Instrument Calibrations and Precision Measurements ($250)	**Michigan,** Ann Arbor
June 16-20	Applied Optics ($200)	**Wisconsin,** Madison
June 16-27	Lens Design ($375)	**UCLA,** Los Angeles
June 23-27	Modern Optics ($390)	**RCA,** Palm Beach, Fla.
June 23-27	Materials Evaluation: Infrared ($200)	**Automation Industries,** Boulder, Colo.
June 23-July 2	Fundamentals of Electron Beam Technology ($320)	**University College,** Syracuse
June 23-July 11	Lasers—Quantum Mechanics—Holography ($275)	**UCLA,** Los Angeles
July 7-11	Industrial Radiography, X-Ray and Gamma Ray ($190)	**Nevada,** Reno
July 14-18	Modern Optics ($390)	**RCA,** Chicago
July 14-25	Laser Engineering ($300)	**Ohio State,** Columbus
July 14-25	Electron and Light Microscopy ($400)	**Cornell,** Ithaca, N.Y.
July 21-22	Applications of Infrared and Thermal Techniques in Material Analysis ($100)	**Nevada,** Reno
July 21-Aug. 1	Fundamentals of Applications of Optical Data Processing and Holography ($350)	**Michigan,** Ann Arbor
July 28-Aug. 1	Modern Optics ($390)	**RCA,** Rochester, N.Y.
July 28-Aug. 1	Recognition of Two Dimensional Images and Image Processing ($275)	**USC,** Los Angeles
Aug. 11-15	Modern Optics ($390)	**RCA,** Wash., D.C.
Aug. 11-15	Applications of Optical Mehods to Microwave Problems ($175)	**Ohio State,** Columbus
Aug. 11-22	Image Processing ($375)	**UCLA**
Aug. 25-29	Modern Optics ($390)	**RCA,** Los Angeles

Integrated Circuits

June 2-4	Integrated Circuits ($295)	**RCA,** Palo Alto, Calif.
June 9-11	Advanced Device and Circuit Modeling ($180)	**Michigan,** Ann Arbor
June 9-11	Integrated Circuits ($295)	**RCA,** San Diego, Calif.
June 9-13	Integrated Circuits ($225)	**Michigan**
July 7-18	The Third Annual Integrated Circuits Summer Institute of Fabrication and Design	**Arizona,** Tucson
July 14-16	Integrated Circuits ($295)	**RCA,** Wash., D.C.
July 28-Aug. 8	The Third Annual Integrated Circuits Summer Institute of Fabrication and Design	**Arizona,** Tucson
Aug. 4-6	Integrated Circuits ($295)	**RCA,** Chicago
Aug. 11-15	Integrated Circuits ($175)	**Texas,** Austin
Aug. 25-27	Integrated Circuits ($295)	**RCA,** Boston

Reliability

June 1-13	The Ninth Annual Reliability Institute ($395)	**Connecticut,** Storrs
June 9-13	Principles of Reliability for Engineers ($160)	**Purdue,** Lafayette
June 9-13	Reliability and Failure Analysis ($375)	**George Washington,** Wash., D.C.
June 16-27	Systems Safety Analysis ($350)	**Washington,** Seattle
June 23-28	Management Seminar in Reliability Engineering ($425)	**UCLA,** Los Angeles
July 7-18	Reliability and Maintainability Workshop ($295)	**Washington,** St. Louis
July 7-18	Design by Reliability ($375)	**UCLA**

Semiconductors

June 2-6	Semiconductor Circuits ($225)	**Michigan,** Ann Arbor
July 14-16	Introduction to Solid State Electronic Devices ($125)	**Texas,** Austin
July 21-Aug. 1	Radiation Effects on Semiconductors ($375)	**UCLA,** Los Angeles
July 28-Aug. 1	Solid State Electronic Devices ($175)	**Texas,** Austin

Date	Course (and cost)	Location
Aug. 4-15	Microwave Solid State Electronics ($350)	**Michigan,** Ann Arbor

Systems

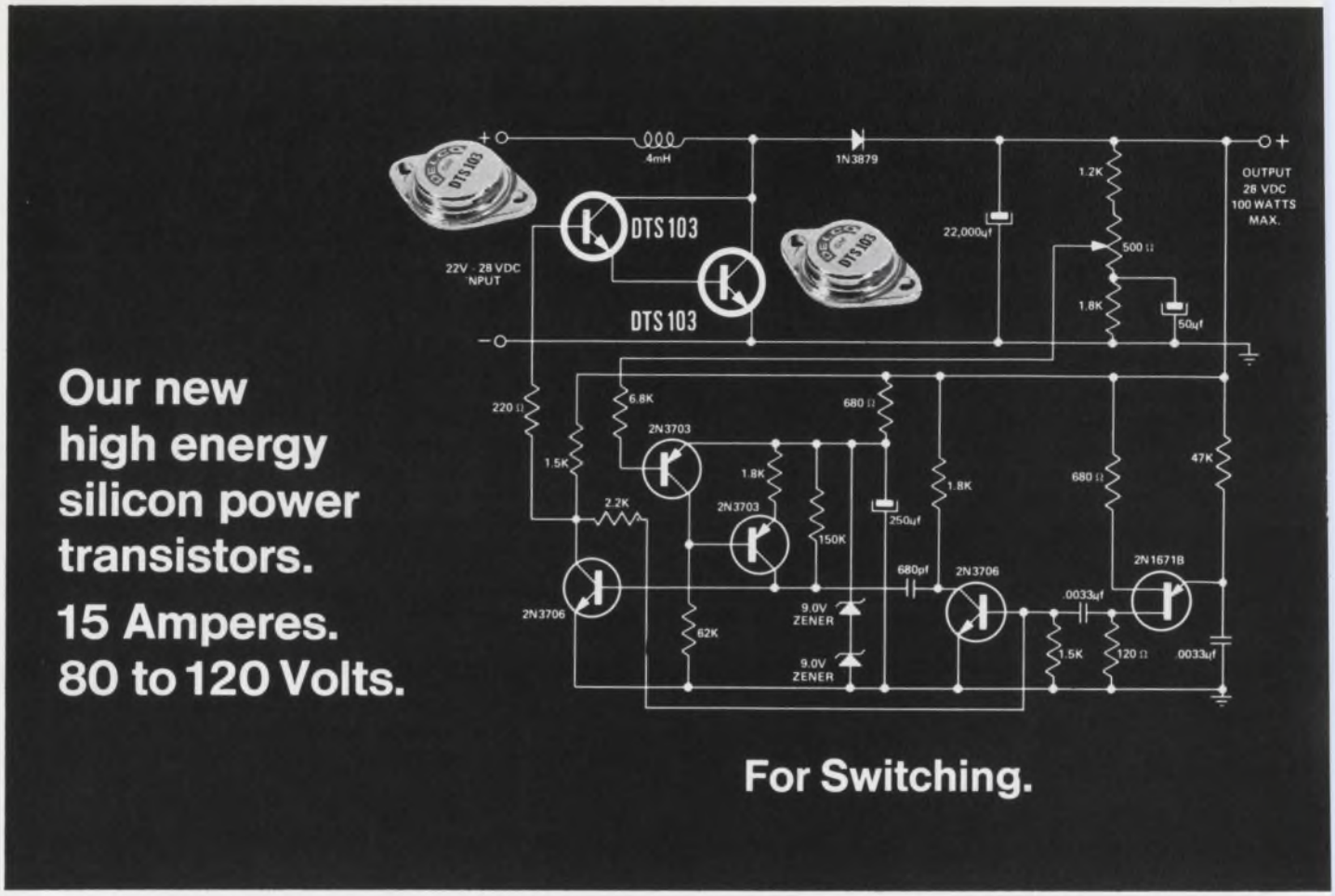
June 2-4	Applied Modeling of Engineering Systems ($150)	**Texas,** Austin
June 2-6	Pulse Modulation Telemetry Systems ($200)	**Purdue,** Lafayette
June 2-6	Digital Systems Engineering ($390)	**RCA,** Boston
June 2-13	Advanced APT Programing ($950)	**C-E-I-R,, Inc.,** Wash., D.C.
June 2-20	Short Course Computational Methods for Power Systems Analysis ($550)	**Purdue,** Lafayette
June 9-13	Systems Effectiveness ($275)	**George Washington,** Wash., D.C.
June 9-20	System Identification ($375)	**USC,** Los Angeles
June 16-20	Modern Digital Systems Design ($150)	**Texas A&M,** College Station
June 16-27	Polymer Systems ($350)	**Cornell,** Ithaca, N.Y.
June 16-27	Large Scale Systems Techniques ($375)	**UCLA,** Los Angeles
June 22-28	Management Seminar in System Reliability & Engineering Operation ($425)	**UCLA,** Los Angeles
June 23-27	Automatic Text and Picture Processing ($200)	**Cornell,** Ithaca, N.Y.
July 7-11	Matrix-Computer Methods in Engineering Systems ($275)	**UCLA,** Los Angeles
July 7-11	Digital Systems Engineering ($390)	**RCA,** Rochester, N.Y.
July 7-18	Introduction to Fundamental Analytical Methods in Systems Theory ($375)	**UCLA,** Los Angeles
July 7-18	Queueing Systems—Theory and Applications ($375)	**UCLA,** Los Angeles
July 7-18	Introduction to Fundamental Analytical Methods in Engineering Systems ($375)	**UCLA,** Los Angeles
July 14-18	Numerical Analysis and Digital Computer Methods in Engineering Systems ($275)	**UCLA,** Los Angeles
July 14-18	Introduction to the Theory of Adaptive, Learning and Pattern Recognition Systems ($275)	**UCLA,** Los Angeles
July 14-18	Communication Systems ($375)	**UCLA,** Los Angeles
July 21-25	Current Applications of Adaptive Learning, and Pattern Recognitions Systems ($275)	**UCLA,** Los Angeles
July 21-25	Material Flow Systems Short Course ($300)	**Purdue,** Lafayette
July 21-Aug. 1	Principles of Imaging Radar ($350)	**Michigan,** Ann Arbor
Aug. 4-8	Mathematical Modeling of Dynamic Systems ($200)	**Ohio State,** Columbus
Aug. 4-8	Strapdown Inertial Navigation and Guidance ($275)	**UCLA,** Los Angeles
Aug. 4-15	Space Navigations and Guidance ($375)	**UCLA,** Los Angeles
Aug. 4-15	Development of Real-Time Computer Systems ($375)	**UCLA,** Los Angeles
Aug. 4-29	Digital Systems ($1000)	**M.I.T.,** Cambridge
Aug. 15-29	Inter-System Electromagnetic Compatibility ($275)	**University College,** Syracuse
Aug. 18-22	Display Systems Engineering ($275)	**UCLA,** Los Angeles
Aug. 18-22	Design and Application of Measurement Systems ($200)	**Ohio State,** Columbus
Aug. 25-29	Information Processing Short Course ($200)	**Purdue,** Lafayette

Technical Editing, Writing, Etc.

June 16-20	Technical Communications ($200)	**Cornell,** Ithaca, N.Y.
June 17	Technical Writing for Engineers and Scientists	**MCC,** Los Angeles
June 18	Technical Writing for Engneers and Scientists	**MCC,** San Francisco
July 21-25	Technical Writing ($175)	**Nevada,** Reno
Aug. 4-8	Written Communication for Engineers Scientists and Technical Writers ($250)	**Michigan,** Ann Arbor

Miscellaneous

June 2-6	Medical Engineering ($300)	**George Washington,** Wash., D.C.
June 2-6	Fundamentals of Electrochemical Engineering ($225)	**Michigan,** Ann Arbor
June 9-12	Applications of Engineering Sciences in Surveillance to the Fields of Police, Military and Industrial Intelligence ($180)	**Nevada,** Reno
June 9-13	Dynamic Instrumentation ($275)	**George Washington,** Wash., D.C.
June 9-13	Maintainability-Failure Analysis ($275)	**George Washington** Wash., D.C.
June 16-27	Principles of Nondestructive Testing ($285)	**Nevada,** Reno
June 16-27	Nuclear Propulsion and the Future of Space Flight ($375)	**UCLA,** Los Angeles
June 23-27	Fundamentals of Plasmas ($200)	**Wisconsin,** Madison
June 30-July 3	Ultrasonics in Material Analysis and Quality Control ($180)	**Nevada,** Reno
July 14-18	Introduction to Kalman Filters with Emphasis on Application to Aided Navigation Systems ($150)	**Iowa State,** Ames
July 21-Aug. 1	Modern Circuit Theory ($375)	**UCLA,** Los Angeles
Aug. 4-15	Remote Sensing of the Environment ($375)	**UCLA,** Los Angeles
Aug. 18-22	Electromagnetic Compatibility ($175)	**Georgia Tech.,** Atlanta
Aug. 18-22	Display Systems Engineering ($275)	**UCLA,** Los Angeles



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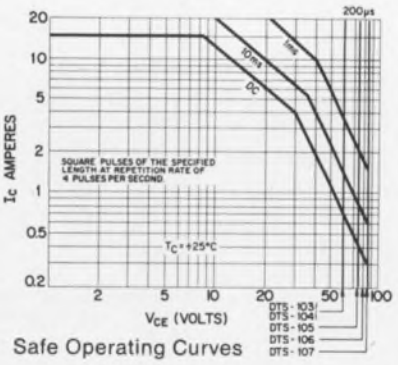
The Delco triple sequential diffusion gives the DTS-100 series the high energy reliability that's needed for very tough switching jobs—resistive or inductive. The 28-volt shunt regulator above, for example, is amply handled by the DTS-103 (V_{CEX} of 80 volts). For complete data on this circuit, ask for our application note No. 42.



Safe Operating Curves

In the direct coupled audio amplifier above right, the DTS-107 displays the excellent frequency response, gain linearity and transconductance of this family. This circuit is covered in our application note No. 43.

Our solid copper TO-3 package provides maximum thermal capacitance to absorb peak power pulses. Its low thermal resistance (0.75°C/W Max.) assures the extra reliability you expect from Delco.

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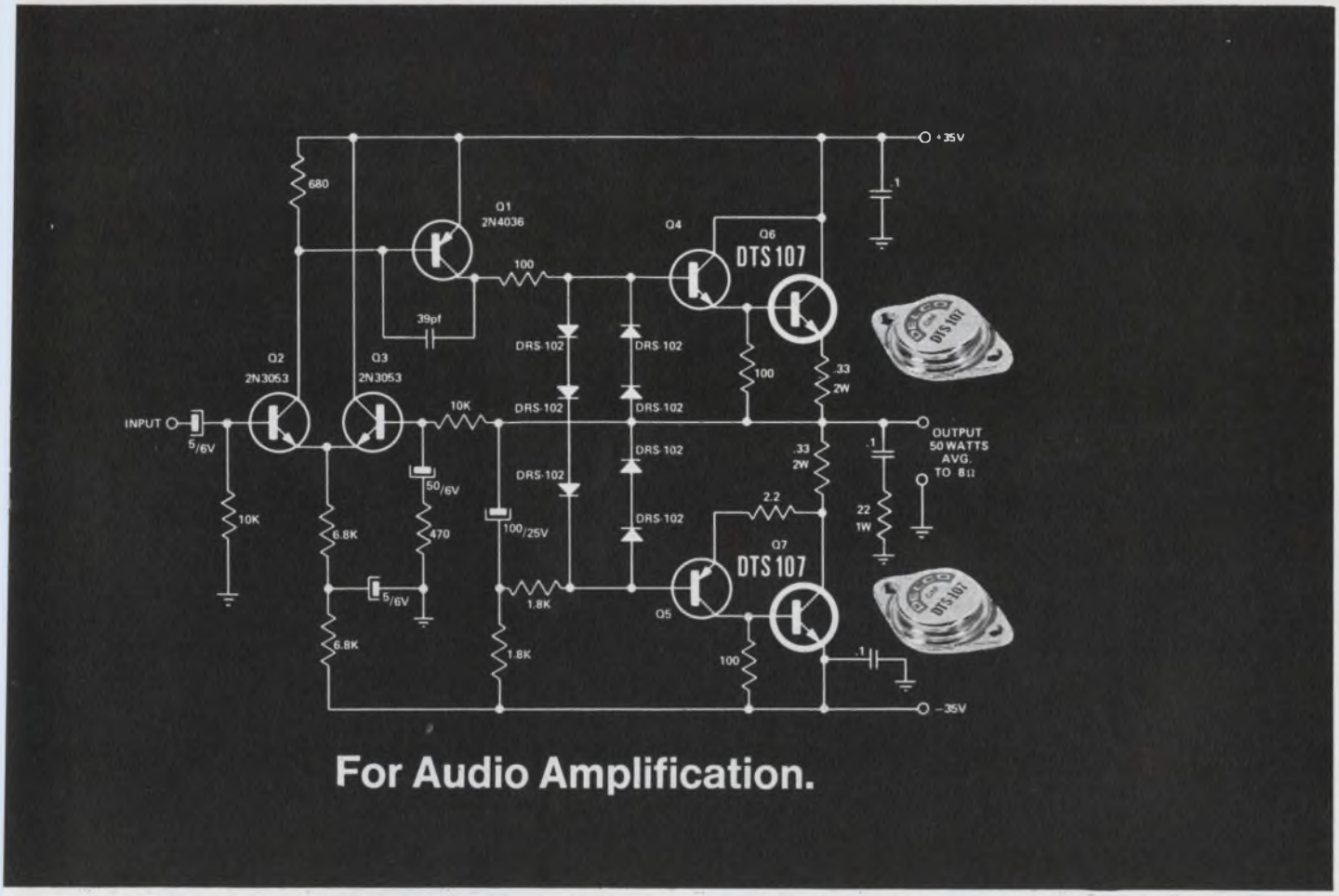

	Ic Cont. Amps.	Ic Pulsed Amps.	V_{CEX} @ .5mA Volts	V_{CEO} @ .25mA Volts	$V_{CEO(sus)}$ @ 250mA Volts	h_{FE} @ 5A	h_{FE} @ 20A (Min.)	$V_{CE(sat)}$ @ 10A (Max.)	f_t MHz (Min.)	P_t Watts (Max.)
DTS-103	15	20	80	60	60	20-55	5	1.8	4	125
DTS-104	15	20	80	60	60	50-120	10	1.5	4	125
DTS-105	15	20	100	80	75	20-55	5	1.8	4	125
DTS-106	15	20	110	90	80	20-55	5	1.8	4	125
DTS-107	15	20	120	100	85	20-55	5	1.8	4	125

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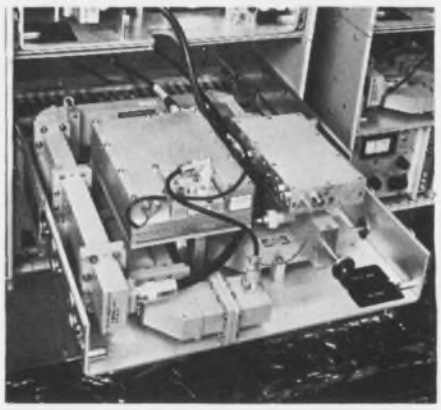
INFORMATION RETRIEVAL NUMBER 54

Great Milestones in Packaging

BEING NUMBER ±0.00301 IN A "PEOPLE PACKAGING" SERIES WILLFULLY UNDERTAKEN BY JONATHAN MANUFACTURING COMPANY

At the Duke's command, a bunch of knights-errant were seeking the one untroubled lass in the domain with nary a problem cluttering her life. Or so the legend goes. Mounted in typical Early-Medieval fashion, they narrowed the search to a castle where dwelt newly-wed Lady Cordelia, reputed far and wide to be trouble-free. Wearing a smile upon her comely countenance, she prettily satisfied their every inquiry until the quest seemed achieved. Then abruptly she led them to an upstairs closet housing a skeleton, that of her new husband's former rival for her rosy hand. "I try," she said, "to keep my troubles to myself, but every night at bedtime, my spouse compels me to kiss this darned skeleton." Whereupon she wandered away muttering a strangely nostalgic line, "dem bones, dem bones," which later became the basis for a popular camp song.

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



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

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INFORMATION RETRIEVAL NUMBER 55

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INFORMATION RETRIEVAL NUMBER 56

Two VVCs are often better than one—if they're back-to-back

A fundamental disadvantage of the voltage variable capacitor (VVC) is that the drive voltage used to change the capacity of the diode normally appears in whatever circuit configuration is being used. This normally presents quite a problem when a combination of both high frequency and high drive voltages are needed. In some instances elaborate precautions must be taken, especially when working with low-level signals, to eliminate the undesired voltage variation.

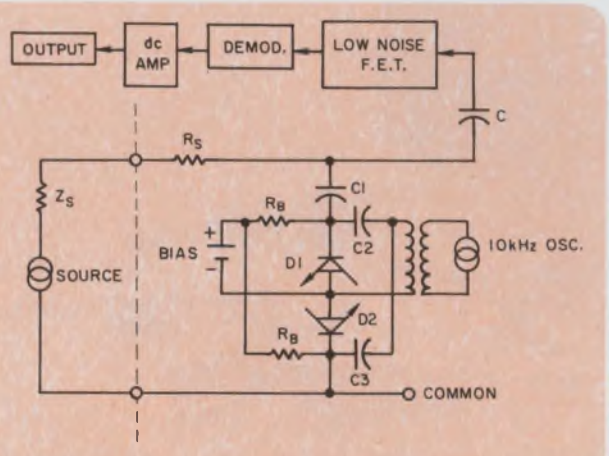
If one could utilize two VVCs in a back-to-back configuration, so that the sum of the voltage drop across these diodes would always equal zero, the problem would be eliminated. Figures 1 through 3 illustrate several examples using this technique.

Figure 1 illustrates a solid-state replacement for the electromechanically vibrating capacitor in an electrometer. As in the mechanically driven, or electromechanically driven capacitor electrometer, a variation in capacity from point "A" to the common line modulates the nominally dc source voltage by causing a voltage drop across the large resistor, R_s. The constant frequency ac signal is coupled into a low-noise tuned amplifier and processed in the usual manner.

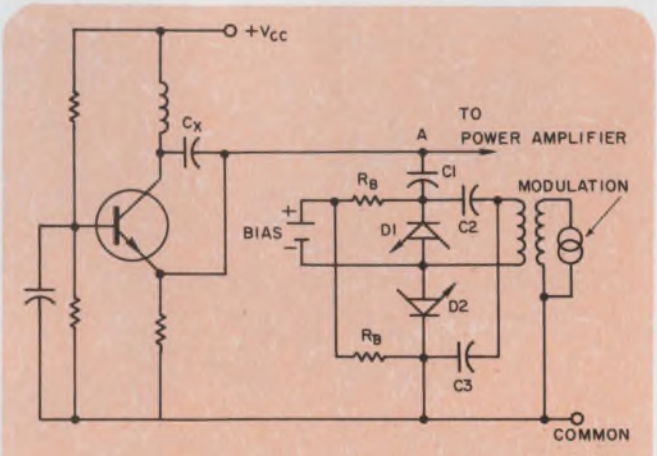
Diodes *D1* and *D2* are the voltage variable capacitors. They are reverse biased to the desired linear portion of their curve by the bias battery and resistors R_b. These resistors can be matched to the desired degree of precision. An intentional mismatch can be utilized to compensate for small nonlinearities in the diodes.

The desired drive signal is transformer coupled to both diodes. Capacitors C_2 and C_3 are matched, and present a capacitance that is small compared with that of the diodes. Capacitor C_1 is large and serves only to isolate the dc signal from the source. Since the same bias and drive voltage is impressed across both diodes, but in opposite polarity, the summation of the voltage drops from the bottom of C_1 to the common point is equal to zero. Point "A" then sees only a capacitance change, and no component of either the bias or drive voltage.

Figure 2 is a frequency modulator, using essentially the same principle as the circuit of Fig. 1. The oscillator is a modified Colpitts type, using the common-base configuration. Its frequency is determined by the inductor in the collector, plus the combination of C_x and the capacitance from point "A" to common. The frequency delivered to the power amplifier is determined by the amplitude of the modulation voltage. In this instance, the bias voltage may be used to control the center

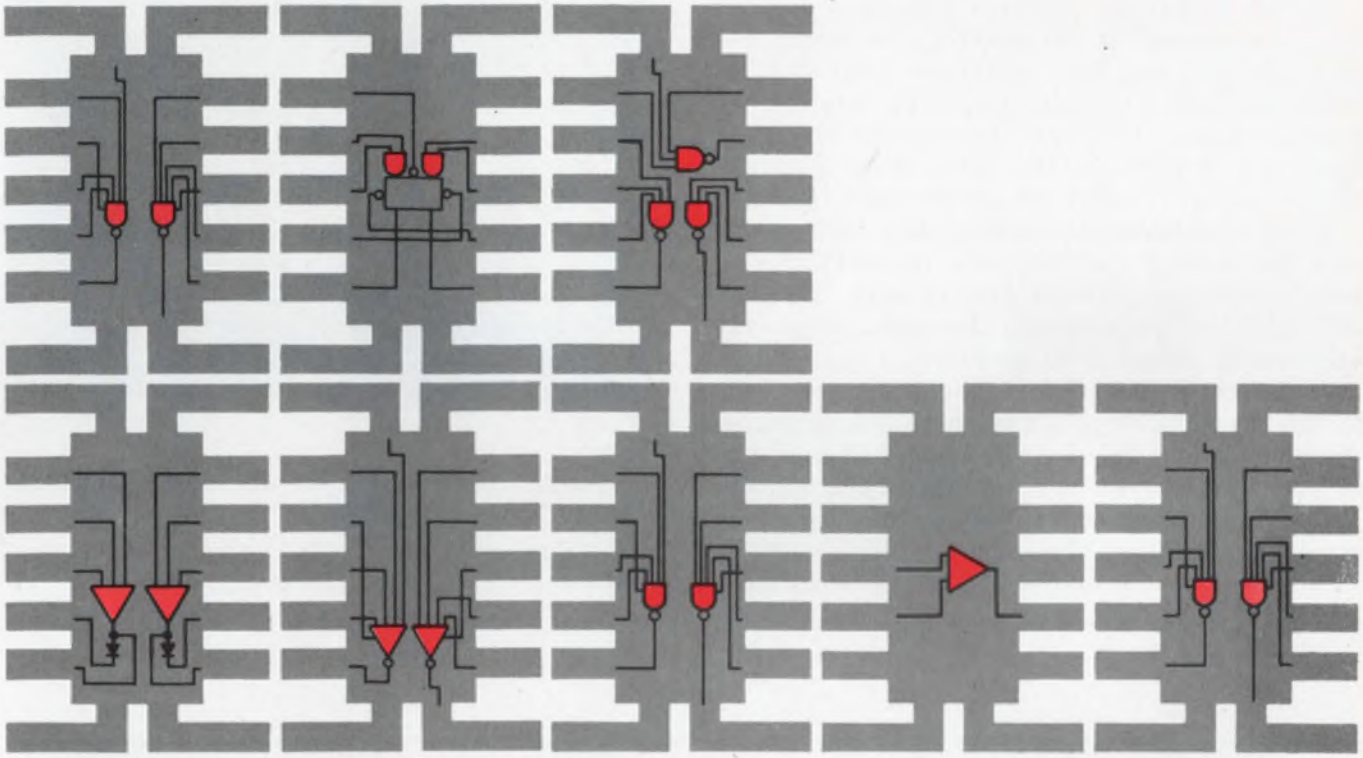


1. **Solid-state "vibrating capacitor" electrometer** uses two reverse biased, back-to-back voltage variable capacitors.



2. **Frequency modulator** uses the back-to-back VVC configuration to control a modified Colpitts oscillator.

Pick the BEST IC for the job



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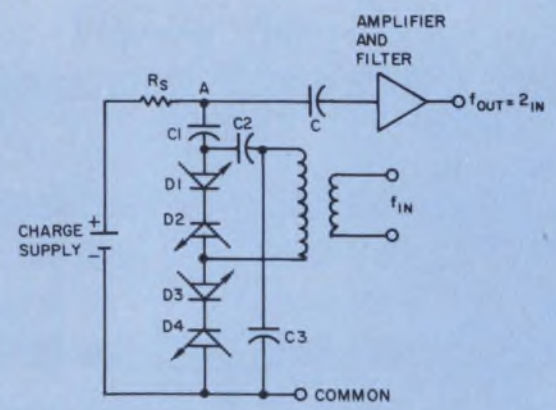
INFORMATION RETRIEVAL NUMBER 57

frequency of the oscillator—if the device is employed in something like an fm transmitter configuration.

Figure 3 shows a nonlinear frequency doubler that can be used in the ultrahigh frequency region. In this case, four diodes are connected, as indicated, with no bias battery. The device operation is similar to that of the electrometer configuration of Fig. 1, with resistor R_s and capacitors C_1, C_2 and C_3 performing the same function.

In this configuration, during each half of the incoming cycle one of the diodes in each half section of the configuration (for example, *D1* and *D4*) is forward biased, and the other two diodes are reverse biased. This results in a capacitance change from maximum to minimum for each half of the incoming cycle. The resultant output is therefore double the drive frequency. Again, the source voltage does not appear in the circuit. Point "A" to common sees only the change in capacitance, and not the change in drive voltage. This device should find use in the 1 to 10 GHz region.



3. **Frequency doubler** uses no bias battery for the voltage variable capacitors.

It should be noted that the efficiency of all these circuits is extremely high.

William W. Gile, Staff Engineer, California Institute of Technology, Pasadena, Calif.

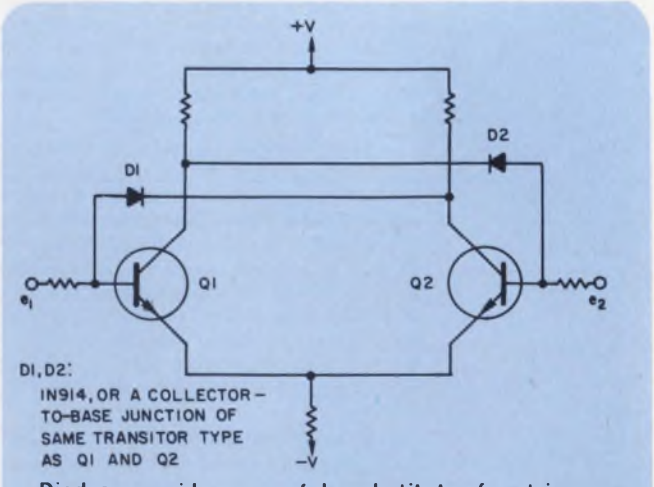
VOTE FOR 311

Neutralize your differential amplifier with diodes

A common method of extending the bandwidth and increasing the speed of a differential amplifier is to connect a trimmer capacitor from each collector to the opposite transistor's base. By adjusting the trimmers, the collector-to-base capacitance of the transistors may be balanced out, thereby increasing the speed. This method, though, suffers from drawbacks: specifically, the cost and availability of the required trimmers.

A practical alternative is to substitute a common laboratory item for the trimmers—namely, the 1N914 or other low-capacitance diode. When connected as shown, the diodes' reverse capacitance provides the necessary neutralization.

In some cases the diodes themselves may be more costly than the transistors (epoxy types, for example). In these cases, it is recommended that two additional transistors of the same type be purchased. The collector-to-base junction of these can then be used in place of the diodes. These transistors will actually be closer to complete neutralizers than the diodes.



Diodes provide a useful substitute for trimmer capacitors in neutralizing differential amplifiers.

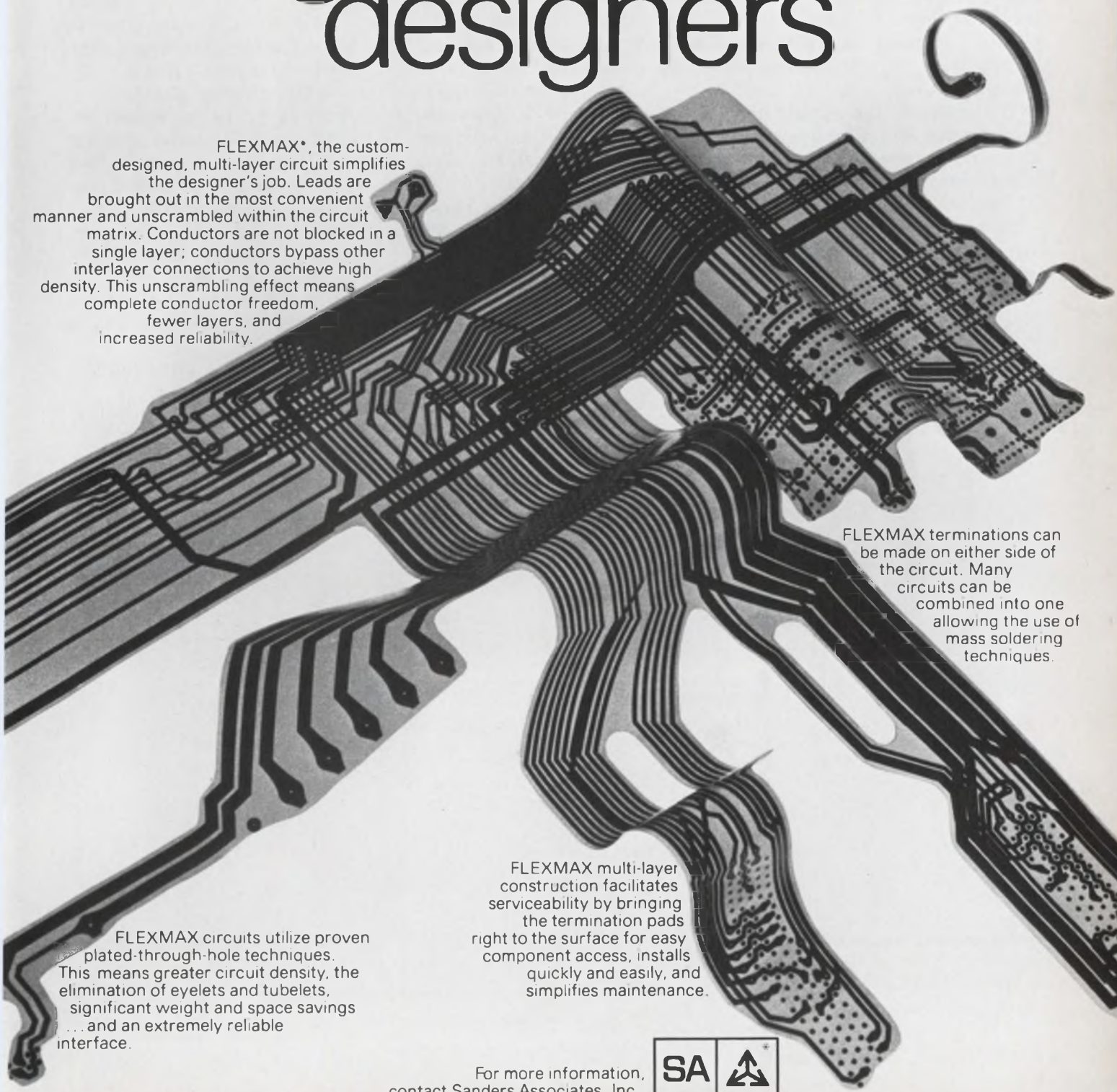
This technique is also suitable for use in linear IC amplifiers, many of which use a differential amplifier in their front end.

William E. Peterson, Associate Engineer, ITL Research Corp., Northridge, Calif.

VOTE FOR 312

Flexmax: custom-designed for designers

FLEXMAX*, the custom-designed, multi-layer circuit simplifies the designer's job. Leads are brought out in the most convenient manner and unscrambled within the circuit matrix. Conductors are not blocked in a single layer; conductors bypass other interlayer connections to achieve high density. This unscrambling effect means complete conductor freedom, fewer layers, and increased reliability.



FLEXMAX terminations can be made on either side of the circuit. Many circuits can be combined into one allowing the use of mass soldering techniques.

FLEXMAX multi-layer construction facilitates serviceability by bringing the termination pads right to the surface for easy component access, installs quickly and easily, and simplifies maintenance.

FLEXMAX circuits utilize proven plated-through-hole techniques. This means greater circuit density, the elimination of eyelets and tubelets, significant weight and space savings ... and an extremely reliable interface.

For more information, contact Sanders Associates, Inc., Flexprint Division, Grenier Field, Manchester, New Hampshire 03103. Telephone: (603) 669-4615 EXT. 201

SA SANDERS ASSOCIATES, INC.

Circuit generates linear ramp and short duty cycle pulses

Sawtooth and pulse generators are important building blocks in many electronic systems. For example, pulse testing techniques using a short duty cycle are usually employed in transistor parameter testing. To make such tests, positive pulses of approximately 200 μs duration and 15 ms OFF time are often required. Circuit complexity and significant power consumption have usually been the price paid to obtain the desired characteristics.

The simple three-transistor circuit shown provides not only a positive-going pulse of short (2%) duty cycle, but also generates a negative-going ramp voltage of excellent linearity. And it does so while consuming little power.

Transistors *Q2* and *Q3* in the diagram constitute an emitter-coupled complementary pair, while *Q1* is a constant-current source. The value of R_5 is adjusted to give the desired ON time. Final duty-cycle adjustment is accomplished by changing the setting of R_8.

In the ON state, capacitor C_c discharges toward ground with a time constant

$$t_1 = C_c R_4 R_5 / (R_4 + R_5). \quad (1)$$

When the circuit is reset to the OFF condition, C_c is recharged to its quiescent state with a time constant

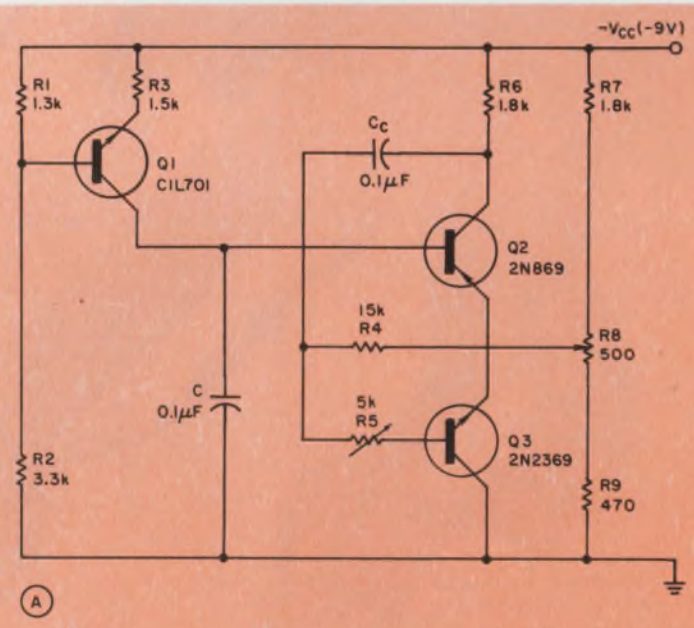
$$t_2 = C_c (R_4 + R_6). \quad (2)$$

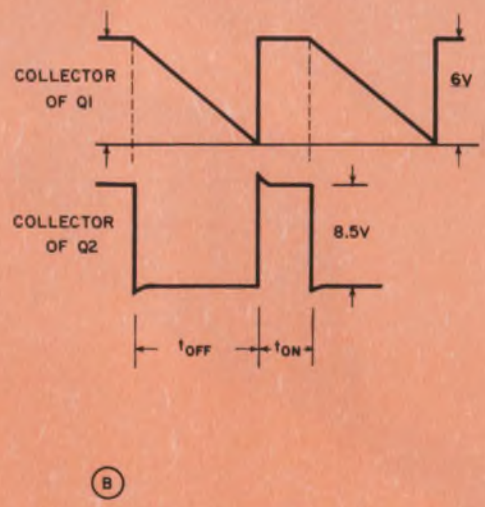
This time constant must be sufficiently large to allow capacitor C to be completely charged. The voltage across C rises linearly, and a linear ramp voltage is available at the collector of *Q1*.

Sawtooths as narrow as 1-2 μs have been obtained from the circuit, with the ramp starting accurately from zero voltage, with no step. Output pulse waveforms as short as 1 to 2 μs are possible. Typical waveforms are shown in b.

Uma Shanker Singh, Electronics Engineer, Space Science & Tech. Centre, Trivandrum, India.

This work was performed at the Central Electronics Engineering Research Institute, Pilani (Raj.), India.





Voltage ramp having excellent linearity, is developed at the collector of Q1 as a result of capacitor C being charged from a constant-current source.

Both the ramp, and the pulse waveform developed at the collector of Q2, are shown in b.

3 That are ready

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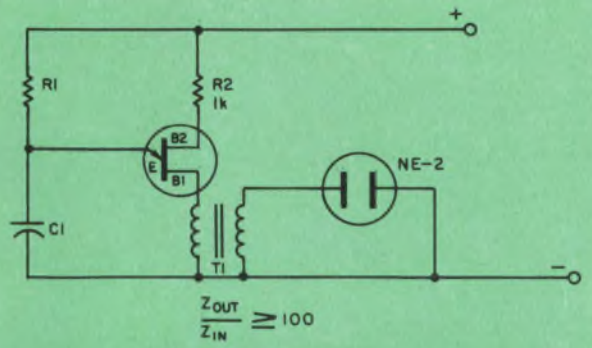
Circuit powers neon lamps from low-voltage sources

In battery operated solid-state equipment it is often difficult to provide a visual "power-on" indicator due to the relatively high power consumption of incandescent lamps. For example, a #47 pilot light consumes about 0.9 watts, which may be more than the circuitry itself requires.

A low-power visual indicator can be constructed by using a simple unijunction transistor oscillator and a transformer to step up the low battery voltage to a value sufficient to operate a small neon bulb. If power consumption is extremely critical, the oscillator frequency and duty cycle can be made low; this results in a flashing operation, which further reduces power requirements.

In the circuit shown, capacitor C_1 charges towards the supply voltage, through R_1. When the capacitor voltage reaches 0.5 to 0.8 times V_{BB} (the η, or intrinsic standoff ratio, of the UJT) the UJT fires. C_1 then discharges through the primary of T_1, which is an inexpensive audio transformer.

Almost any UJT will work in the circuit if the supply voltage is in the 6 to 40 volt range. For very low voltage operation, a 2N2840 should be used, which will operate with voltages as low as 1.5 V. The values of R_1 and C_1 will determine the frequency of oscillation.



The UJT oscillator and transformer boost the battery voltage to a level that is sufficient to light the pilot lamp.

Les Toth, Project Engineer, Cohu Electronics, Inc., San Diego, Calif. VOTE FOR 314

Dc limiter regulates voltage to high-current, low-voltage circuits

Overvoltage protection for high-input-current transistorized devices can be a difficult problem. This is especially true when the power source is a rotary engine-driven supply that services many other units of the same, or considerably larger, current drains that cycle on and off the supply line. Such load changes may cause the line to rise above an acceptable level for some equipments, causing failure.

A reliable and inexpensive solution to this problem makes use of sensitive relays and zener diodes. These react to voltage changes by switching series resistors into the line to limit the input voltage. As shown, the stages of the limiter are in series, and below the circuit threshold limits no power is dissipated. The resistors are selected to drop the overvoltage to the specific current requirement of the protected equipment.

The circuit illustrated will protect transistorized equipment that requires 22-30 V dc at 35 A. The sensing relays are rated at 2.8 V dc, with low differential between pull-in and drop-out. The 27-V zeners pull in the sensing relays at slightly less than the 30-V line voltage. This opens their respective series power relays (K3-K9), each of which inserts approximately 3 volts of IR drop. In this way the input can rise to 40 V with the output remaining below 30 V. Reaction time of the relays is acceptable, and hunting is not noticeable.

This approach to voltage protection can be

When you need clean low-level signals with improved settability, the 204D's built-in step attenuator is a step-saver. It eliminates the aggravating process of hanging an attenuator between the signal source and your system. And, it eliminates the extra problems that extra interconnections create. As a result, you get the clean signals you need for accurate measurements – quicker and easier.

The 204D has the same low distortion, high stability, and wide frequency range of 5 Hz to 1.2 MHz that makes the HP 204C an industry standard. Both models can be operated with line power, mercury battery, or a rechargeable battery pack.

Not all our changes are big ones, but each is intended to help you make better measurements in less time with less effort. Whether you chose a 204C or 204D depends, of course, on your requirements. If you don't need a built-in calibrated step attenuator, then get the 204C and save the $75 difference in price.

Whichever you chose, order today by calling your nearest HP order desk. For data sheets, write to Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland. Price: HP 204C, $250; HP 204D, $325.

099/12

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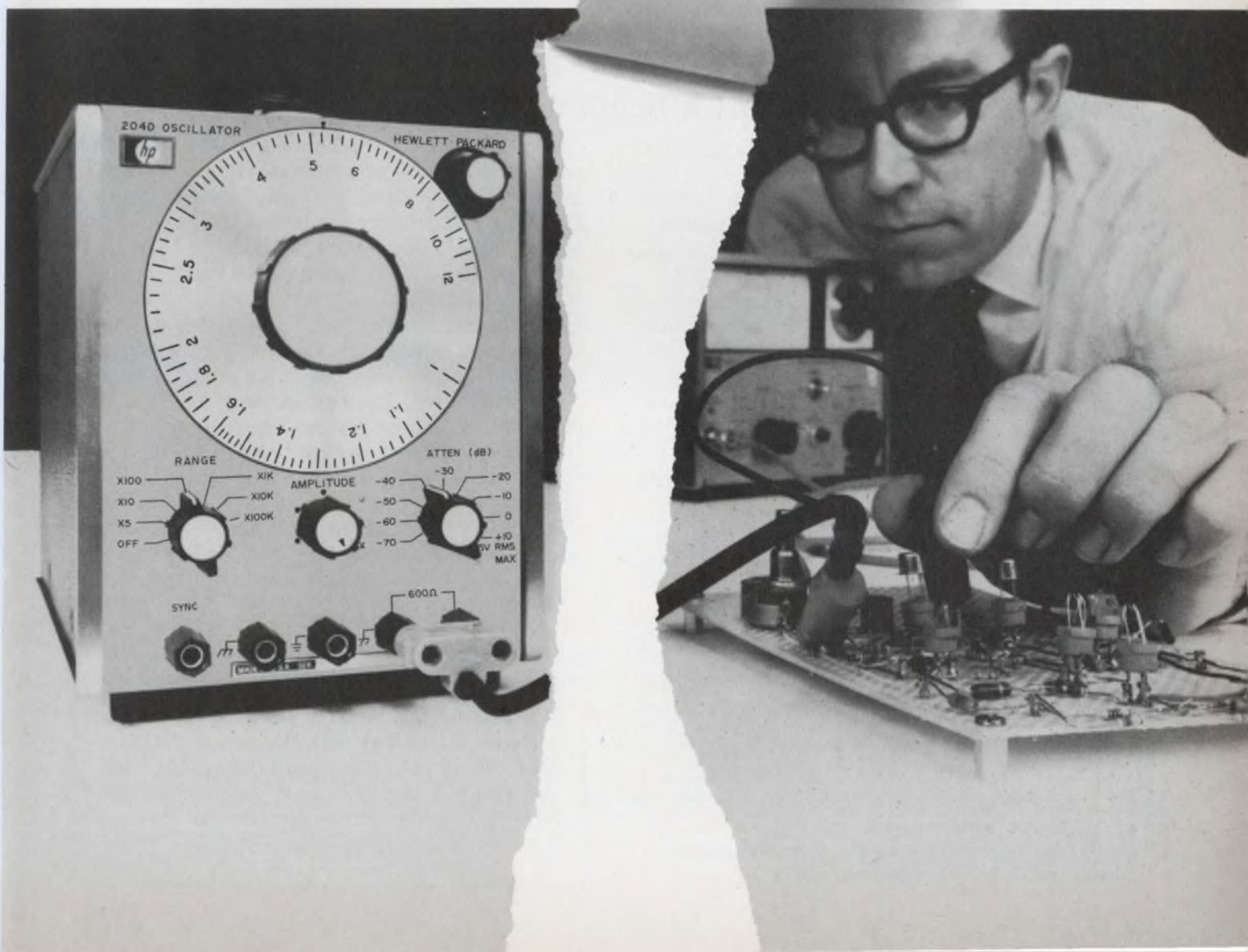
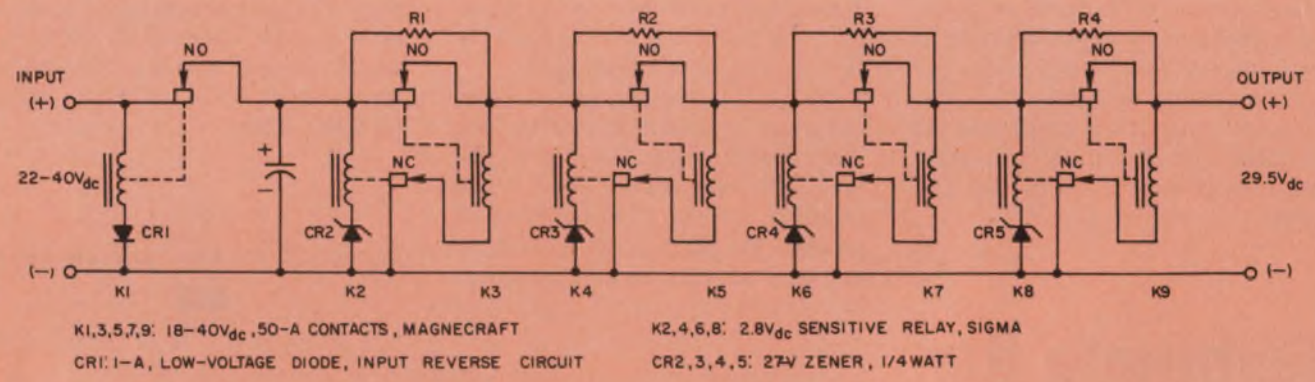
SIGNAL SOURCES

Eliminate the unnecessary...With the 80 dB step-attenuator in the new HP 204D Oscillator





Series resistance is added to the line by the various stages of the limiter when an overvoltage condition occurs. K1 protects against input-voltage polarity reversals.

applied to systems having other power requirements by changing zeners, power relays, and resistors accordingly.

Howard Cohen, Project Manager, Decitron Electronics Corp., Brooklyn, N.Y.

VOTE FOR 315

Low-cost circuit can protect a boardful of high-cost ICs

Complete protection for a board of expensive IC packages can be provided with a circuit built for less than $6. The circuit protects against overvoltages due to supply transients or failures, as well as against overvoltages or wrong polarities caused by "human errors."

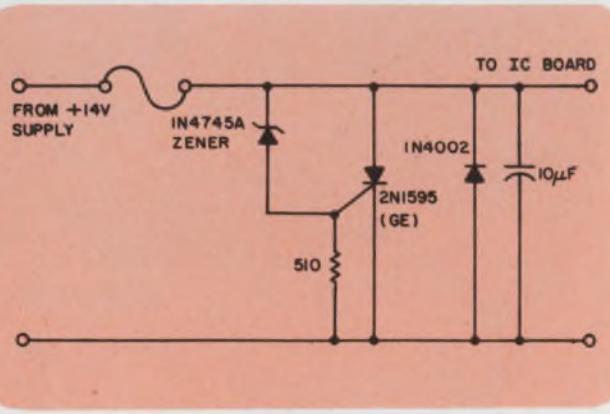
The 1N4002 diode protects against reverse polarities caused by wrong connections or other causes. In this application, the integrated circuits could tolerate negative levels of —1 V, so that an ordinary silicon diode (the 1N4002) provides enough current to blow the fuse before the reverse voltage harms the integrated circuits.

The 2N1595 SCR has a maximum required gate voltage of 0.8 V. The 5 per cent 1N4745A zener diode breaks over at a maximum of 16.8 V, so that the SCR turns on at an input voltage of 17.6 V or less, and does so in less than one microsecond. This is compatible with the +18-V limit of the particular ICs being protected.

The capacitor protects the integrated circuits against noise spikes, and also prevents noise spikes from causing unnecessary "crowbarring" by the SCR and diode. The value of the capacitor can be decreased. The resistance of the fuse and the capacitor can be designed to form a low-pass filter that will slow the rate-of-rise of the input voltage to a value compatible with the SCR turn-on-time.

Al Geiersbach, Design Engineer, Allis Chalmers, Milwaukee, Wis.

VOTE FOR 316

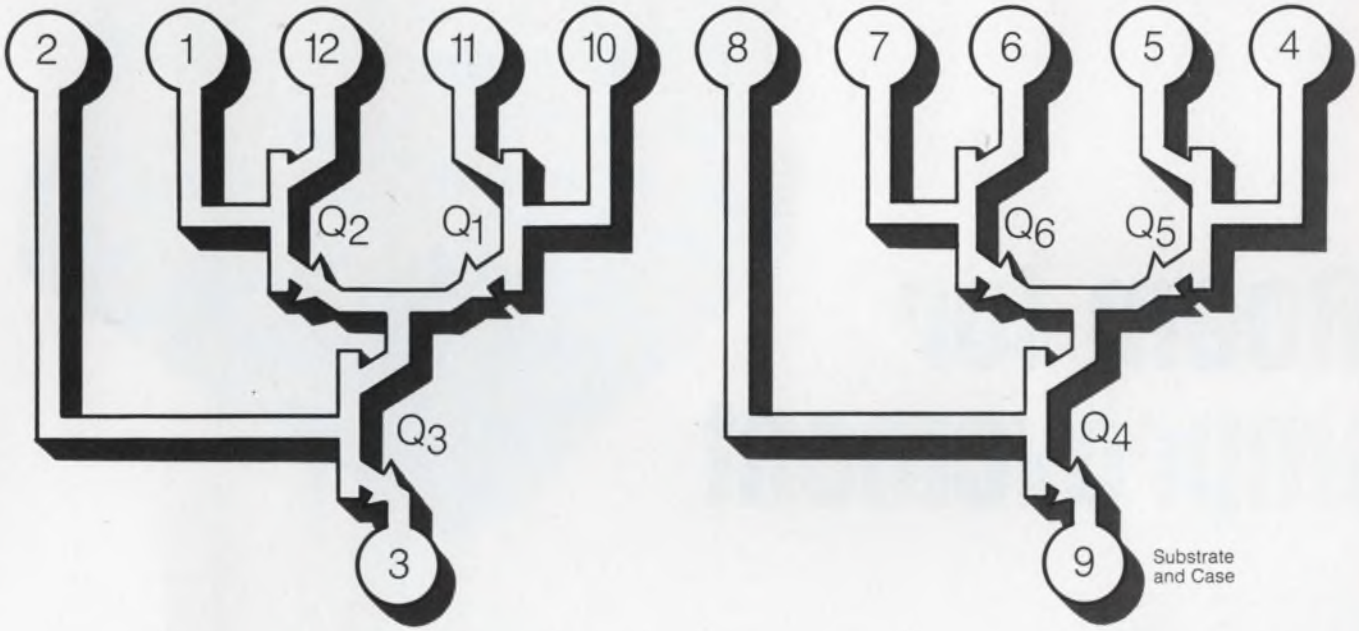


Protection against overvoltage and polarity reversals is provided by this inexpensive circuit.

IFD Winner for January 18, 1969
Thomas E. Skopal, Piscataway, N. J. His Idea, "Feedback technique dynamically resonates tuned circuit," has been voted the Most Valuable of Issue award.
Vote for the Best Idea in this Issue.

First 200 MHz IC Amplifier Array

RCA-CA3049 for −55° to 125°C operating temperature, $1.95 (1,000 units)



Here's another of RCA's growing family of "building block" IC's—usable as high-speed sense amplifiers, low noise IF and RF amplifiers, balanced mixers, wideband amplifiers, oscillators, and many more.

It's the RCA-CA3049—a pair of differential or cascode amplifiers on a single chip. Each amplifier provides a transducer power gain of 23 dB (typ.) in a cascode connection at 200 MHz with a current of only 2 mA. This unit—useful to 500 MHz—marks another "first" for RCA stemming from new high-frequency IC design and production techniques.

Ask your local RCA Representative or your RCA Distributor for details. Or for complete technical information, write RCA Electronic Components, Commercial Engineering, Section ICG5-1, Harrison, N. J. 07029.

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RCA-CA3018	Two isolated transistors plus Darlington pair	$ .98 (1000 units)
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RCA-CA3026	Dual independent diff amps for DC to 120 MHz	1.25 (1000 units)
RCA-CA3045	3 isolated transistors and 1 diff pair for −55° to +125°C operation, DC to VHF (DIC package)	1.50 (1000 units)
RCA-CA3046	Same as CA3045 but in dual-in-line plastic package (0°C to +75°C operation)	.98 (1000 units)
RCA-CA3050	Two Darlington-connected diff amps with diode bias string: −55° to +125°C, DC to 20 MHz operation (DIC)	2.25 (1000 units)
RCA-CA3051	Same circuit for 0°C to +75°C operation (DIP)	1.65 (1000 units)

RCA
Integrated Circuits

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We didn't cut any corners on this high-reliability, transistor-size sealed relay. We left them on so there'd be more room for a more powerful magnet—2½ times more powerful.

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

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

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

GENERAL ELECTRIC

INFORMATION RETRIEVAL NUMBER 62

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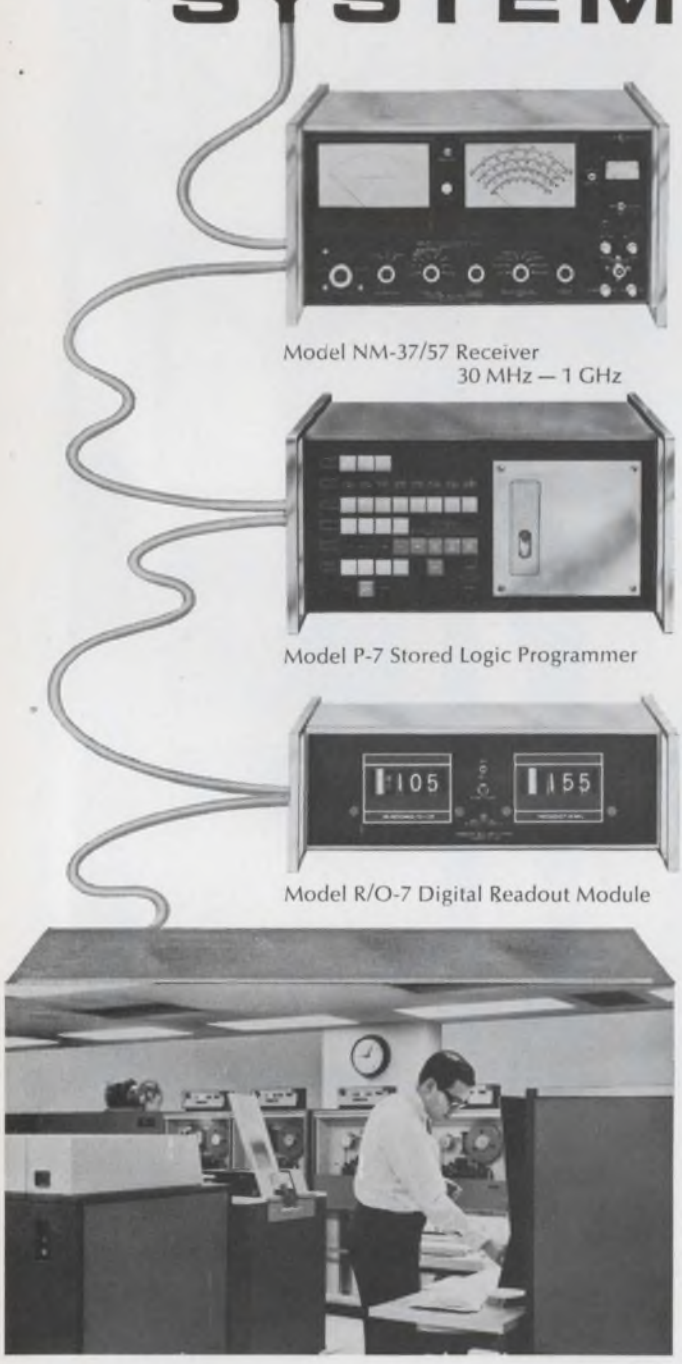

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Model P-7 Stored Logic Programmer

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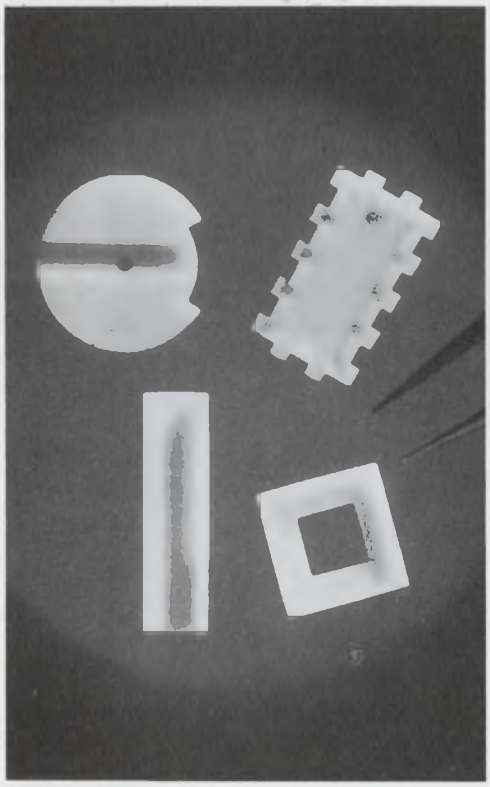
INFORMATION RETRIEVAL NUMBER 64

increase ic yield



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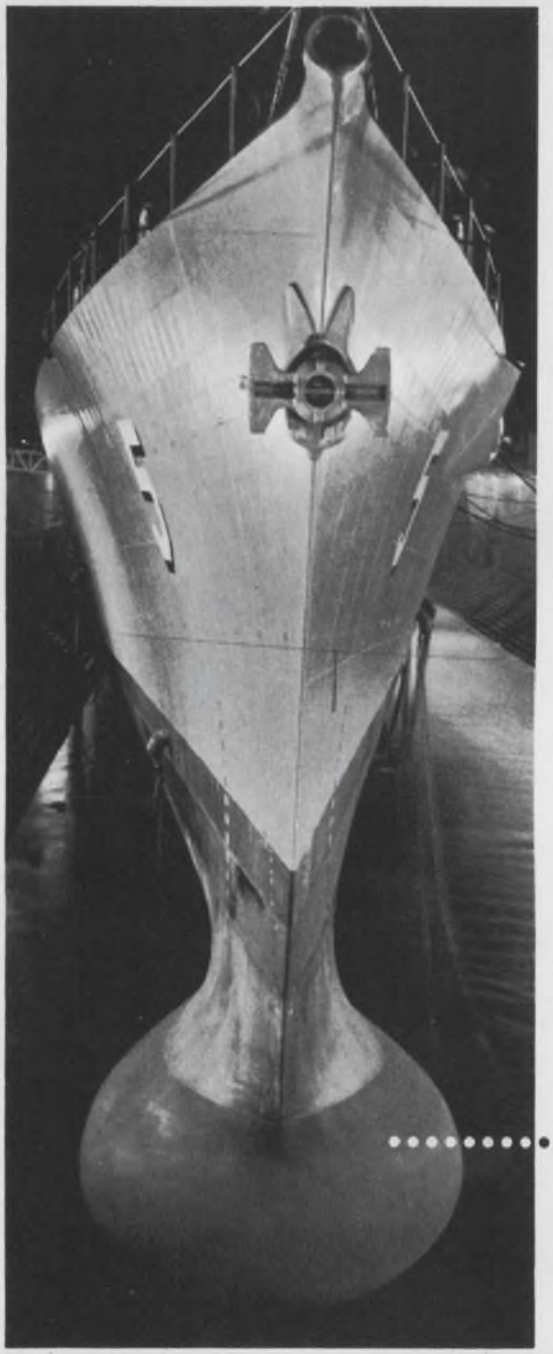

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GENERAL ELECTRIC

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INFORMATION RETRIEVAL NUMBER 901

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10

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Prime Experience	Secondary Experience

Desired Salary	**Availability Date**

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City, State			
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Title			
Specialty			

Education – indicate major if degree is not self-explanatory

Degree			
College			
City, State			
Dates	to	to	to

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ELECTRONIC DESIGN
850 Third Avenue
New York, New York 10022

Book Reviews

Grid-Dip oscillators

How To Use Grid-Dip Oscillators, 2nd. ed., (Rider Series, Hayden Book Co., New York) 111 pp. $2.95

The revised second edition of *How To Use Grid-Dip Oscillators* concentrates on practical applications that have been proven by experience. It tells how to check L-C circuits, linear and coaxial tanks, how to convert a signal generator or rf test oscillator into a GDO or a GDO into either a conventional or market generator, signal injector, or cw oscillator. It also describes how to use the GDO as a field-strength meter, a signal source for an SWR meter, an rf meter, and in numerous other ways. A complete roundup of commercial GDOs—both assembled and in kit form—and their features is included.

CIRCLE NO. 323

Relativity

Introduction to the Theory of Relativity, Francis W. Sears and Robert W. Brehme, (Addison-Wesley Publishing Co., Reading, Mass.) 216 pp. $9.75.

It is fairly easy, in most engineering schools, to acquire an EE degree with no more than a minimum knowledge of the general and special theories of relativity. Although this may not affect performance on the job, it is certainly a handicap for anyone who wishes to keep up with the scientific advances of our age.

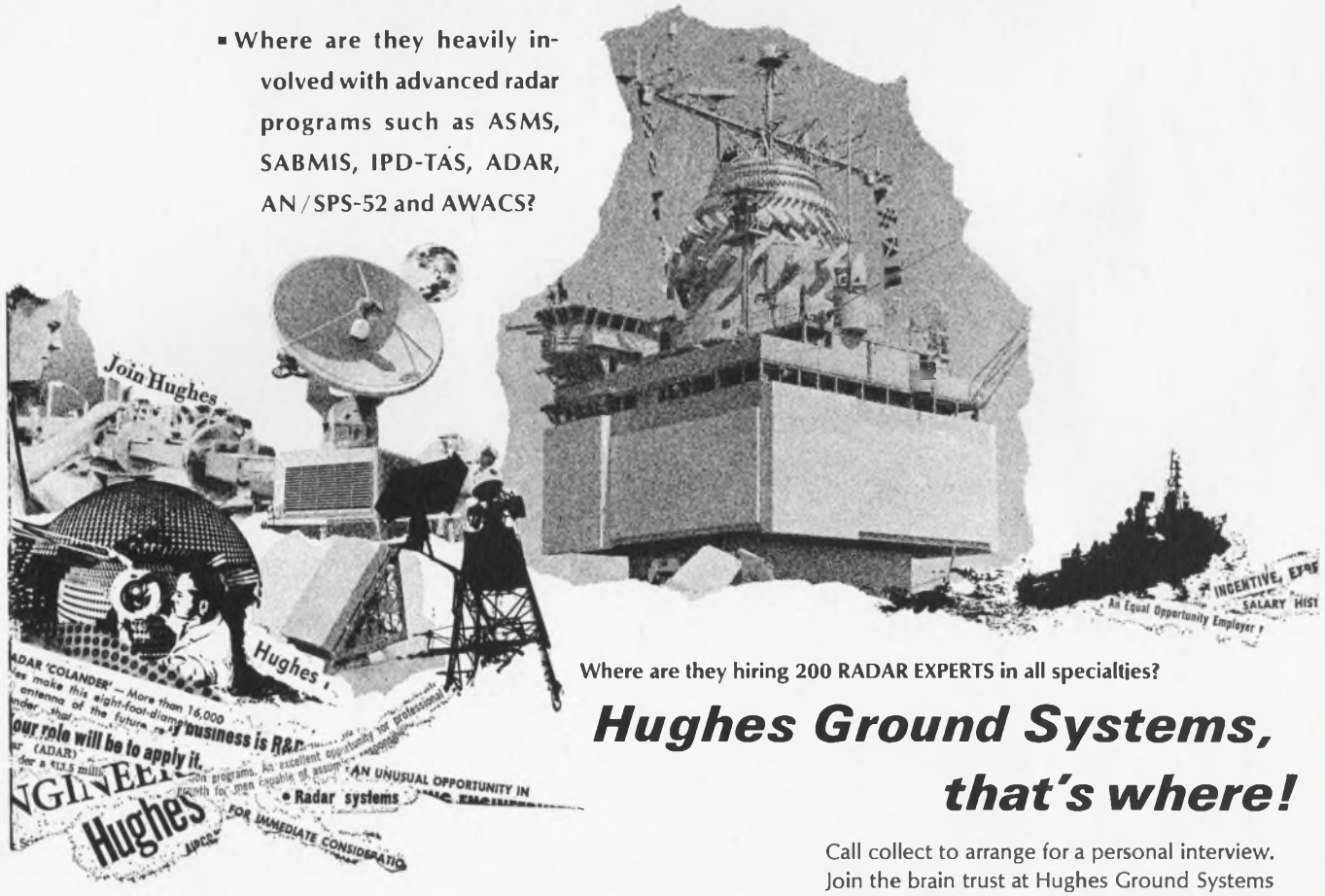
The authors of this text have developed a method of using geometric diagrams to explain Einstein's theory of relativity. The level of mathematical sophistication is well within the grasp of any electronic engineer.

The first four chapters present the essence of theory, the relativistic treatment of space and time. A full chapter is devoted to electric and magnetic fields and a final chapter covers curved space-time and gravitation.

CIRCLE NO. 324

where the brains are . . .

- Where was the world's first operational frequency scan radar developed?
- Where was the world's first operational phased array radar developed?
- Where was the world's first multiple target autotrack radar developed?
- Where are they designing and building the next generation phased array radar?
- Where are they heavily involved with advanced radar programs such as ASMS, SABMIS, IPD-TAS, ADAR, AN/SPS-52 and AWACS?



Where are they hiring 200 RADAR EXPERTS in all specialties?

Hughes Ground Systems, that's where!

Call collect to arrange for a personal interview. Join the brain trust at Hughes Ground Systems and find out where radar technology really is. Call 714-871-2321. Weekdays 9 am to 6 pm.

HUGHES
HUGHES AIRCRAFT COMPANY
GROUND SYSTEMS GROUP

WRITE: **RADAR ENGINEERING EMPLOYMENT** ■ HUGHES AIRCRAFT CO., FULLERTON, CALIFORNIA 92634

Our new compact oiltight pushbuttons give you up to six functions in a 1 7/16" square.

Size is the only thing that's small about our new compact pushbuttons. They handle full-size jobs.

We've gone square to give them style, and full 600-volt quality and flexibility.

And we've gone small to give you six operating and indicating functions in a 1 7/16" square. You save space, and money.

You also get unlimited flexibility with stacking contact blocks.

And a choice of pushbuttons and indicating lights that doesn't quit—with a virtually unlimited range of sizes, forms and colors of buttons and lenses.

With all you're getting, you still get the same oiltight performance you're used to with full-size Cutler-Hammer oiltight pushbuttons.

Ask your Cutler-Hammer Distributor or Sales Engineer to show you our six packs. Remember, the best things come in small packages.

New Cutler-Hammer compact pushbuttons put a world of control into a 1 7/16" square, and mount in industry-standard 1 3/16" round holes.

Try our 6 pack.

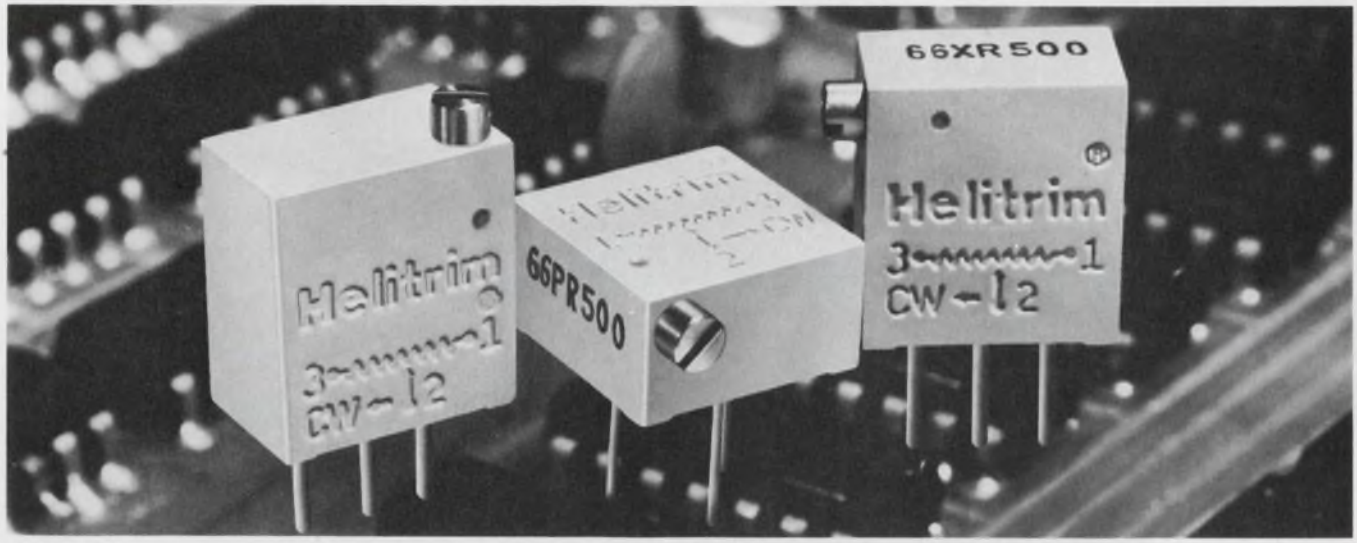
See your Cutler-Hammer Distributor—the man who has everything

CUTLER-HAMMER

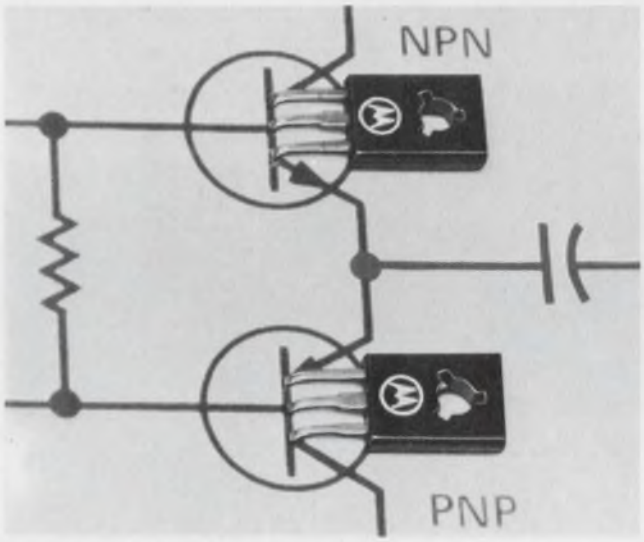
POWER DISTRIBUTION & CONTROL DIVISION, Milwaukee, Wis. 53201

INFORMATION RETRIEVAL NUMBER 68

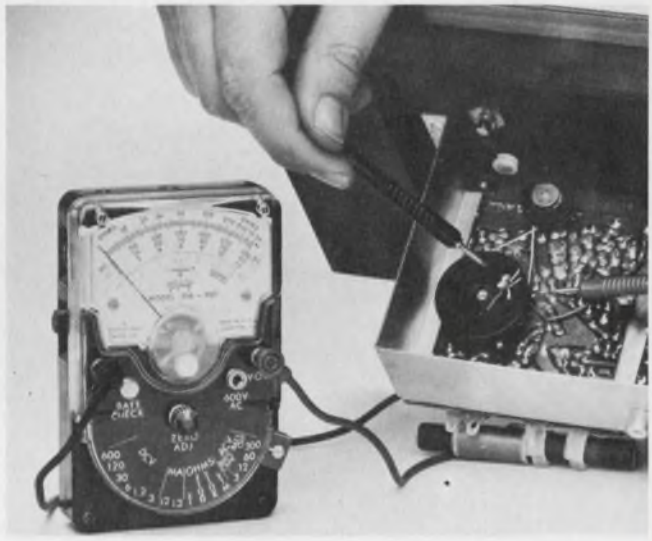
Products



Low-cost 0.5-W cermet trimmers with 3/8-in. square configurations are now available for industrial applications. Resistances range from 10 Ω to 2 MΩ, p. 150.



Miniature plastic npn/pnp transistor pairs complement 35-W audio amplifiers, p. 158.



Shirtpocket battery-operated VOM features constant 10-MΩ FET-input, p. 168.

Also in this section:

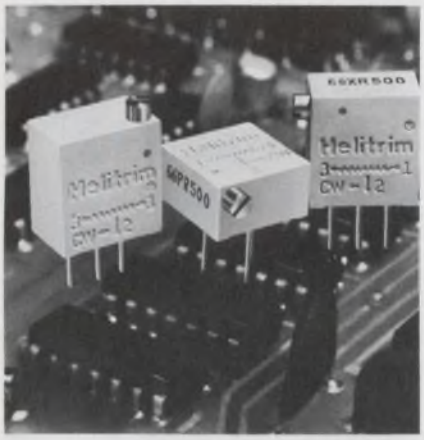
Integrated circuit array packs four same-chip independent ac amplifiers, p. 161.

Palm-sized power supply modules drive Nixie tubes with 200 V at 3 mA, p. 182.

Rf power transistors deliver 25-W output with 5-dB gain at 175 MHz, p. 194.

Design Aids, p. 228 . . . **Application Notes,** p. 230 . . . **New Literature,** p. 234.

Low-cost trimmer pots are industrial cermets



Beckman Instruments, Inc., Helipot Div., 2500 Harbor Blvd., Fullerton, Calif. Phone: (213) 691-0841. P&A: $3.50; stock.

Offering cermet performance at wirewound prices, a new line of cermet trimming potentiometers is now available in the popular 3/8-in. square configuration. Heralded as the first industrial cermet trimmers with their price tag of $3.50, series 66 units have a power rating of 0.5 W, derating to 0 W at 105°C, and resistance values ranging from 10 Ω to 2 MΩ.

Leaving the realm of the military, the new trimmers bring the inherent advantages of cermet to the industrial market. These include essentially infinite resolution because cermet is a continuous material, and high reliability since cermet is fused at very high temperatures.

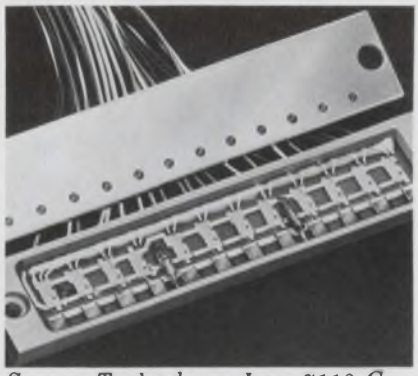
All models have 20 adjustment turns and may be set to a desired voltage within +0.05% of full scale. Maximum input voltage is 200 V, dc or ac rms, and resistance tolerance is ±10 or ±20%, depending on the resistance value. Dielectric strength is 500 V rms, and insulation resistance is 100 MΩ.

Three mounting configurations are available: models 66P, side adjust with pins; models 66X, side adjust with edge-mount pins; and models 66W, top adjust with edge-mount pins.

The units have mechanical stops that use a clutch action at both ends. Their maximum starting torque is 5 oz.-in., and nominal weight is 0.04 oz.

CIRCLE NO. 325

Hybrid readouts sense and amplify

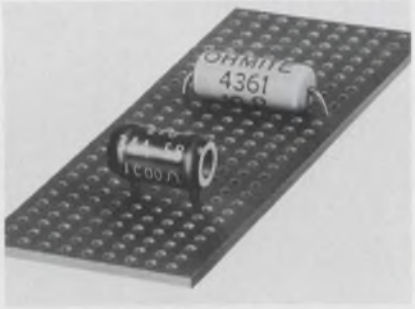


Sensor Technology, Inc., 7118 Gerald Ave., Van Nuys, Calif. Phone: (213) 873-1533.

Thin-film hybrid photovoltaic readout assemblies, which are DTL/TTL compatible, put sensors and amplifying circuits together in a single small package. This arrangement permits the assembly output to be at higher voltages and lower impedances than is usual for this kind of sensor. The arrays are monolithic formations of light-sensitive areas on a common substrate.

CIRCLE NO. 326

Power resistor has radial leads



Ohmite Manufacturing Co., 3601 W. Howard St., Skokie, Ill. Phone: (312) 675-2600. P&A: from 24¢; 6 wks.

Supplied in 3-, 5- and 8-W sizes, the first wirewound power resistor with radial leads is now available. By eliminating the need to cut, bend and form leads, model PC-58 can cut labor costs by 21.9% and can increase productivity by 28.1%. It is designed to fit standard 0.1-in. matrix boards with standard 0.046-in.-diameter holes.

CIRCLE NO. 327

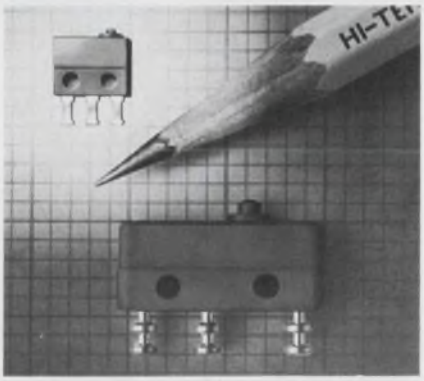
Tilting switch rolls to contact

Roltec, Inc., Mound View Rd., River Falls, Wis. Phone: (715) 425-6848. Price: $9.50.

Using the virtually friction-free rolamite mechanical principle, a new 1-A 125-V electromechanical tilt switch operates at any angle of 15° or greater with any horizontal plane. Rolamite is an elementary mechanism that suspends rollers in such a way that there is virtually no sliding friction. Usually, two cylindrical rollers move freely within the loops of an S-shaped band.

CIRCLE NO. 328

Thirty tiny switches snap into one in.²



Hi-Tek Corp., Switch Div., 2220 S. Anne St., Santa Ana, Calif. Phone: (714) 540-3520. Price: from 98¢; stock.

Measuring only 0.3 by 0.2 by 0.1 in. (exclusive of terminals), new precision snap-action switches permit stack or matrix mounting on 0.1-in. centers of up to 30 switches in one square inch of space. (Terminal spacing is also on 0.1-in. centers.) Only one-fifth the size of existing subminiature switches, Miniswitch units are rated at 1 A resistive, 28 Vdc or 115/250 Vac.

CIRCLE NO. 329

new!

New Allen-Bradley hot-molded Type GD dual variable resistor shown actual size

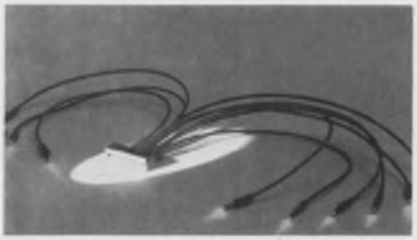
Allen-Bradley hot-molded dual variable resistor

Here's the most compact two section variable resistor currently available—the new Allen-Bradley dual Type GD. It's one-half inch in diameter and only a fraction of an inch longer than the popular single section Type G control. The case is dust-tight as well as watertight. ■ Both resistance tracks in the dual Type GD are solid, hot-molded elements, which provide long operating life. As with the single Type G, the noise level is low initially and actually decreases with normal use. Adjustment is smooth at all times with virtually infinite resolution. And low inductance permits operation at frequencies far beyond the usable range of wirewound controls. ■ In addition to standard application, these new dual Type GD controls are ideally suited for use in compact attenuators. ■ Dual Type GD controls are available with nominal resistance values from 100 ohms to 5.0 megohms. For complete specifications on tolerances, tapers, and options, please write Henry G. Rosenkranz, Allen-Bradley Co., 1201 South Second Street, Milwaukee, Wis. 53204. Export Office: 1293 Broad Street, Bloomfield, N.J., U.S.A. 07003. In Canada: Allen-Bradley Canada Limited.

A-B ALLEN-BRADLEY
QUALITY ELECTRONIC COMPONENTS

EC69-9

Universal read-head uses fiber optics



Bendix Corp., Mosaic Fabrications Div., Galileo Park, Sturbridge, Mass. Phone: (617) 347-9191. Price: $50.

Using flexible optical-quality glass-fiber bundles, a new universal read-head can be used with any currently available paper-tape reader array. This fiber-optic device can modulate each light channel so that coded information can be received at each tape hole. It consists of a machined aluminum case into which individual fiber bundles are potted.

CIRCLE NO. 317

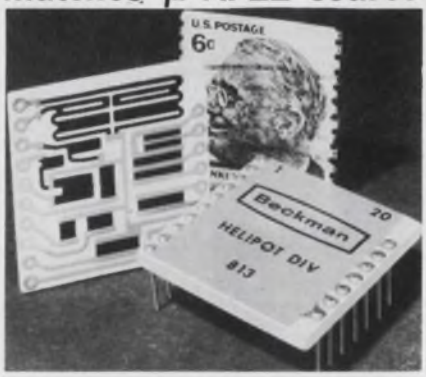
Slide switches double density

Chicago Switch, Inc., 2035 Wabansia Ave., Chicago. Phone: (312) 489-5500. P&A: 50¢ to $2.50; 4 to 6 wks.

New 4pdt subminiature slide switches can double mounted switch density and increase service life by 500 times over competitive units. Measuring only 1.054 in. long, series 23-004 switches have a stroke of 0.136 in., compared to 0.25 in. for competitive units, and withstand 5,000,000 actuations under signal circuit conditions, versus the usual 10,000 to 20,000 for other units.

CIRCLE NO. 318

Cermet resistor network matches μ A722 source

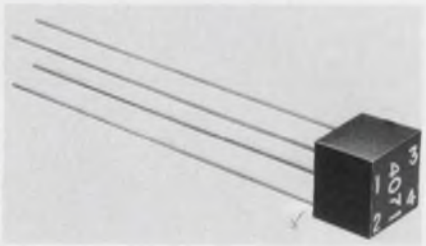


Beckman Instruments, Inc., Helipot Div., 2500 Harbor Blvd., Fullerton, Calif. Phone: (714) 871-4848. P&A: $14; stock.

Designed specifically for use with Fairchild's μA722 10-bit current source, model 813 resistor network—a cermet thick-film device—has directly corresponding resistance values and a compatible terminal arrangement. In addition to ten resistors that set the current source levels, three application resistors are included for output buffer scaling. A fourth application resistor facilitates output offsetting for bipolar applications.

CIRCLE NO. 319

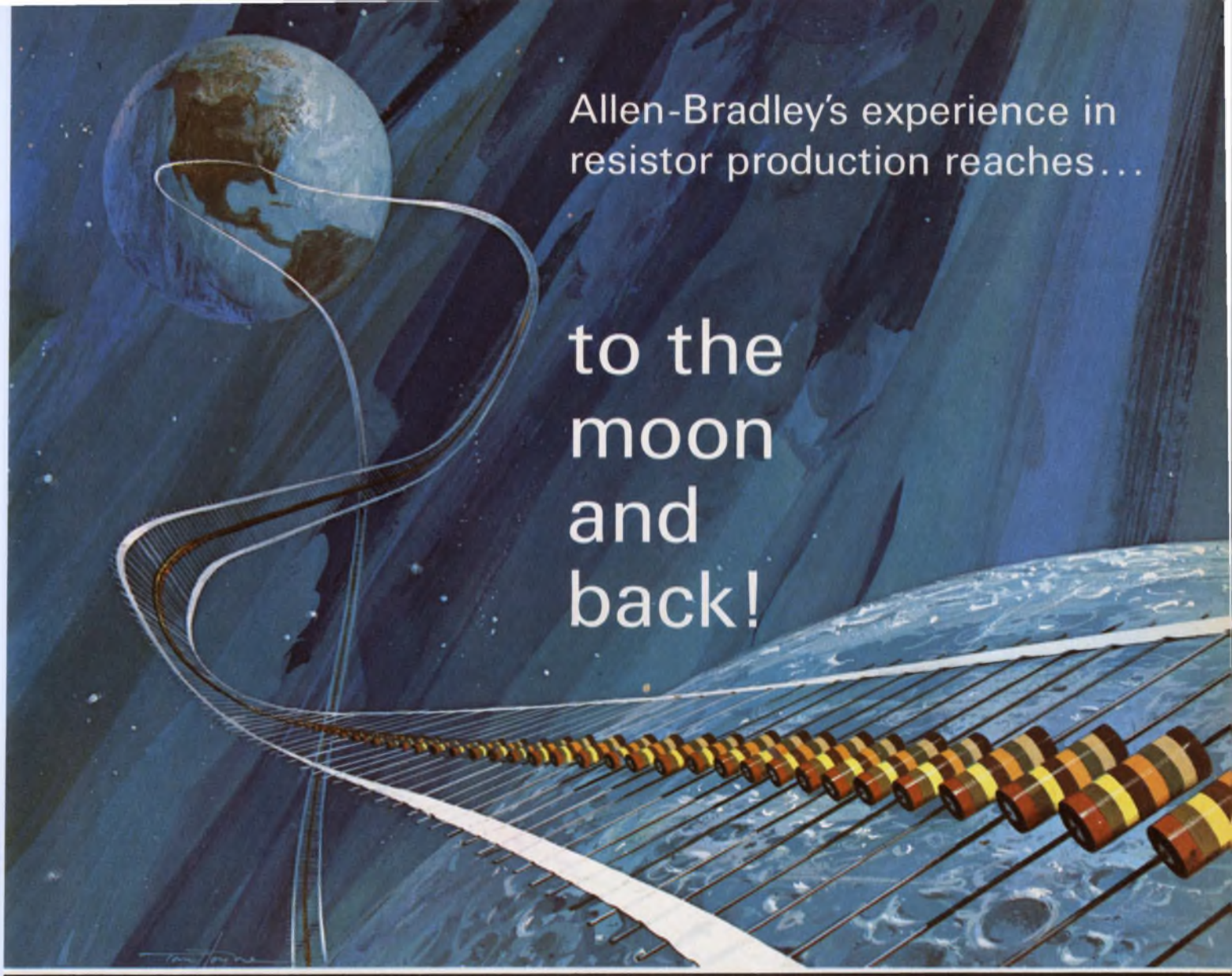
Pulse transformer measures 0.5 in.^{3}

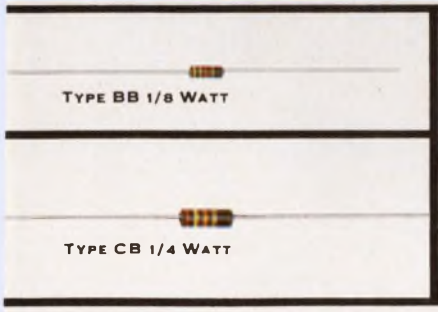


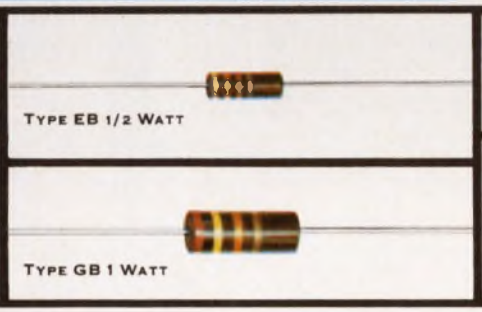
Crescent Technology Corp., SRC Div., 2222 Michelson Drive, Newport Beach, Calif. Phone: (714) 833-2000. P&A: $4.95; 2 wks.

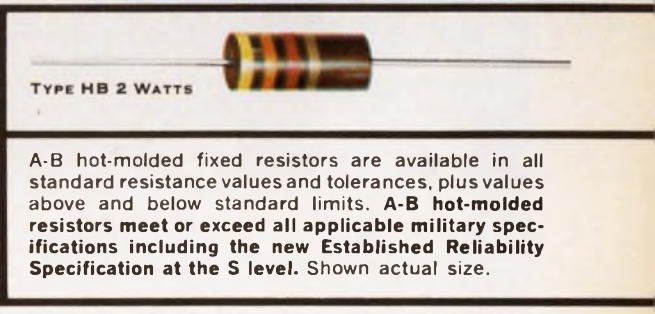
Completely self-contained in a 0.5-in. cube, the 4071 pulse transformer has a 240-V/μs pulse capability into a 25-Ω load. Secondary winding ratings are 6, 12 or 24 V with a standard 24-V primary. Standard risetimes are 100 ns; risetimes down to 15 ns are available.

CIRCLE NO. 320









A-B hot-molded fixed resistors are available in all standard resistance values and tolerances, plus values above and below standard limits. **A-B hot-molded resistors meet or exceed all applicable military specifications including the new Established Reliability Specification at the S level.** Shown actual size.

After more than three decades and untold billions of hot-molded resistors, Allen-Bradley has accumulated manufacturing "know-how" which cannot be approached by anyone else. The fact that the resistors made by A-B over the years—if placed side by side—would more than reach to the moon and back, may be impressive. But "how" they are made is the key.

Allen-Bradley resistors are produced by an exclusive hot-molding technique—developed by A-B. They're made by completely automatic machines—also developed, built, and used only by Allen-Bradley. The human element of error is removed. Uniformity is so precise from one resistor to the next—year in and year out—that long-term resistor performance can be closely predicted. And there has been no known incident of catastrophic failure of an A-B hot-molded resistor.

The reputation for quality and performance established by Allen-Bradley hot-molded resistors is reflected in the fact that they have been an integral part of virtually every U.S. space probe. And they are "on" the moon. No other resistor applications demand a higher measure of reliability.

For detailed specifications on this superior line of hot-molded resistors, please write Henry G. Rosenkranz and request a copy of Technical Bulletin 5000: Allen-Bradley Co., 1201 South Second Street, Milwaukee, Wisconsin 53204. Export Office: 1293 Broad St., Bloomfield, N.J., U.S.A. 07003. In Canada: Allen-Bradley Canada Limited.

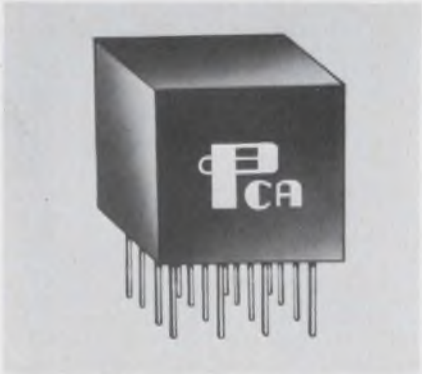
EC 6815

QUALITY ELECTRONIC COMPONENTS

A-B QUALITY

ALLEN-BRADLEY

Balun transformers shrink over-all size

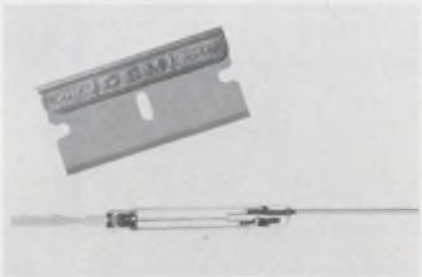


PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif. Phone: (213) 892-0761. Price: $2.50.

Designed for low-impedance operation on transmission lines, balanced to unbalanced, a new line of broadband balun transformers are only 0.65 in. long by 0.5 in. wide by 0.7 in. high. Their open-circuit inductance is 350 μH minimum, and leakage inductance is 0.5 μH maximum. The units are housed in cases of molded epoxy and are fitted with AWG 24 tinned copper leads.

CIRCLE NO. 338

High-ohm reed switch cuts ringing effects



Hamlin, Inc., Lake and Grove Sts., Lake Mills, Wis. Phone: (414) 648-2361.

Incorporating a backstop to effectively eliminate any motion of the reed after switch opening, a new reed switch minimizes the ringing caused by noise-generating variations in open-circuit capacitance. Type SRR-3 has an open-circuit impedance of 10^6 MΩ and a dc contact rating of 10 W at 0.5 A. Nominal operating characteristic is 50 to 110 ampere-turns.

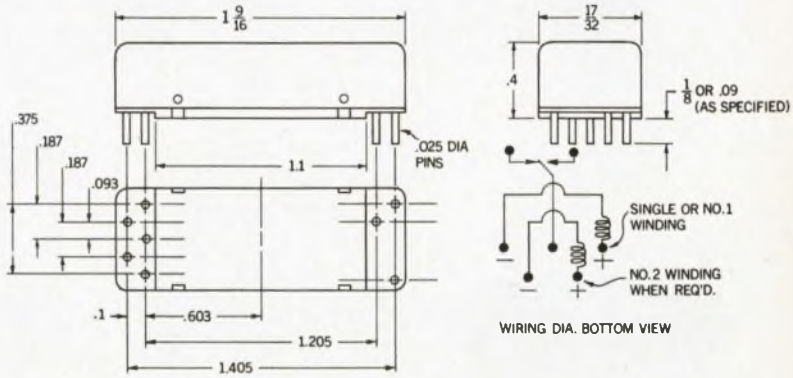
CIRCLE NO. 339

when size makes the difference

Adlake makes the size

Adlake's new AWCM and AWDM Mercury Wetted Contact Relays — Sub-Miniature in size for printed circuit board use (see diagram) provides the answer to the high component density question. Small in size, yet made to Adlake's stringent quality requirements. Depend on Adlake's reliability and this new product to help solve your space problems. Available as contact Form C or contact Form D.

Write, please, for BULLETIN No. MW 5.



Adlake SINCE 1857

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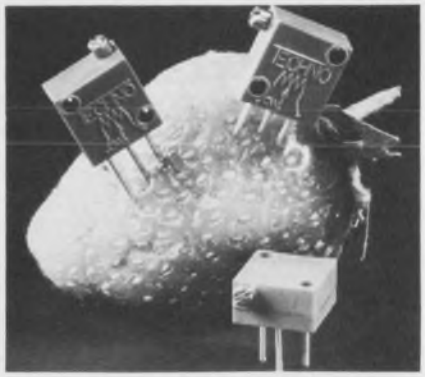
Monolithic filters yield four poles

Damon Engineering, Inc., 115 Fourth Ave., Needham Heights, Mass. Phone: (617) 449-0800.

Four new four-pole monolithic crystal filters are now available with center frequencies of 10.7 or 21.4 MHz. Models 6347MA, 6347-MB, 6348MA and 6348MB have 3-dB bandwidths of 6 or 15 kHz minimum and 40-dB bandwidths of 24 or 55 kHz maximum. Maximum ripple is 0.5 or 1 dB, maximum insertion loss is 2 or 3 dB, and operating temperature range is 0 to 60°C.

CIRCLE NO. 340

Military trimmers are 3/8 in. square



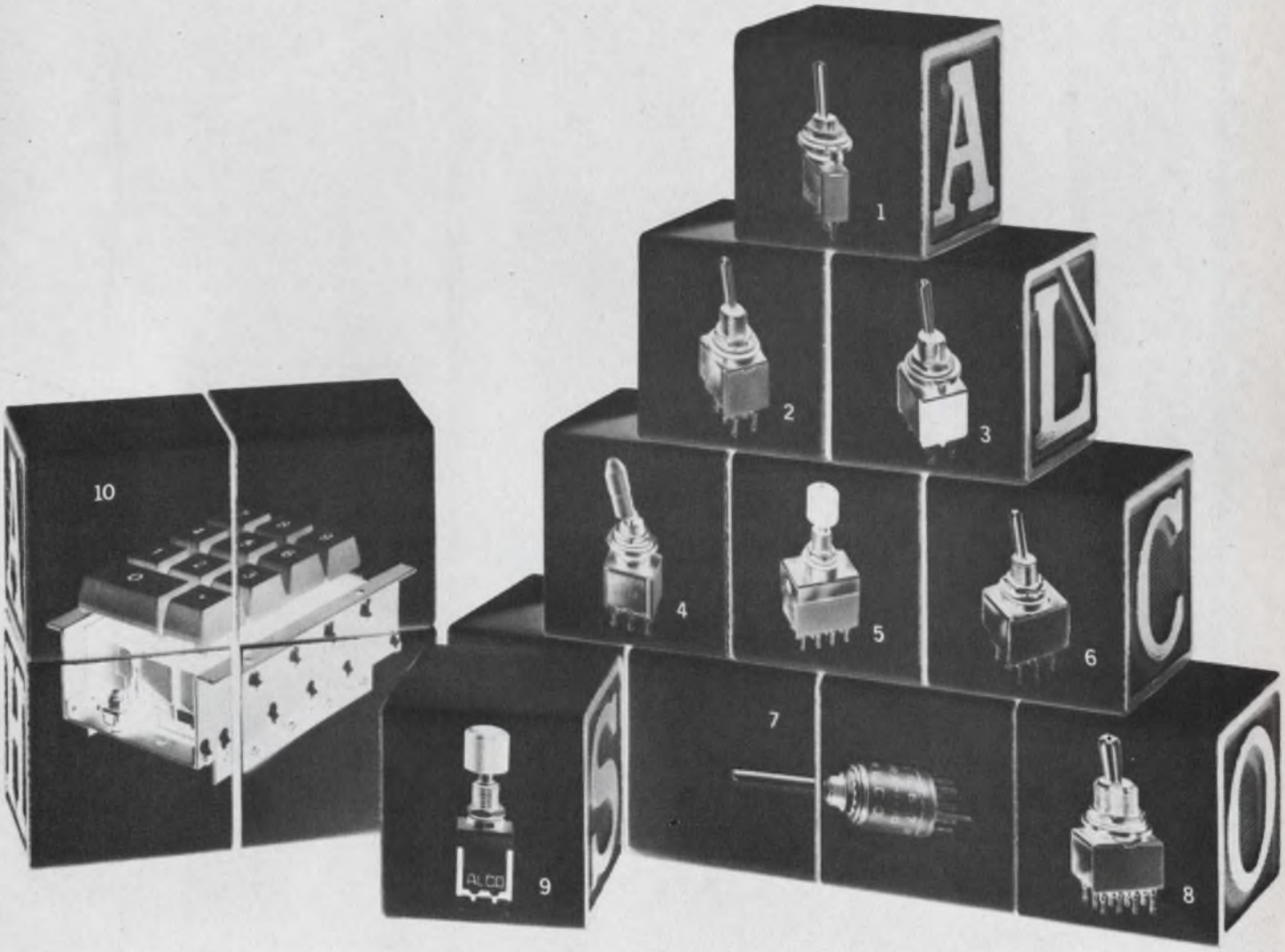
Techno Components Corp., Sub. of Oak Electro/Netics Corp., 7803 Lemona Ave., Van Nuys, Calif. Phone: (213) 781-1642.

A new family of 3/8-in. square trimming potentiometers meet the requirements of MIL-R-39015. Series RTR 24 trimmers are available in the popular P, W, and X configurations with resistance values ranging from 10 to 10,000 Ω. Power rating is 3/4 W at full load with an ambient temperature of 85°C, and insulation resistance is greater than 100 GΩ at 500 V dc.

CIRCLE NO. 341

build with . . .

ALCOSWITCH

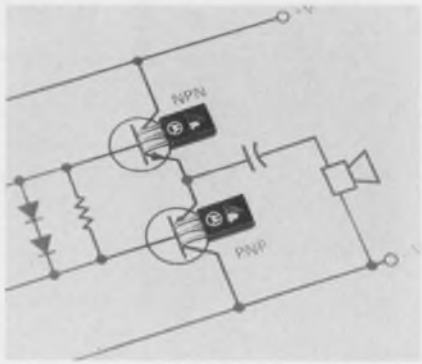


Build quality and reliability into your equipment with a top performing miniature Alcoswitch. Here are typical miniature switches from the many families of Alcoswitch which you can select: 1 — SPDT "A" Series Toggle Switch, 2 — DPDT "E" Series Toggle Switch, 3 — DPDT "MST" Series Toggle Switch, 4 — DPDT Locking Toggle Switch, 5 — 4PDT "E" Series Push Button Switch, 6 — 3PDT "E" Series Toggle Switch, 7 — "E" Series Waterproof Rotary Switch, 8 — 4PDT "Mustang" Toggle Switch, 9 — DPDT "MST" Series Push Button Switch, 10 — Reed Switch Operated Keyboard Assembly. Whatever your design problem or production budget, there is a miniature switch to fit your needs from Alcoswitch . . . the No. 1 choice in the U.S.A.

ALCO® ELECTRONIC PRODUCTS, INC. ▪ LAWRENCE, MASS.

Circle 129 on reader service card

Plastic npn/pnp pairs handle up to 35 W



Motorola Semiconductor Products Inc., P.O. Box 20924, Phoenix, Ariz. Phone: (602) 273-6900. Price: $1.25 to $1.95.

Encapsulated in a miniature plastic package, four new low-cost silicon transistors are now available for use in 20- and 35-W complementary audio amplifiers. The npn MJE205 and pnp MJE105 are 5-A units, while the npn MJ2801 and pnp MJ2901 are 10-A units. Power dissipation is 65 or 90 W, and current gain ranges from 25 to 100 for collector currents of 2 or 3 A, respectively.

CIRCLE NO. 342

Monolithic source socks out 1 mA

Optical Electronics, Inc., P.O. Box 11140, Tucson, Ariz. Phone: (602) 624-8358. P&A: $12; stock.

With input current determining its output current, a new monolithic temperature-stabilized source supplies output currents from 100 nA to 1 mA. Model 8106 is a four-lead low-profile device in a TO-5 package. Its bandwidth is 20 MHz, and output impedance is 100 MΩ. Applications include pulse amplifiers, staircase generators and integrator current sources.

CIRCLE NO. 343

Zener specialists— 10^7 times a year

Centralab produces 10,000,000 zeners a year, each hermetically sealed for reliability

Production figures prove that buyers have confidence in Centralab zeners. They know, for example, that we originated microglass zener regulators and are still the industry's leading producer and developer. There are hermetically sealed zeners (or passivated chip devices) that meet or exceed hi rel military and demanding industrial requirements, plus others produced for low-cost entertainment applications. Our zener regulators cover thousands of JEDEC numbers, ratings, case styles and applications. Or we can design to your particular requirements. And every order gets special treatment. That's how we got to be the zener specialists — we provide the zener regulators you want, when you want them. Count on us. Call Centralab Customer Service, 213/686-0567.

Find out about Centralab's chip diodes, including an exclusive chip diode kit for lab and short production run applications.

Shown, are reel-packed microglass zeners for high production applications

THE ZENER SPECIALISTS

CENTRALAB
Semiconductor Division
GLOBE-UNION INC.
4501 NORTH ARDEN DRIVE
EL MONTE, CALIFORNIA 91734

M-6907

INFORMATION RETRIEVAL NUMBER 77

Now... the highest concurrent-rated inverter SCR

AMPLIFYING GATE (TM)

C398 inverter SCR utilizes amplifying gate design for high speed and high voltage.

The new C398 is now the highest rated SCR in GE's complete line of inverter thyristors. This new 1200 volt design boasts soft-firing gate, high di/dt and fast turn-off time. These features are the result of over one and a half years of General Electric experience in amplifying gate technology. This structure also permits superior ratings for other Press Pak (C358) and stud-mounted (C158) units.

C398's Press Pak package means simpler installation and increased application flexibility, plus double-side cooling permits a higher current capability. To mount the hermetically-sealed Press Pak, simply insert it into GE's new universal spring clamp assembly. To change polarity, just turn the unit over.

With this latest addition, GE's full line of inverter thyristors includes virtually every rating necessary for total design flexibility . . . including Press Paks (C354/355, C385, C358, C510, C398) and stud mounts (C141, C154/155, C185, C158).

Also designed for inverter use is the A96 and its Press Pak counterpart, A396. This pair of fast-recovery diodes is specifically designed to complement GE's high-speed SCR's in inverter and chopper applications.

For more information on these and other General Electric semiconductor products, call or write your GE sales engineer or distributor, or write General Electric Company, Section 220-71A, 1 River Road, Schenectady, N. Y. 12305. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: Electronic Component Sales, IGE Export Division, 159 Madison Avenue, New York, New York 10016.

GENERAL ELECTRIC

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INFORMATION RETRIEVAL NUMBER 78

Four ac amplifiers fit on single chip

RCA/Electronic Components, 415 S. Fifth St., Harrison, N. J. Phone: (201) 485-3900. Price: $2.45.

Consisting of four independent ac amplifiers on a single silicon chip, model CA3048 circuit array incorporates, for each amplifier, internal dc bias and feedback for temperature-stabilized operation. Each circuit features a typical noise figure of 2 dB at 1 kHz, minimum voltage gain of 53 db, typical input resistance of 90 kΩ and a typical output impedance of 1 kΩ. Minimum undistorted output voltage is 2 V rms, and open-loop bandwidth is 300 kHz typical.

The monolithic array may be used with amplifiers cascaded for high-gain dual-channel operation. It operates from a single-ended power supply and has independently accessible inputs and outputs. Its housing is a 16-lead dual-in-line plastic package; operating temperature range is −25 to +85°C.

Applications include multi-channel or cascade operation, low-level preamplifiers, equalizers, linear multivibrators, ac integrators, as well as other ac circuits where operational amplifiers have been employed previously.

CIRCLE NO. 344

Hybrid semiconductors simplify assemblies

Ferranti Electric Inc., E. Bethpage Rd., Plainview, N.Y. Phone: (516) 293-8383.

Series Micro-E microminiature plastic encapsulated transistors and diodes eliminate many of the difficulties involved in producing active devices suitable for use with thick- and thin-film circuits. Since their leads emerge at each end, the new devices simplify the setting up of automatic assemblies and provide large power dissipation levels at high operating temperatures. They are designed to interface with normal track spacing or thin- and thick-film circuits.

CIRCLE NO. 345

INFORMATION RETRIEVAL NUMBER 79 ►

We had big things in mind when we developed our tiny toggle switches.

Things like airplanes, computers, aerospace hardware, communications gear and data processing equipment. Things where small size and minimum weight count. But where long-life operating characteristics count more.

For instance, excellent tactile feedback and "proof-of-position." Our TW toggle switches provide both. The result of a 35° toggle throw and positive detent. And for aircraft applications, there's a new, large bat handle that meets your human factor requirements.

Then there's switching versatility. Both standard 1/4" and our new 15/32" bushing versions are available with a two or three-position, maintained or momentary action and in either one or two-pole circuitry. All can be obtained with standard or pull-to-unlock toggle levers to meet your needs.

Sealed, molded-in solder terminals won't pull out. Go ahead, try.

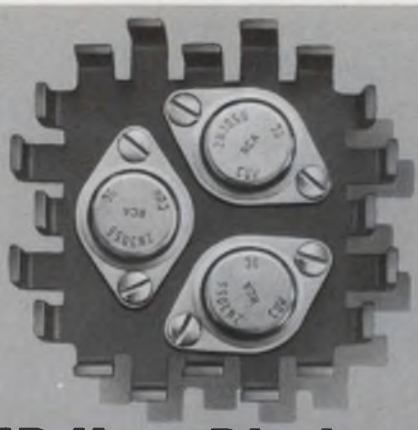
What this all adds up to is reliability. The kind that's evidenced by meeting MIL-S-3950 requirements for shock, vibration, moisture, corrosion and altitude.

There are accessories, too. Dress hardware, lever caps, boot seals, panel seals. Each improves switch effectiveness as well as panel appearance.

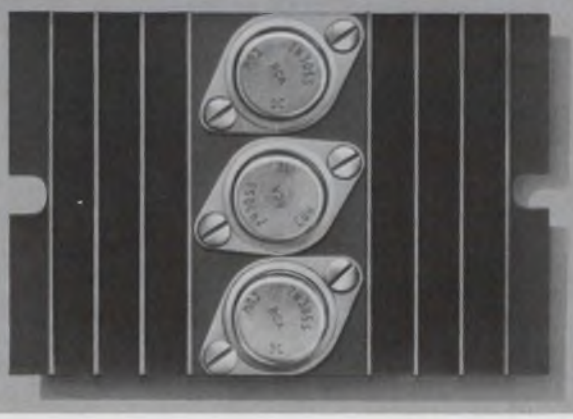
It's all in Product Sheet TW. Plus a lot more. You can get a copy from your MICRO SWITCH Branch Office or Distributor. (They're in the Yellow Pages under "Switches, Electric.") Or write and we'll send a copy. You're sure to find it a big help.

MICRO SWITCH
FREEPORT, ILLINOIS 61032
A DIVISION OF HONEYWELL

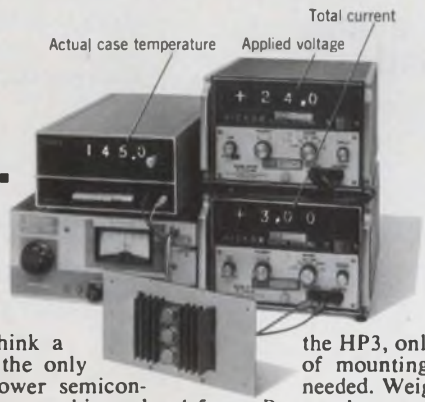
INFORMATION RETRIEVAL NUMBER 80

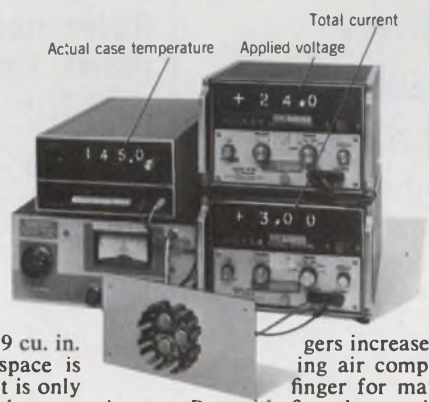


IERC's HP Heat Dissipator is only 1/3 the weight and 2/3 the volume of extrusions– yet it dissipates the same amount of heat.



Here's proof.





Many circuit designers think a hefty hunk of extrusion is the only thing to use to cool off power semiconductors. Of course, extrusions are big and heavy but that's the price one had to pay.

No more.

The test setups shown above prove there is a better way.

On the left: A conventional extruded aluminum heat sink and three TO-3 case silicon transistors. 13.5 cu. in. (3 x 4.5 x 1) are required for mounting. Weight is 4.4 ozs. Total power dissipation is 72 watts with case temperature rise of 120°C (plus 25°C ambient).

On the right: IERC's efficient HP3 Dissipator with three TO-3s. (The HP3 will actually accommodate four TO-3s.) With the HP3, only 9 cu. in. of mounting space is needed. Weight is only 1.5 ozs. But, as shown, *performance is exactly the same.* It's just that the HP3 does the job with only ⅔ the size and ⅓ the mass!

See the secret? It's the multiple staggered finger design. In still air the separate fingers dissipate, by radiation and convection, directly to the ambient—not to another finger surface. Conversely, extrusion fins radiate to each other. And, the free movement of convection currents is hampered by their being confined in the deep cavities between the fins.

In forced air the HP is even more efficient. The staggered fingers increase turbulence, directing air completely around each finger for maximum dissipation. But with finned extrusions the forced air begins to leave the surfaces immediately. By the time it is part way down the extrusion it is hitting only the top edges of the fins, resulting in minimal dissipation.

Also, extrusions are directional. The HP is not. Mount it in any vertical or horizontal mode. It gives the same high efficiency with forced air from any direction.

Convinced? Then send for Technical Bulletin No. 139 and our new 4-page Short Form Catalog. They're loaded with ways to keep your transistorized circuitry cool *and* small.

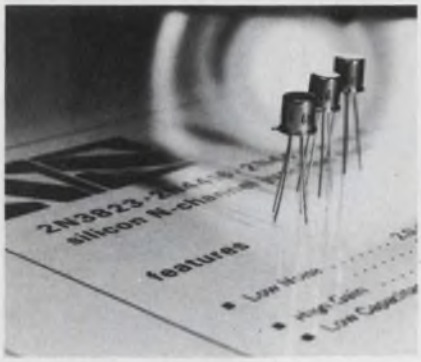
IERC

Heat Sinks/Dissipators
for all lead mounted and case mounted semiconductors

INTERNATIONAL ELECTRONIC RESEARCH CORPORATION • A CORPORATE DIVISION OF DYNAMICS CORPORATION OF AMERICA • 135 W. MAGNOLIA BLVD. • BURBANK, CALIF. 91502

INFORMATION RETRIEVAL NUMBER 81

Three vhf/uhf FETs gain 18 dB at 100 MHz

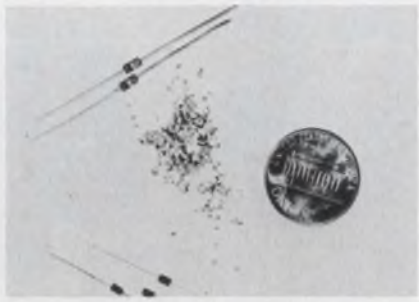


National Semiconductor Corp., 2950 San Ysidro Way, Santa Clara, Calif. Phone: (408) 245-4320. P&A: $1.70 to $3.35; stock.

Three new vhf/uhf FETs deliver 18-dB power gain at 100 MHz and 10-dB power gain at 400 MHz. Types 2N3823, 2N4416 and 2N-4416A exhibit at low noise figure of 2 dB at 100 MHz, 4 dB at 400 MHz, in addition to a low capacitance of 0.8 pF. Applications for the new devices include amplifiers, mixer and oscillators, and receivers and tuners.

CIRCLE NO. 346

Reference diodes resist radiation



Microsemiconductor Corp., 11250 Playa Court, Culver City, Calif. Phone: (213) 391-8271. P&A: $8.28; stock to 2 wks.

A new line of radiation-resistant temperature-compensated reference diodes is said to exhibit one order of magnitude more resistance to fast neutron radiation than competitive units. These hardened silicon devices have nominal voltages of 6, 2, 8.4 and 9 V, and temperature coefficients from −50 to +100°C.

CIRCLE NO. 347

Linear monolithics compare and amplify

Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif. Phone: (408) 739-7700. Price: $3.15 amplifier, $4.15 comparator.

Two new linear integrated circuits are now available—the 517 dual operational amplifier and the 526 analog comparator. The amplifier is supplied in two versions, a military unit and a commercial/industrial one. It offers a power capability of 75 mW per channel and a typical gain of 15,000.

CIRCLE NO. 348

IC amplifier costs only 49¢

RCA/Electronic Components, 415 S. Fifth St., Harrison, N.J. Phone: (201) 485-3900. Price: 49¢.

Priced at 49¢ in quantities of 1000, a new monolithic differential/cascode amplifier offers exceptional economy for i-f and general-purpose amplifier applications. Model CA3053 features a wide operating-current range and an agc capability. Electrical characteristics include a typical power gain of 39 dB for cascode and 32 dB as a differential amplifier.

CIRCLE NO. 349

Linear multiplier is monolithic IC

Motorola Semiconductor Products Inc., P.O. Box 20924, Phoenix, Ariz. Phone: (602) 273-6900. Price: $18.

Intended for use in the control, instrumentation, communications, computer and navigation fields, a new monolithic four-quadrant multiplier, said to be the industry's first, provides an output voltage that is a linear product of two input voltages and a constant scale factor. The MC1595 is designed so that the scale factor and the input/output voltage ranges may be adjusted by the user to accommodate a wide variety of applications.

CIRCLE NO. 350

BUT IN THIS HORSE RACE – THAT'S NOT BAD !

Although we have a winning line of ECL's – Motorola's still a few circuits ahead. But we're announcing that we can match their 14 most popular MECL II units right now – with more to come!* So if you've been afraid to take advantage of the high-speed characteristics of these unique new ECL devices because you don't like sole-sourcing – relax. Go ECL II with confidence. Now you've got Stewart-Warner to back up Motorola...or vice versa.

STEWART-WARNER ECL II

CIRCUIT FUNCTION	MILITARY −55°C. to 125°C.	INDUSTRIAL 0°C. to 75°C.
Dual 4-input Complementary Gate	SW1204	SW1004
Dual 4-input Complementary Gate	SW1205	SW1005
Dual 4-input Complementary Gate	SW1206	SW1006
Quad 2-input NOR Gate	SW1210	SW1010
Quad 2-input NOR Gate	SW1211	SW1011
Quad 2-input NOR Gate	SW1212	SW1012
85-MHz AC-Coupled J-K Flip-Flop	SW1213	SW1013
Dual R-S Flip-Flop (Positive Clock)	SW1214	SW1014
Dual R-S Flip-Flop (Negative Clock)	SW1215	SW1015
Dual R-S Flip-Flop (Single Rail, Positive Clock)	SW1216	SW1016
Translator – ECL to Saturated Logic	SW1218	SW1018
Dual 2-input Expandable Gate	SW1224	SW1024
Dual 4-5 input Expander	SW1225	SW1025
Dual R-S Flip-Flop (Single Rail, Negative Clock	SW1233	SW1033

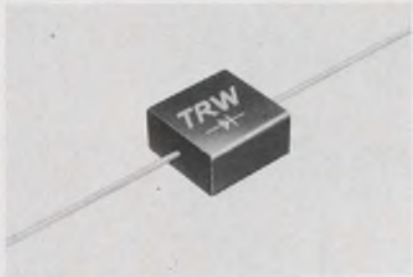
For more information, send for our new ECL II data sheets. And, for off-the-shelf product delivery, call your local Stewart-Warner Microcircuits Distributor.

**We also offer 11 ECL's in the 300 and 350 series.*

STEWART-WARNER COMPANIES — SYMBOL OF EXCELLENCE SW

STEWART-WARNER MICROCIRCUITS, INC.
730 EAST EVELYN AVENUE, SUNNYVALE, CALIFORNIA 94086
PHONE 408/245-9200 TWX 910-339-9210

Capacitance diodes vary C by 5:1 ratio

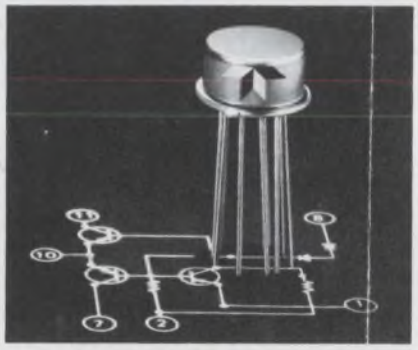


TRW Inc., Semiconductor Div., 14520 Aviation, Lawndale, Calif. $13.70 to $19.60; stock.

Over the frequency range of 1.6 to 5 MHz, three new high-capacitance diodes feature a 5:1 capacitance ratio between 2 and 90 V. Designed for low-frequency circuits, the devices have less than 1-μA leakage and a Q factor of greater than 150. Type PQ2150 has a capacitance of 150 pF; type PQ2300, 300 pF; and type PQ2500, 500 pF. Their flat encapsulated package is 0.32-in. square by 0.165 in.

CIRCLE NO. 351

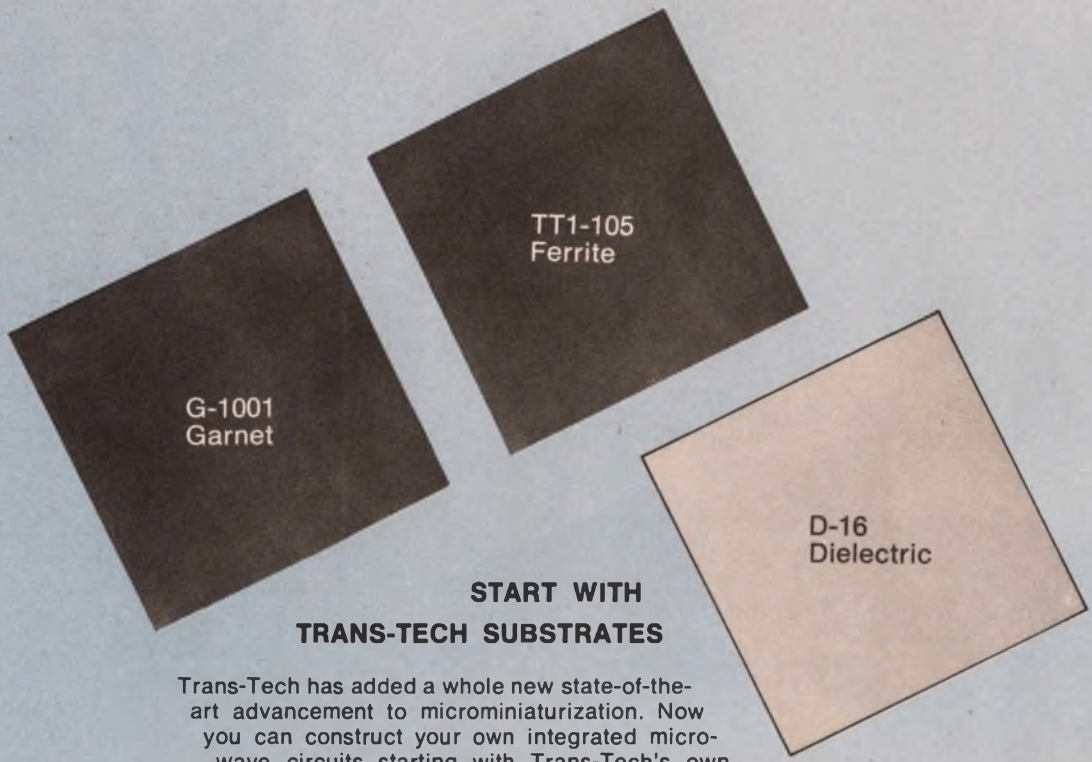
Dual-circuit hybrid is spst FET switch



Crystalonics, a Teledyne Co., 147 Sherman St., Cambridge, Mass. Phone: (617) 491-1670. P&A: $60; stock.

Containing two complete circuits in a single low-profile TO-5 package, a new spst hybrid FET switch operates directly from DTL or TTL inputs. Designed for analog gating, model CAG13 provides break-before-make switching action. Over the voltage range of ±9 V, each circuit has a maximum on-resistance of 50 Ω and a typical switching time of 300 ns.

CIRCLE NO. 352



START WITH TRANS-TECH SUBSTRATES

Trans-Tech has added a whole new state-of-the-art advancement to microminiaturization. Now you can construct your own integrated microwave circuits starting with Trans-Tech's own ferrimagnetic or dielectric substrates.

These substrates have the same "high-reproducibility", technical characteristics as all Trans-Tech materials . . . only the form is changed.

Design investigation begins with any one of the three standard substrates listed below. And the beauty of it is you can get into microstrip design economically. Order just one or a few standard substrates for prototype design. Immediate delivery on all orders.

Production orders can be conformed to other custom sizes, surface finishes or other material requirements.

Part No.	Material Type	$4\pi M_s$	Surface Finish (micro-inches)	Price
TT S-10101	G 1001 (Garnet)	1200± 5%	≤20	$17.00
TT S-10201	TT1-105 (Ferrite)	1750± 5%	≤25	8.00
TT S-10301	D 16 (Dielectric)		≤25	5.00

All Substrates are 2.000±0.010 x 2.000±0.010 x 0.050±0.001 inches.

TRANS-TECH, INC.
12 Meem Avenue, Gaithersburg, Md. 20760 / (301) 948-3800

Get into Microstrip Design

INFORMATION RETRIEVAL NUMBER 85

Shirtpocket VOM has FET input

Triplett Electrical Instrument Co., Bluffton, Ohio. Phone: (419) 358-5015. P&A: $70; stock.

Model 310-FET, a battery-operated volt-ohm-milliammeter, features FET circuitry, 10 MΩ constant input resistance on all dc voltage ranges, and can make resistance readings to 5000 MΩ. The little unit slips easily into a shirt pocket. Dimensions are 2-3/4 × 4-1/2 × 1-1/8 in.; weight is only 14 ounces. It includes a provision for attaching an ac clamp-on ammeter adapter.

CIRCLE NO. 353

Solid-state injector traces circuits

Allied Radio Corp., 100 N. Western Ave., Chicago. Phone: (312) 421-6800. P&A: $4.95; stock.

A new solid-state signal injector is now available in low-priced, easily assembled kit form. Model KG-644 is completely portable and self-contained. It produces a signal rich in harmonics for tracing audio, rf and i-f circuits. The insulated test probe features a battery condition light and push-button operation. A cylindrical handle houses the circuit, permitting long use without tiring.

CIRCLE NO. 354

INFORMATION RETRIEVAL NUMBER 87 ►

The Friden 1150 Digital Printer: fast, reliable– and inexpensive.

The Friden* 1150 Digital Printer has a printing speed of 50 characters a second.

Because it has fewer moving parts than ordinary medium-speed printers, it is easier to maintain. This means less downtime for your OEM product. The unit contains a single 20-character print wheel and a synchronized print hammer. Both are driven across the tape from right to left at a uniform speed.

The hammer's short impact time ensures quality printing from the continuously rotating wheel. Your output looks good and is easy to read. And we have even eliminated ribbons with a disposable ink roller.

Logic requirements are simple, making it easy for you to integrate the 1150 into your OEM product.

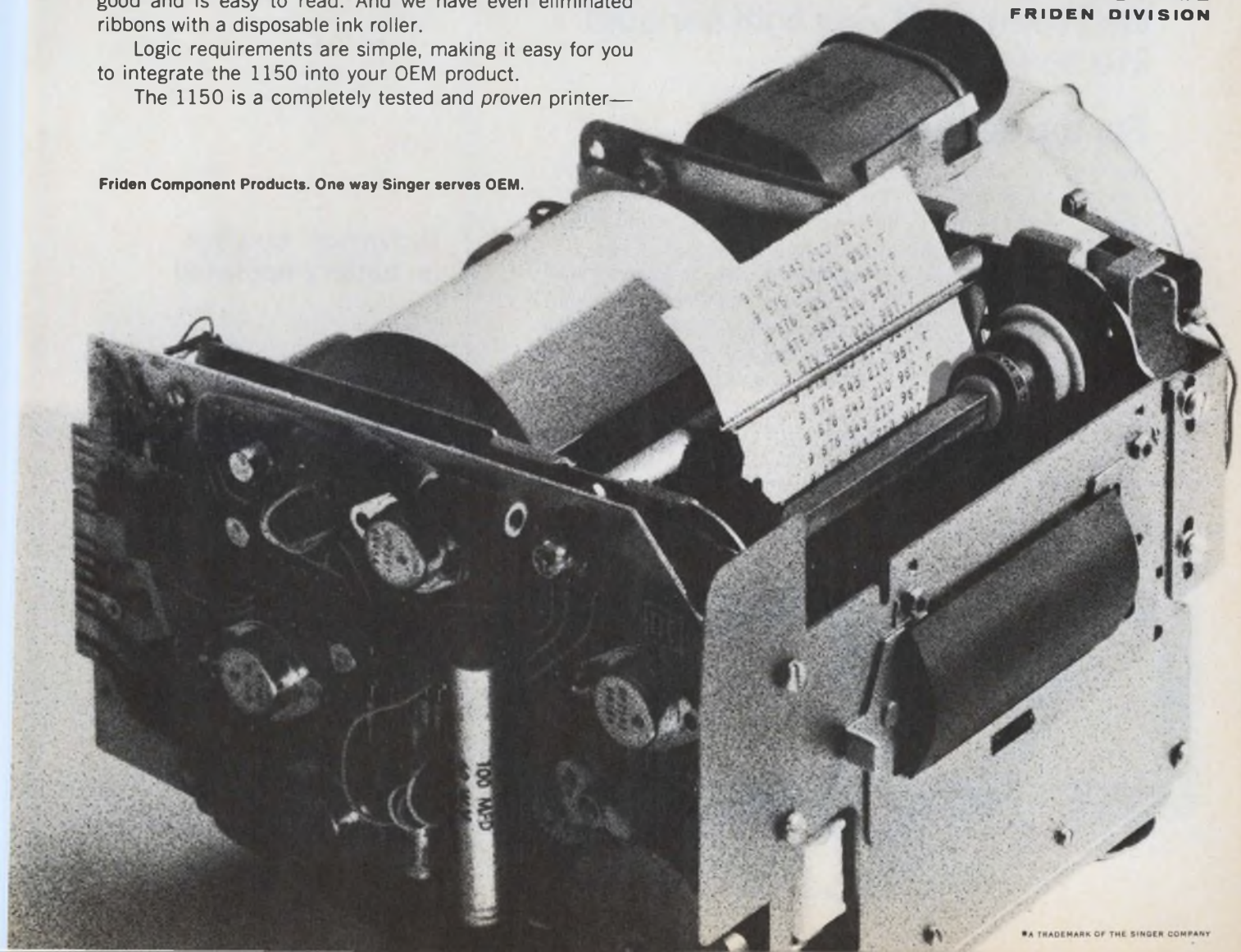
The 1150 is a completely tested and *proven* printer—a vital component of Friden electronic printing calculators for nearly two years. And Singer's Friden Division provides maintenance backup throughout the world.

With its low initial cost and desirable operating features, the 1150 gives you a price/performance ratio that is unique among OEM printers.

We'd like you to have complete specifications. Just write Friden Division (Component Products), The Singer Company, San Leandro, California 94577. Ask for Specification 1001.

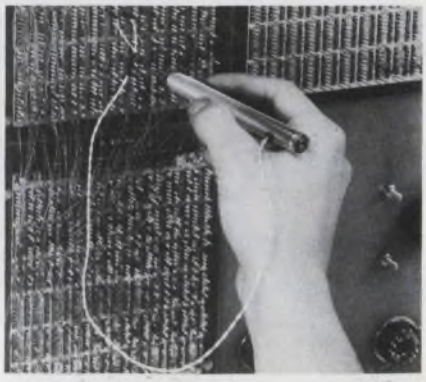
SINGER
FRIDEN DIVISION

Friden Component Products. One way Singer serves OEM.



*A TRADEMARK OF THE SINGER COMPANY

Handheld probes check logic states



Kurz-Kasch, Inc., 1421 S. Broadway, Dayton, Ohio. Phone: (513) 223-8161. P&A: $29.97; stock.

Logic levels of integrated circuit systems can be checked at a glance, without removing the module from the unit, by means of a new 6-in. logic probe. The probe visually displays presence or absence of logic current levels for gates, flip-flops, one-shots, etc., without requiring the service technician or inspector to shift his eyes to an oscilloscope screen or voltmeter. Readout is displayed through two circular windows located in the end of the probe.

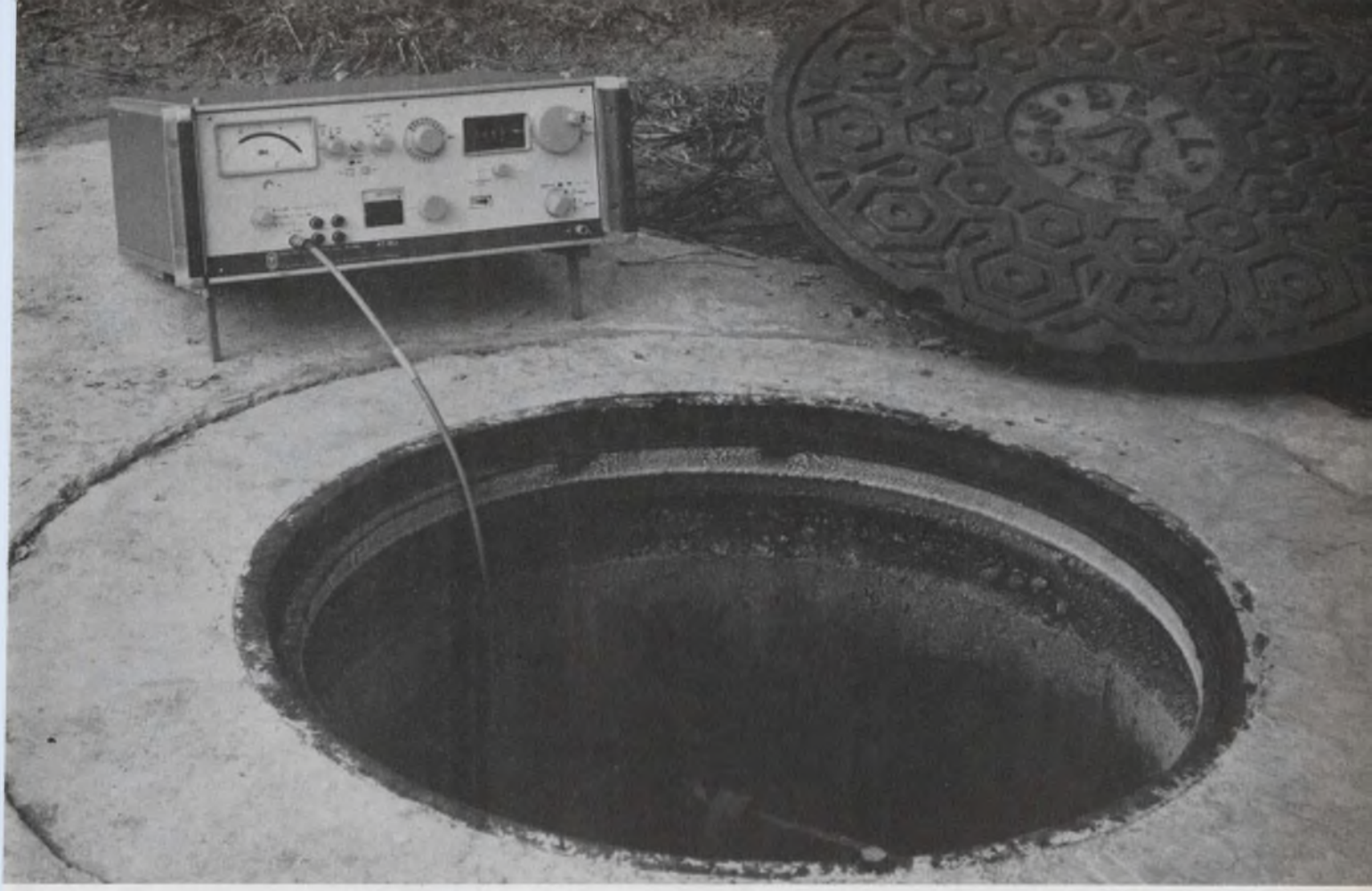
CIRCLE NO. 355

Universal counter is battery-operated

Micro Electronic Systems, Inc., 1275 Bloomfield Ave., Fairfield, N. J. Phone: (201) 228-4472. P&A: $650; 60 days.

A universal counter and portable battery pack in a single housing, type 4061 B, includes a standard counter with a 100-kHz option. The battery automatically recharges when the unit is connected to the line, and overcharge protection is built in. A panel meter indicates battery condition, and the unit is capable of operation for a minimum of 8 hours.

CIRCLE NO. 356



Level Meter Independent from Power Line, with Higher Accuracy

These were the basic requirements for a new selective level meter for balanced and coaxial cables and radio systems. In order to satisfy these demands from manufacturers and operating and service personnel in the carrier frequency field of telecommunications, a new instrumentation concept was developed employing techniques never before utilized. The result: the Selective Level Meter SPM-6 (6kHz to 18.6 MHz).

For example, the unusual measuring accuracy was achieved through automatic level calibration which makes the troublesome manual calibration superfluous and eliminates an additional source of potential error. Once every second the instrument calibration is checked against an internal standard, and, when necessary, automatically corrected. The frequency of the calibration signal is not — as is conventionally the case — constant, but is always tuned to the same frequency as the signal being measured, and applied at the very input. Frequency response and attenuator errors are therefore extremely small, and measurements with high absolute accuracy can be made with no warm up time whatsoever.

Selective Level Meter-SPM-6

6 kHz to 18.6 MHz balanced to 620 kHz

A new type of measuring instrument for the measurement of modern carrier systems: High accuracy, precise frequency setability — operable from AC power or built in internally rechargeable batteries.

Wandel & Goltermann West Germany / represented in U.S.A. by

W & G INSTRUMENTS, INC. 6 Great Meadow Lane. Hanover, N. J. 07936 • (201) 887-8700

Little black box boosts VOM punch

Integrated Controls, Inc., P.O. Box 17296, San Diego, Calif. Phone: (714) 453-5800. Price: $50.

A new meter expander increases the voltage and current sensitivity of any VOM by as much as 1000:1. The instrument has selectable gain settings of 10, 100 and 1000. It is connected as a buffer amplifier between the test leads and the VOM. The direct-coupled, integrated circuit buffer amplifier produces a nominal full output of ± 2.5 V and increases the voltage sensitivity of the meter up to 60 dB and the input impedance to more than a megohm.

CIRCLE NO. 357

Oscilloscope plug-in plots characteristics

U-Tech, 4190 S. State St., Salt Lake City, Utah. P&A: $595; stock.

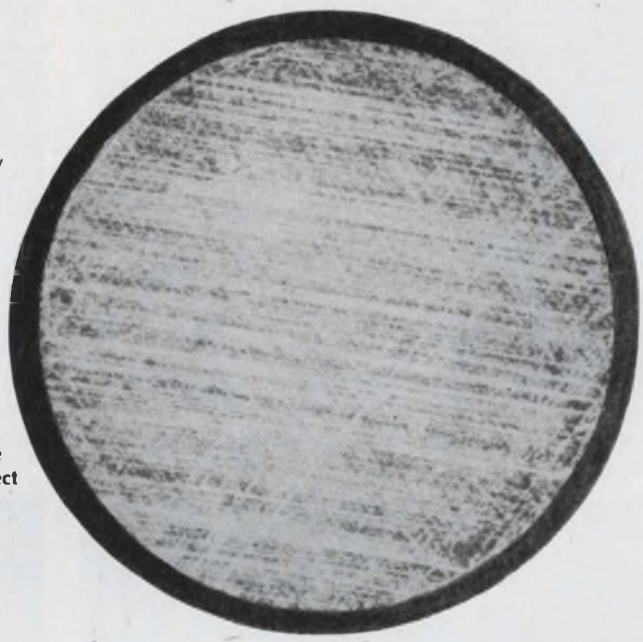
Designed to be used with Tektronix 560-series plug-in oscilloscopes, the model 681 characteristic curve tracer offers substantial savings to users who already own a scope. The 681 displays the dynamic characteristics of both npn and pnp transistors, n- and p-channel junctions, FETs, MOSFETs, bipolars, unijunctions, diodes, tunnel diodes, and SCRs. It offers curve tracer capability at less than half the price of a separate self-contained instrument.

CIRCLE NO. 358

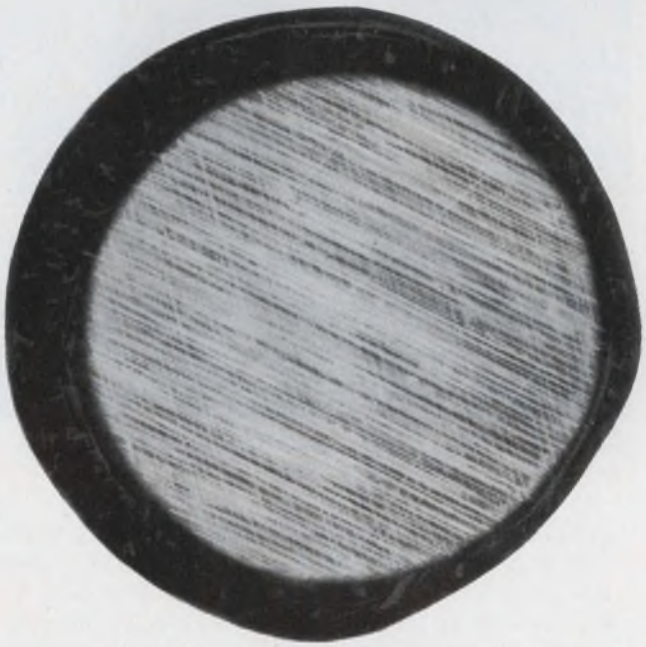
Nothing eccentric about us

We make fine magnet wire PERFECTLY CONCENTRIC within its insulation. No thin spots or thick spots. Which means consistently filled bobbins. Uniform coil diameters. Few reject problems. No shorting. It's what we call "dimensional control." It's unique with Belden (and so is the equipment and processes that produce it). And it makes your quality control a lot easier.

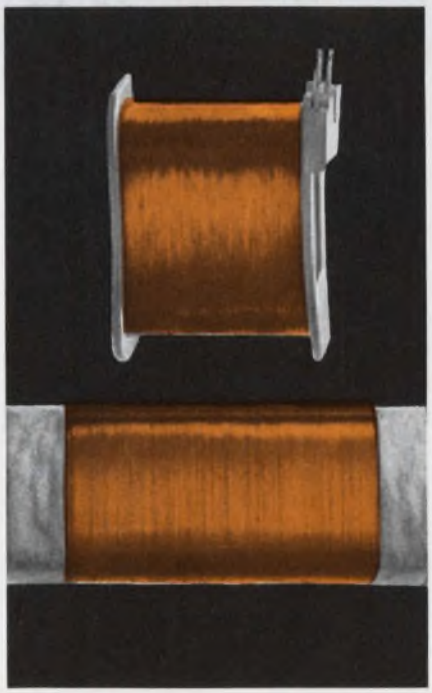
We're also the only people to take raw copper rod and strip off the oxidation before we draw it. This makes it easier to solder or weld. And we ship our ultra fine magnet wire in unique, maximum-protection packages. To make sure you get your wire in perfect shape. All down the line we've problem-proofed Belden fine and ultra fine magnet wire. To give you plenty of good reasons for calling your Belden Representative or local Belden Magnet Wire Distributor (ask him for your copy of the "Belden Magnet Wire Handbook" when you do). Or write: Belden Corporation, P.O. Box 5070-A, Chicago, Illinois 60680.



Yeay! That's ours. A photomicrograph cross-section of dimensionally controlled Belden Fine Magnet Wire. Note the unique, perfect concentricity of the wire within its insulation.



Nay! That's the alternative to Belden —a cross-section of conventionally insulated fine magnet wire. Note the thin spots that can quickly burn through to cause shorting. And the thick spots that cause uneven windings.



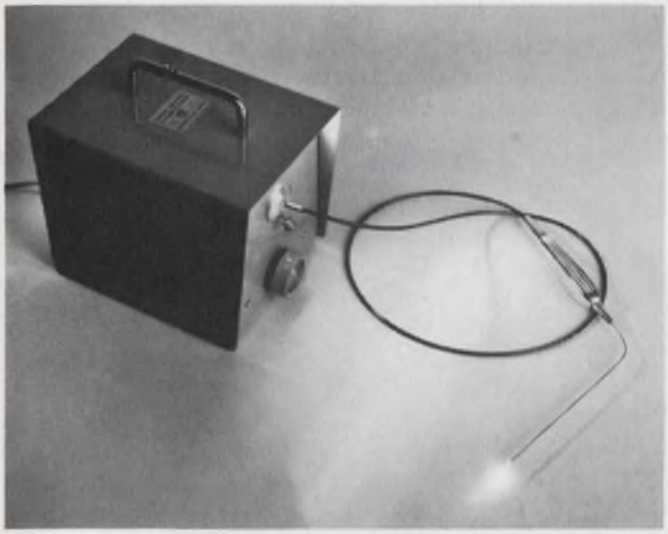
...new ideas for moving electrical energy

BELDEN

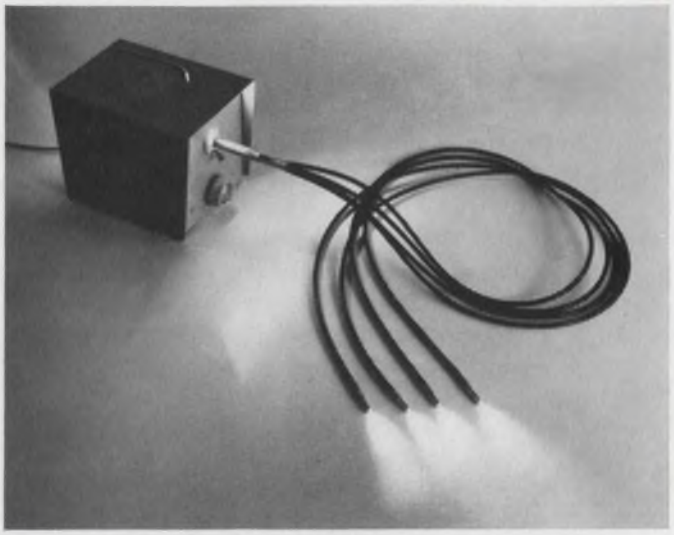
1-2-8

INFORMATION RETRIEVAL NUMBER 91

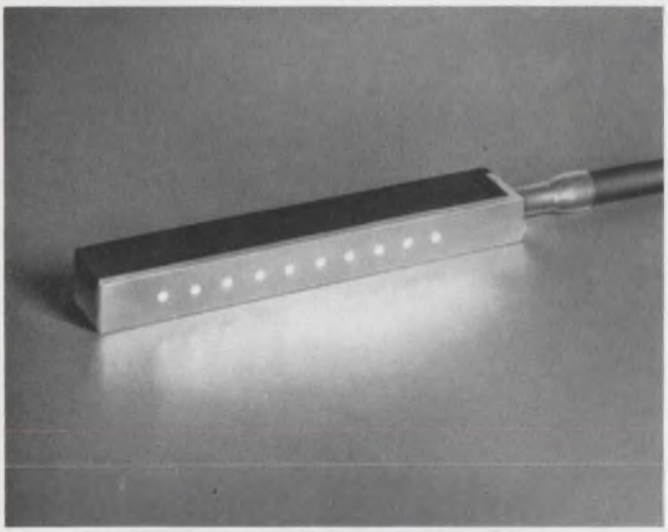
How AO fiber optic light guides solve illumination problems.



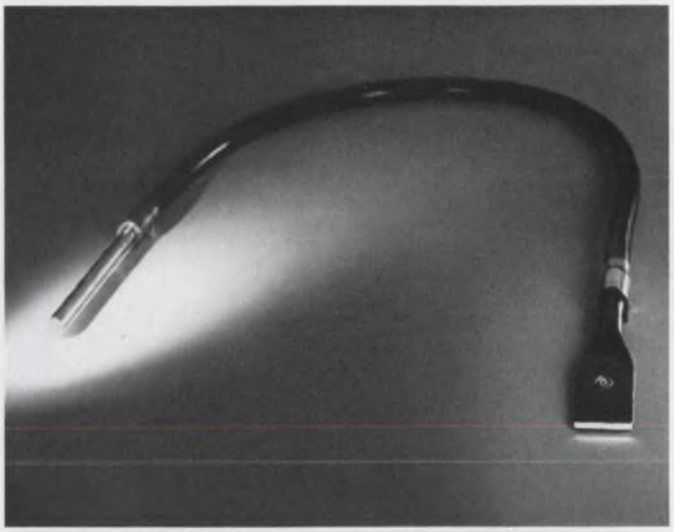
Transmit "cold" light like other forms of energy—by flexible routing to remote or inaccessible locations, hazardous areas, or any abnormal environment.



Supply multiple illumination from a single light source, with multi-branched light guides.



Simplify lighting problems by eliminating lens systems, multiple lamps, complex electrical circuitry.



Provide input-output geometry conversions such as round-to-square, round-to-slit, etc.

These are only a few of the ways in which American Optical fiber optic light guides are used to help solve illumination problems. Specific applications range from mark sense readout to electro-optical sensing in data processing, circuit verification, fire control, null detection, light pens, spot illumination, and many others.

Simple, reliable, economical. AO fiber optic light guides are simple, passive elements which remain extremely reliable under normal vibration, temperature or humidity changes, or other environmental fluctuations. This results in long service life with minimum maintenance.

Standard and custom light guides from American Optical have light transmission ranges from 400 to 1500 millimicrons. Standard light guides are available in bundle sizes from .020" to ¼", with 30 to 6000 fibers, lengths up to 72", plastic or stainless steel tips, and PVC sheaths. Custom light guides can be supplied in any length desired, with special end tips, sheaths, diameters, input-output face configurations, and branchings.

A leader in optics since 1833, American Optical Company brings a great breadth of related experience to the technology of fiber optics. Our versatility in fiber optics is unmatched by any other manufacturer. In fact, AO scientists already hold more than 200 important patents or patents pending in this relatively new field.

For Fiber Optics Data Kit, write to:

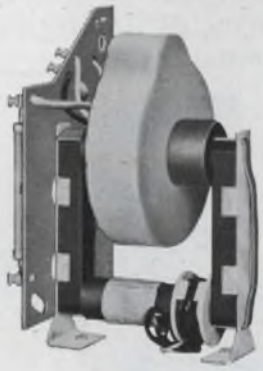
AMERICAN OPTICAL CORPORATION

FIBER OPTICS • SOUTHBRIDGE, MASSACHUSETTS 01550

®TM Registered by American Optical Corporation

INFORMATION RETRIEVAL NUMBER 92

From Stackpole: A New H.O.T. Ferrite Material That Doesn't Lose Its Cool



Ceramag® 24C was developed by Stackpole engineers especially for Horizontal Output Transformer applications. Because this new material offers an unequalled combination of high power permeability and low power loss under flyback circuitry operating conditions, it provides improved efficiency and cooler operating temperatures.

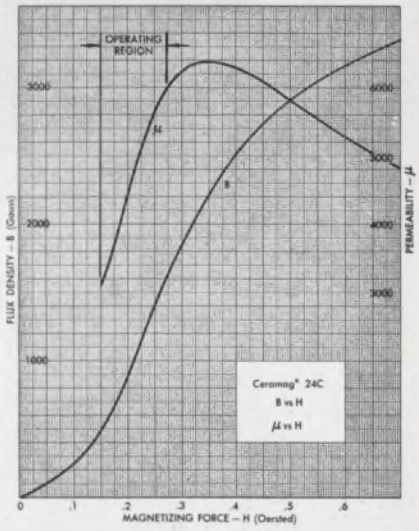
Excellent electrical and mechanical properties are combined to provide fabricated parts that easily meet standard industry strength and warpage requirements.

The Stackpole Ceramag® family of power ferrite materials has been the accepted standard of the television industry for over twenty years. Ceramag® 24C is no exception. It features a power permeability of 6200 @ 1800 gauss (typical operating condition), compared to Grade 24B with a permeability of 4200 @ 1800 gauss.

Equally important, the power losses of 24C at operating frequencies and temperatures are 15% lower than those of the widely recognized Ceramag® 24A, an industry workhorse.

Stackpole engineering pioneered the first Ceramag® horizontal output transformer cores as far back as 1947. Since then, continuous developments have made Stackpole a leading contributor to the growth of black and white, and now color, television technology.

For additional information and samples of Ceramag® 24C, write or call: Stackpole Carbon Company, Electronic Components Division, St. Marys, Pa. 15857. Phone: 814-781-8521. TWX: 510-693-4511.



STACKPOLE
ELECTRONIC COMPONENTS DIVISION

ALSO A LEADER IN THE MANUFACTURE OF QUALITY FIXED COMPOSITION RESISTORS

INFORMATION RETRIEVAL NUMBER 93

Digital clocks have BCD output

Vidar, 77 Ortega Ave., Mountain View, Calif. Phone: (415) 327-6340.

Series 624 digital clocks display real time for data systems and provide BCD digital output for recording. Timed command pulses can be preselected to occur at one of 70 time intervals ranging from one second to 25 hours. A six-digit version shows hours, minutes and seconds, and a second version has three additional digits for data or manually set data identification.

CIRCLE NO. 359

Digital multimeter features autoranging

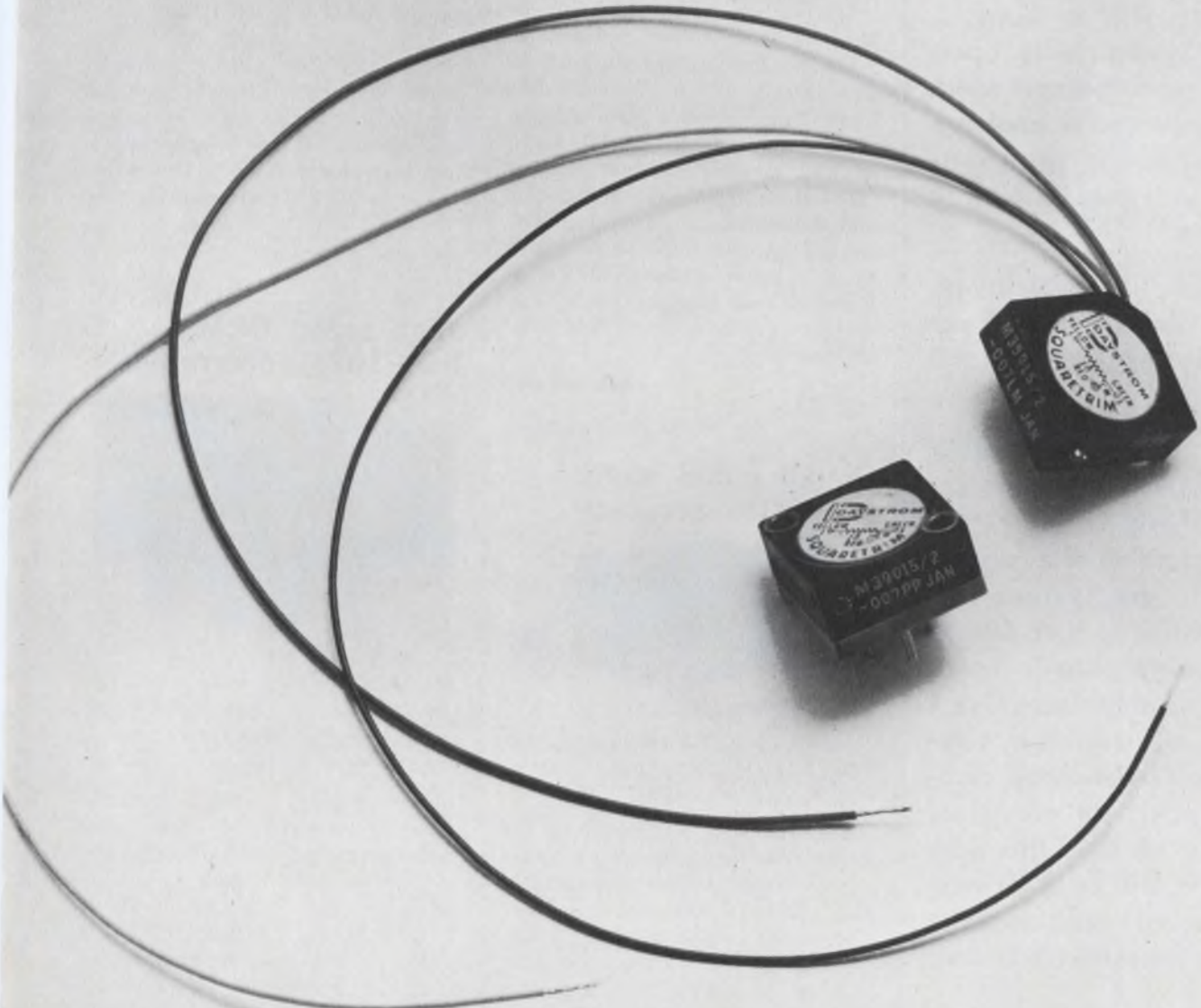
Philips Electronic Instruments, 750 S. Fulton Ave., Mt. Vernon, N.Y. Phone: (914) 664-4500. Price: $1125.

A digital multimeter can make readings as low as 10 μV and 10 pA, yet combines operating convenience with teleprinter/recorder outputs. The PM2421 multimeter allows the user to select a basic measuring range, after which the instrument will automatically select one of three sub-ranges that displays the reading with best resolution. Dc voltage range is 10 μV to 1000 V; maximum on ac is 500 V rms. The multimeter reads dc and ac current between 10 pA and 1.4 A, and resistances from 0.01 Ω to 1400 MΩ.

CIRCLE NO. 360

INFORMATION RETRIEVAL NUMBER 95 ►

Hi-Reliability from Weston is no put on.



When we say Hi-Reliability, we mean it! Weston offers units designed, manufactured and tested in complete conformance with MIL-R-39015. You'll find a designator stamped on every Weston Squaretrim® Hi-Rel pot in the 200 ohm to 20K range. This number verifies its failure rate and confidence level at full ¾ watt operating power. Design, materials and workmanship must be tops. Not to mention Weston's 45 to 1 adjustment ratio, patented wire-in-the-groove construction, and slip clutch mechanical protection which are standard features of these pedigreed models. Insist on the genuine item—Squaretrim Hi-Rel Model 313-160HS with flexible leads or 318-160HS with pins—in all critical applications. Contact the factory about other Hi-Rel values available, or see your local distributor. Daystrom potentiometers are another product of WESTON COMPONENTS DIVISION, Archbald, Pa. 18403, Weston Instruments, Inc.

a Schlumberger company

WESTON®

Digital panel meters have BCD output

Instrument Displays, Inc., 18-36 Granite St., Haverhill, Mass. Phone: (617) 373-1501.

High-accuracy, low-cost, single-range digital voltage, current, or resistance meters are suitable for a multitude of display and data logging applications. Standard features include 8-4-2-1 BCD output, latching memory circuitry, trigger input for remote-control operation and automatic ± polarity indication. The instrument is contained in a rugged extruded aluminum housing, and its front bezel can be customized with the user's name or logo.

CIRCLE NO. 361

Digital panel meter is ±0.1% accurate

Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio. Phone: (419) 358-5015.

Model 5000, a 3-1/2-digit digital panel meter with non-blinking display, movable decimal point, automatic polarity and overrange indicator, has sensitivity of 100 mV dc, 100-μV resolution and an accuracy of ±0.1% full range ±1 digit. Dual-slope integration is provided. Model 5000 has BCD and decimal outputs to drive remote display or printer units. A 1000 MΩ input resistance reduces loading and improves reading accuracy.

CIRCLE NO. 362

Tiny digital meter gauges frequency

Eldorado Electronics, 601 Chalomar Rd., Concord, Calif. Phone: (415) 686-4200. P&A: $325; 30 days.

A low-cost digital frequency meter is suited for applications where space is at a premium. Crystal-controlled, the model 224 measures only 2 by 5 by 6.4 inches deep and is available with an optional panel mounting kit. It offers a four-digit display with storage and decimal. Range of the standard instrument is dc to 100 kHz; range to 10 MHz is available.

CIRCLE NO. 363

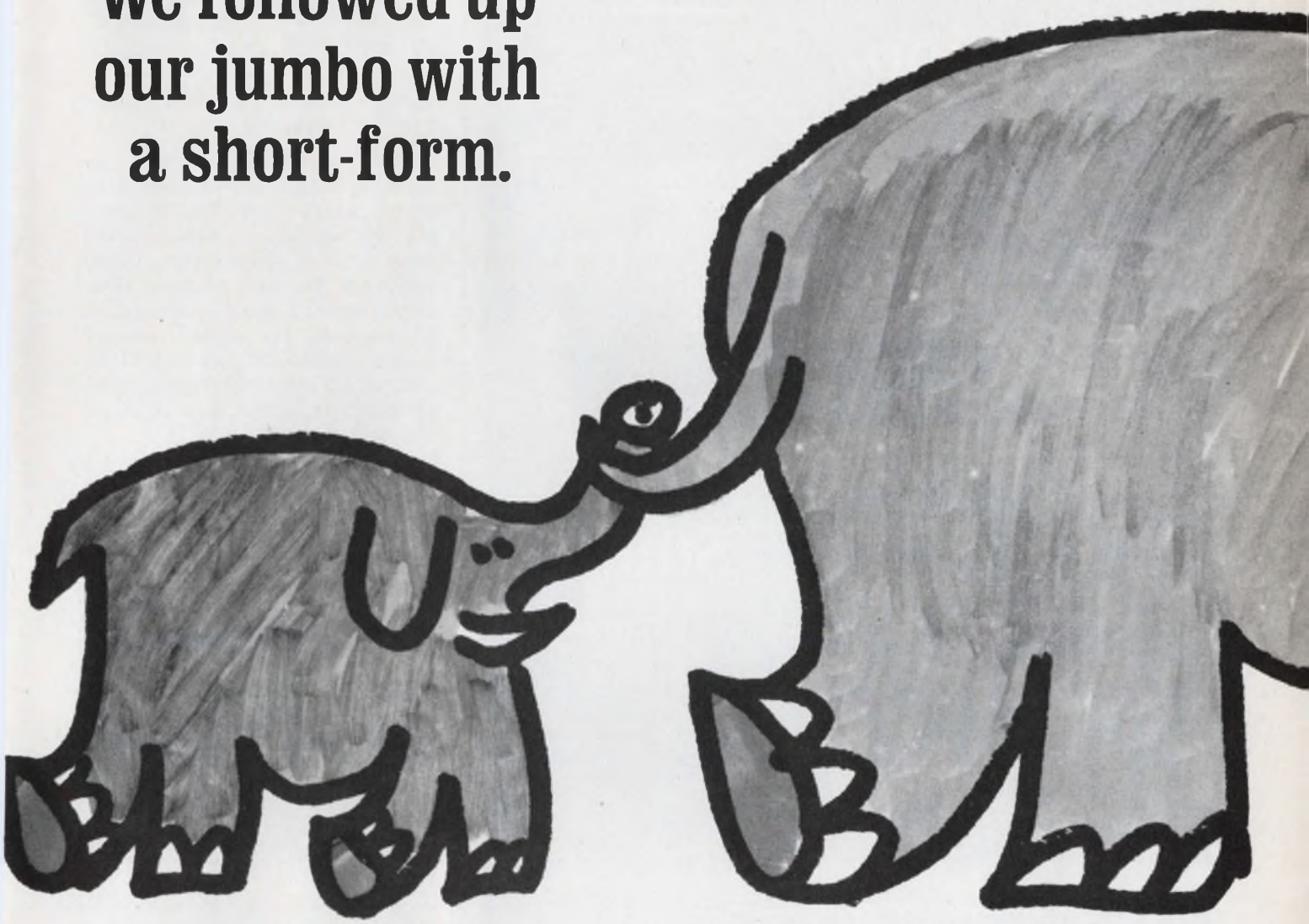
High-speed DPM has 100% overrange

Preston Scientific Inc., 805 E. Cerritos Ave., Anaheim, Calif. Phone: (714) 776-6400. Price: $150 to $225.

A high-speed, 3-digit dc voltammeter with 100 per cent overrange and ±0.1 per cent accuracy is supplied with a wide choice of full-scale ranges: 199 mV to 1999 V, with 19.99 μA to 199.9 mA. The X-Mod DPM features automatic polarity indication, continuous tracking of 100 readings per second, integral dc power supply and optional positive true output logic levels with true bipolar BCD output code. The instrument features front access to all internal components by means of a hinged door.

CIRCLE NO. 364

We followed up our jumbo with a short-form.



Get one free.

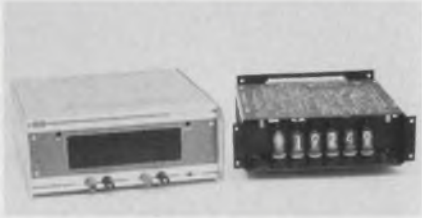
We've gathered information on all our coaxial connectors in the standard series from low-cost UHF types to new MIL-C-39012 versions plus subminiatures, crimps, and adapters of all sorts (over 7000 connectors in all) and combined it in brief form with details on Amphenol RF switches. We call it our SF-1 Short-Form Catalog. You'll call it a complete, concise reference on connectors, switches and cable.

For your free copy, circle the reader service number, or write Amphenol RF Division, 33 E. Franklin St., Danbury, Conn. 06810.

AMPHENOL
THE BUNKER-RAMO CORPORATION

INFORMATION RETRIEVAL NUMBER 97

Digital panel meter achieves bench status



Electro-Numerics Corp., 2191 Ronald St., Santa Clara, Calif. Phone: (408) 248-5020. P&A: $495; stock.

A new case is now available for a special version of the model 3410 digital panel meter. The result is a very accurate (.01%), 4-1/2 digit, low-cost, single-range digital voltmeter. The unit features automatic polarity, 100% overranging, 10 readings per second, display hold capability, 100 μV resolution, and >1000 MΩ input impedance. A preamplifier providing 10 μV resolution is optional.

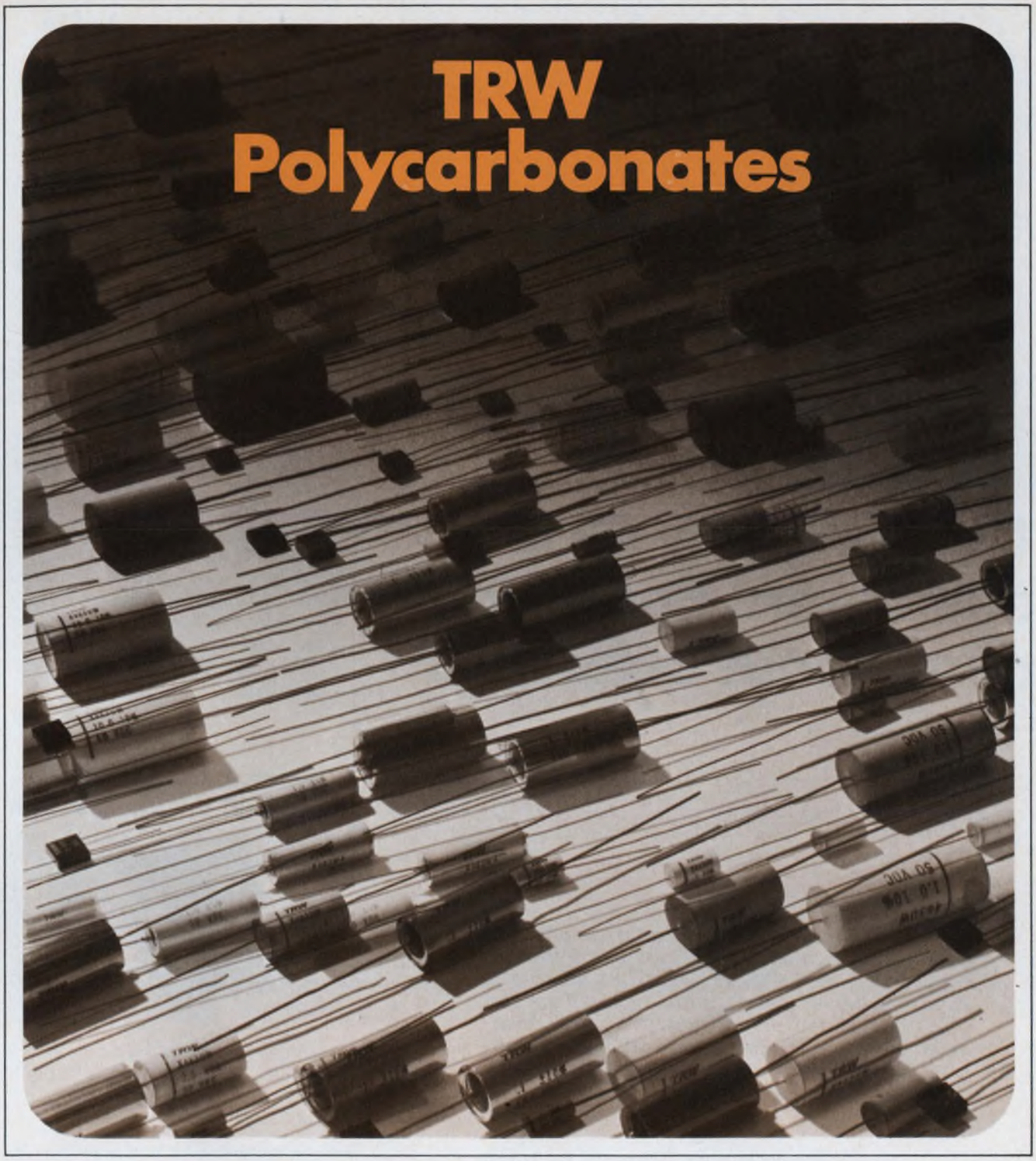
CIRCLE NO. 365

Vhf digital counter measures pulses

Philips Electronic Instruments, 750 S. Fulton Ave., Mt. Vernon, N.Y. Phone: (914) 664-4500. Price: $2220 to $2795.

A 160-MHz digital counter can measure pulse width and delay, as well as frequency, with 10-ns resolution. The PM-6630 counter comes equipped with a temperature-compensated crystal oscillator and six-digit display, stable to ± 5 ppm over a 0 to 45°C temperature range. Engineers who need greater resolution and stability can specify a proportionally controlled oven oscillator and eight-digit display, stable to 2×10^{-9} in 24 hours, and 10^{-7} within seven minutes of turn-on.

CIRCLE NO. 366



...small answers to big problems

Need capacitors with premium electrical and TC properties...and in the smallest possible package? Polycarbonate capacitors are your answer. And no one knows more about polycarbonates than TRW.

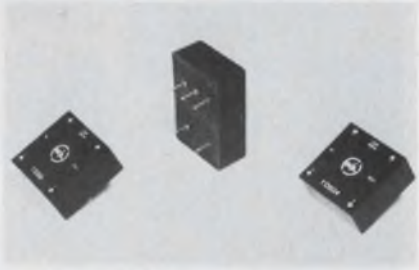
As the pioneer in polycarbonate capacitor development, TRW has the know-how to get that "extra ounce of performance" out of this remarkable material. We can meet your design requirements with either metallized or foil wound polycarbonates in a wide range of capacitances, voltage ratings, shapes, and sizes. Standard types will solve most design problems...if not, let's talk about your special requirements.

For full information, contact TRW Capacitor Division, Box 1000, Ogallala, Nebraska. Phone: (308) 284-3611. TWX: 910-620-0321.

TRW®

INFORMATION RETRIEVAL NUMBER 99

Palm-sized supplies drive Nixie tubes



Mil Associates, Dracut Road, Hudson, N. H. Phone: (603) 889-6671. P&A: $9.95 or $24.95; stock to 10 days.

Requiring input voltages from 5 to 28 V, a new line of miniature power-supply modules delivers outputs sufficient to drive Nixie tubes. Measuring only 1 by 1/2 in., series TD units supply 200 V at 3 mA to drive a single tube. Series PD units, which measure 1 by 1-1/2 by 1/2 in., can drive four or five tubes with their 200-V 12-mA output. All packages are for PC mounting.

CIRCLE NO. 367

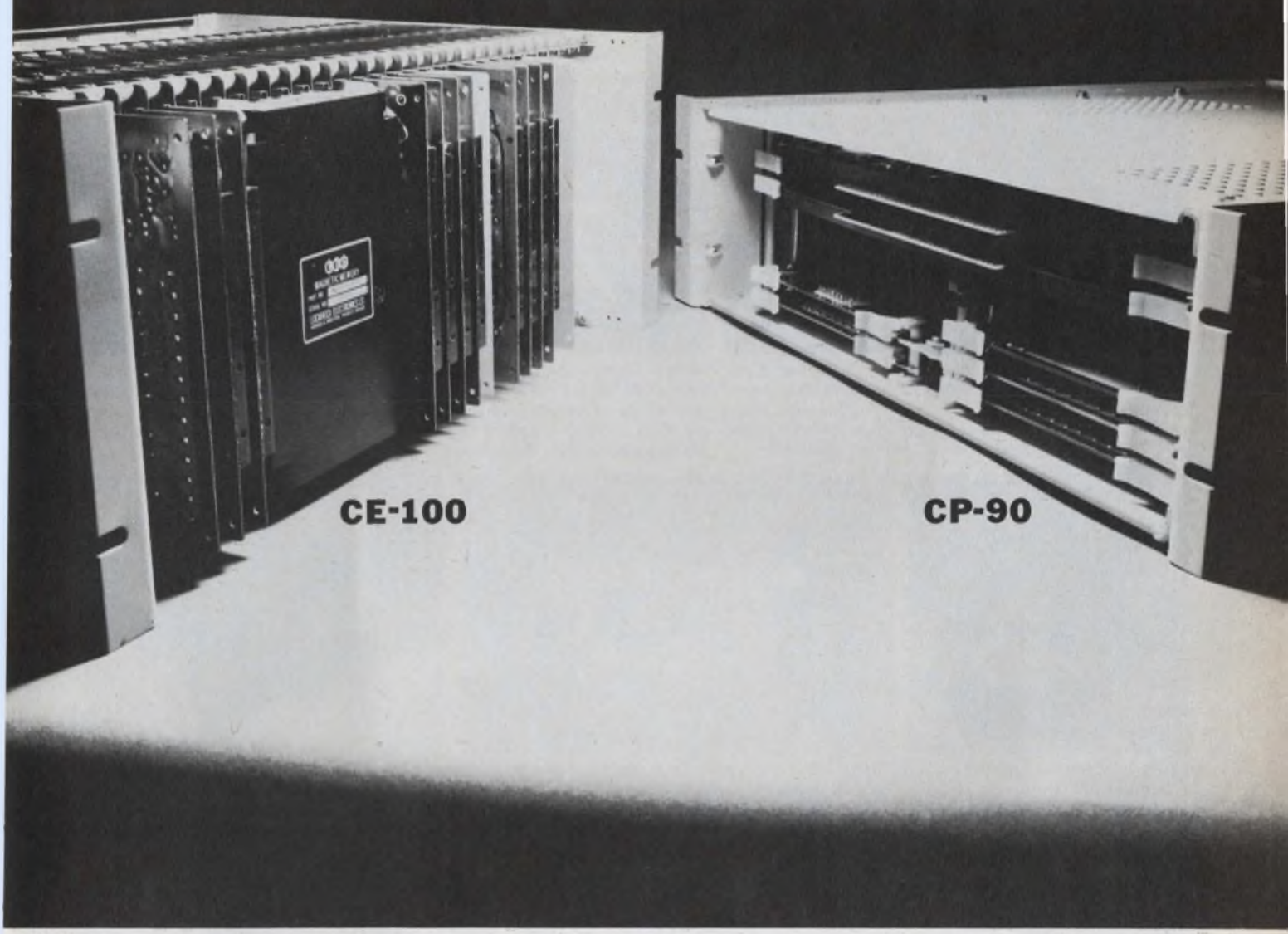
Wideband op amp has 500 V/ μs slew rate

Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. Phone: (602) 294-1431. P&A: $95; 4 wks.

Model 3260/25 is a wideband dc operational amplifier with a guaranteed slew rate of 500 V/μs that is the highest available in its price range. Settling time to 1% of final value is 100 ns (0.1% in 1 to 2 μs). Used for inverting circuits, the 3260/25 has an FET input stage with very low bias current. This feature becomes important when it is necessary to sample or integrate fast transients and then hold the output for a relatively long time for readout.

CIRCLE NO. 368

The case of Lockheed vs. Lockheed



1. Capacity: 4,096 words x 16 bits.
2. Available in capabilities of 4, 8, 16K with 8 to 32 bits.
3. Size: 19″ x 7″ x 13″.
4. Speed: 1 microsecond.
5. Random access time: 450 nanoseconds.
6. Market Response: Excellent.

1. Capacity: 4,096 words x 16 bits.
2. Available in 4K by 16 or 18 bits.
3. Size: 19″ x 5¼″ x 13″.
4. Speed: 900 nanoseconds.
5. Random access time: 400 nanoseconds.
6. Market Response: Too early to form any sort of judgment.

VERDICT

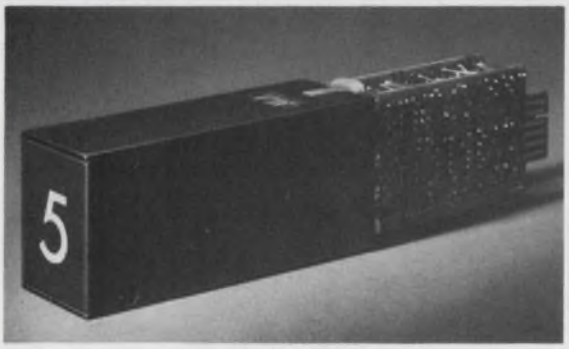
The CE-100 has been the most successful low-cost memory unit on the market (and with good reason). But since the CP-90 is faster, smaller, and since the 16-bit version costs less —it is our considered opinion that the CP-90 will become one of Lockheed's all-time best-selling memory units.

For further information write: Memory Products, Lockheed Electronics Company, Data Products Division, 6201 East Randolph Street, Los Angeles, California 90022. Telephone (213) 722-6810.

LOCKHEED ELECTRONICS COMPANY

90-second look at IEE's wonderful world of readouts

Readouts are our special craft. Using any characters you want. Any colors or color combinations. Any input, BCD or decimal. Any input signal level. Any mounting, vertical or horizontal. Five sizes, up to 3⅜". Many configurations, options and accessories. Long lamp life (to 100,000 hours; up to 175,000 hours at reduced voltage). If it doesn't exist and you need it, we'll build it.



10H—World's most popular readout. And we've improved it. Double condensing lens provides exceptional character brightness. Greater clarity at wider angles and longer distances, even under high ambient light. .937" sq. viewing area. Mil-spec version available.

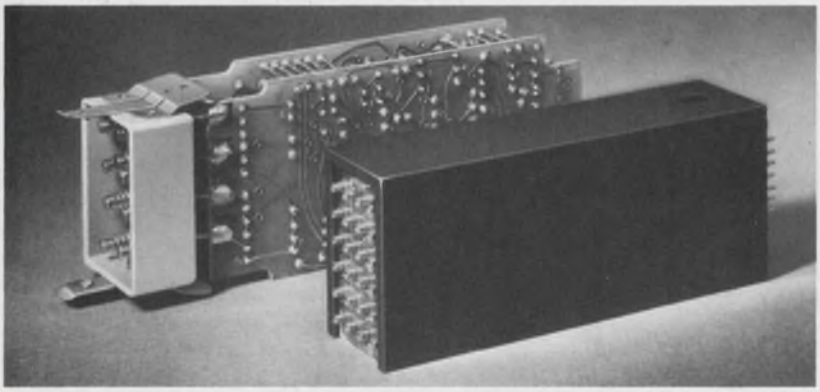
160H—Exceptionally large viewing area (1.56"H x 1.12"W) for overall size. 45 FL character brightness with a 6.3V $.20 lamp. Displays messages simultaneously with symbols.

80—Large screen unit suited for annunciator applications such as factory call systems and production control. 3⅜" character height can easily be read at 100'. 160° viewing angle.

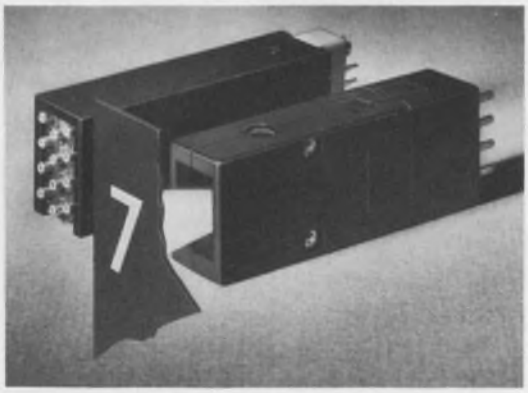
120H—Miniature rear-projection readout (.62" sq. screen) easily read from 30' under high ambient light. Quick-disconnect lamp assembly speeds lamp replacement.

nimo™—First 10-gun CRT single-plane display. Projects numbers, letters and words onto a fluorescent screen. No image ambiguity. No external focusing required. No ambient light worries. Exceptionally wide viewing angle. Ideal for instrument application.

875—Miniature 24-position readout assembly with a cost per display of only $1.45 each. .620 sq. in. viewing area with overall case size of 1.39"H x.90"W x 3.095"D. Exceptional brightness, clarity. Front panel access.



IC Driver/Decoders—Small, reliable units for driving IEE readout incandescent lamps ranging from 250 ma @ 6V to 40 ma @ 28V. Fully compatible with modern IC's. Accept a variety of binary codes for decimal conversion. Require normal signal V., draw less than 2 ma per data input. Internal data storage for pulsed oper.



345—IEE's smallest rear-projection readout. Viewing area .38"H x .34"W. Based lamps. Low cost. Individual readouts plug into perm. wired housing for quick message change. Easy front panel access.

Industrial Electronic Engineers, Inc. IEE 7720 Lemona Ave., Van Nuys, California

INFORMATION RETRIEVAL NUMBER 103

ELECTRONIC
EXPEDITORS, INC.
6045 N. Green Bay Ave.
Milwaukee, Wisconsin 53209
Phone: 414-374-6666

DRW ELECTRONICS
CORPORATION
100 Milbar Blvd.
Farmingdale, Long Island,
New York 11735
Phone: 516-249-2660

DRW ELECTRONICS
CORP. OF CALIFORNIA
8339 Hindry Ave.
Los Angeles, California 90045
Phone: 213-673-2200

LECTRONIX, INC.
214 North Second St.
P.O. Box 188
St. Charles, Missouri 63301
Phone: 314-723-1122

PYTTRONIC
INDUSTRIES, INC.
2034 Worcester St.
Baltimore, Maryland
21230
Phone: 301-539-6525

Five places for mil-spec connectors to lose wait.

Getting the Mil-C-26500 and Mil-C-26482 cylindrical connectors you need doesn't take longer any longer.

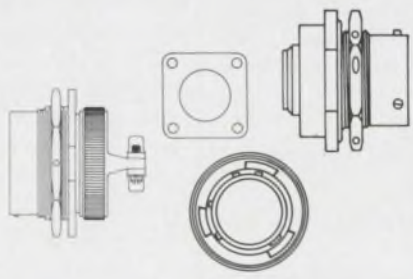
Now you can get Elco cylindrical connectors, overnight, from any of our six stocking-and-assembling distributors. In any configuration. With from 2 to 61 contacts. Bayonet or threaded.

The connectors are the equal of any mil-spec-meeting cylindrical connector. Only, for you, they're a little more equal. Because you can get them faster without paying extra for the privilege.

And the distributors are as willing and able a group of guys as you'll ever deal with. Give the one closest to you a call; you'll see what we mean.

For more information (like our new cylindrical connector catalog, for instance) or for direct factory assistance, write Elco Corporation, Pacific Cylindrical Connector Div. 2200 Park Place, El Segundo, Cal. 90245, or phone 213-675-3311. TWX 910-325-6602.

ELCO Cylindrical Connectors



INFORMATION RETRIEVAL NUMBER 104

MODULES & SUBASSEMBLIES

Stable hybrid op amps hold bias to 5 pA

Data Device Corp., 100 Tec Street, Hicksville, N.Y. Phone: (516) 433-5330. P&A: $20; stock.

Providing 5 pA maximum bias currents, two new series of FET op amps feature thermal drifts as low as 5 μV/°C maximum. The lowest hybrid modules, types 008 and 108, are supplied in low-profile cases that measure 0.6 by 0.6 by 0.25 in.

CIRCLE NO. 369

Wideband multiplier powers fully to 4 MHz

Hybrid Systems Corp., 95 Terrace Hall Ave., Burlington, Mass. Phone: (617) 272-1522. Availability: stock to 3 wks.

Without requiring external amplifiers, model 105 wideband (10-MHz 3-dB bandwidth) analog multiplier delivers a full-power response of 20 V pk-pk out to 4 MHz. Its slew rate is 250 V/μs and accuracy is 1% for four-quadrant operation. The unit's linearity permits distortionless multiplication at output levels from under 100 mV to 20 V pk-pk.

CIRCLE NO. 370

RZ GLASS

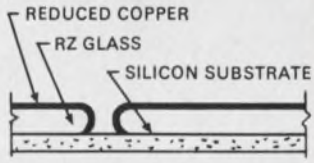
...the big news in sputtering targets...from Owens-Illinois

Owens-Illinois RZ Glass Sputtering Target is a NEW copper alumino-silicate glass readily sputtered on a silicon substrate. After sputter deposition, the RZ glass layer is etched to open up contacts to the silicon substrate. A simple oxidation-reduction process then produces *pure* copper conductive layers on the RZ glass, even in etched undercuts.

RZ glasses are ideal for making single or multilayer interconnections in medium or large-scale integrated circuits. The conductive layer is produced uniformly on RZ-coated substrates regardless of surface geometry.

You now have your choice of *thr*ee sputtering targets from Owens-Illinois . . . 1. NEW RZ copper alumino-silicate, silicon-matching, 2. EE-9 alumino-silicate, silicon-matching, 3. EE-10 alumino-silicate, alumina and gallium arsenide matching.

All three are readily deposited at rates of 250 Å/minute with standard R.F. sputtering equipment, followed by simple etch when needed. A new manufacturing process holds the sodium content of these glasses below 20 ppm.



Owens-Illinois can supply targets promptly in lengths, widths, and thicknesses to fit your R.F. set-up and substrate dimensions. We'll work with you on materials to meet your special needs.

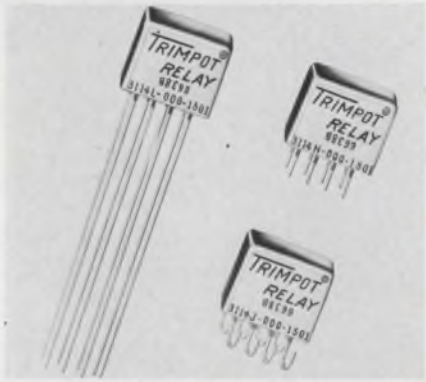
Complete data, specifications, and sputtering procedures developed in the Owens-Illinois microelectronics research labs will be sent to you promptly on request. Ask for information on these other O-I electronic materials: package sealants, substrate glazes and insulating films, preform materials, glazed IC packaged parts and substrates. WRITE TO:

THE O-I FAMILY OF WORK-TOGETHER ELECTRONIC MATERIALS.

OWENS-ILLINOIS
ELECTRONIC MATERIALS
Toledo, Ohio 43601

INFORMATION RETRIEVAL NUMBER 107

Miniature relay senses 200 mW

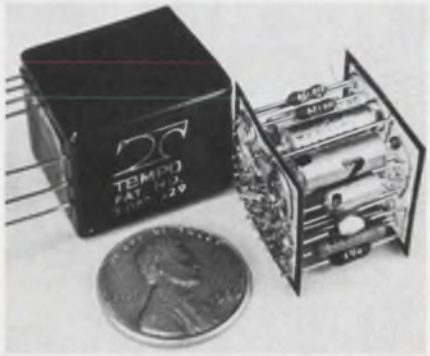


Bourns, Inc., Trimpot Products Div., 1200 Columbia Ave., Riverside, Calif. Phone: (714) 684-1700.

Measuring only 0.23 by 0.5 by 0.4 in., a new dpdt subminiature relay has a pickup sensitivity of 200 mW over an operating temperature range of −65 to +125°C. Model 3114 offers coil resistances from 45 to 980 Ω and a contact rating of 2 A at 28 V dc. The unit meets all requirements of MIL-R-5757/19B and MIL-R-5757/56.

CIRCLE NO. 371

Solid-state timers double ouputs



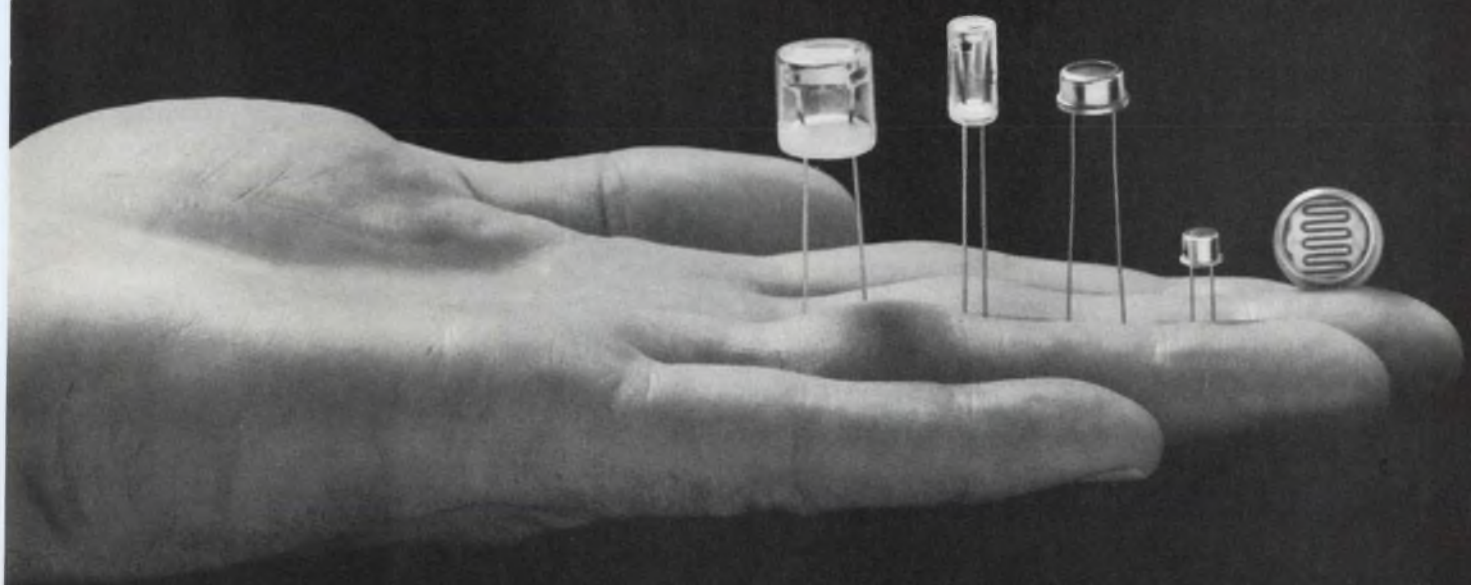
Tempo Instrument Inc., Tempo West Div., 1753 Cloverfield Blvd., Santa Monica, Calif. Phone: (213) 393-0529.

Providing time delays as long as 20 seconds, new miniature solid-state timers have two independent outputs for a variety of output connections in high-reliability applications. For example, two or three timers may be connected together to protect against short-circuit or open-circuit failure modes.

CIRCLE NO. 372

INFORMATION RETRIEVAL NUMBER 109 ►

Five reasons why more engineers have selected Clairex photocells over all others...

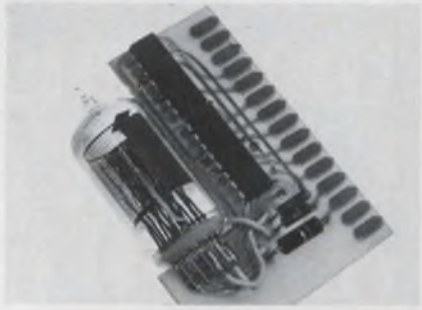


These basic Clairex packages cover 98% of all applications... try one.

Clairex has more experience supplying more high-quality photocells for more applications than anyone. Let us show you how we can perform in handling your problems. Call (212) 684-5512 or write Clairex, 1239 Broadway, New York, N. Y. 10001.

CLAIREX ELECTRONICS, INC.

Decimal displays use IC logic



Computer Products Inc., 2801 E. Oakland Park Blvd, Fort Lauderdale, Fla. Phone: (305) 565-9565. P&A: $25.80 or $31.80; 3 days.

Series DM500 decimal displays are self-contained plug-in units using IC logic. The DM519 includes a decade counter with BCD outputs for the connector as well as the decoder/driver circuit; the DM529 accepts BCD inputs for decoding and display.

CIRCLE NO. 373

Stable amplifiers take 650-mA surge

Data Device Corp., 100 Tec St., Hicksville, N. Y. Phone: (516) 433-5330. P&A: $125; stock to 2 wks.

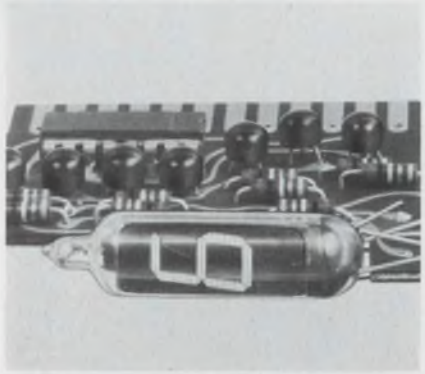
Intended for use in servo, control, and signal conditioning systems, a new series of operational amplifiers maintains a minimum output of ±280 mA at ±17.5 V with a 650-mA surge capability. In addition, series D-34 devices feature a current stability of 5 nA/°C, a voltage stability of 30 μV/°C and a quiescent current of only 30 mA. They are designed for printed circuit mounting.

CIRCLE NO. 374

INFORMATION RETRIEVAL NUMBER 111 ►


It's new. Our Molex 1820 Switch.
You can use one, or a gang of them, for an infinite variety of applications. Its lighted push button can be wired to light independently of the switch. And there are colors galore. But what's really nice is price. About seventy cents in quantity.
It's a good example of the Molex creative approach to design problems. And the ability to design reliability and ease of assembly into a product without letting costs run wild due to over-engineering.
The 1820 is really one you have to see to believe.
And we would like to show it to you. For a free sample of our new switch, write or phone (312) 969-4550.
molex
MOLEX PRODUCTS COMPANY
Downers Grove, Ill. 60615
M153

Neon decoder/display needs only 0.5 in.



Integrated Circuit Electronics, Inc., 237 Riverview Ave., Newton, Mass. Phone: (617) 899-2700. Price: $18.

Using a seven-segment neon tube, a new decode/display module mounts on 0.5-in. centers on PC boards with all input/outputs from its rear connector. Model D200-7 has a built-in decimal point in the lower right-hand position and a colon in the upper left-hand position. It measures 1-7/8 by 2-11/36 by 0.5 in. wide.

CIRCLE NO. 375

Low-cost op amps hold 5-mA output

Analog Devices, Inc., 221 Fifth St., Cambridge, Mass. Phone: (617) 492-6000. P&A: $24 or $34; stock.

Two new low-cost differential operational amplifiers deliver a 5-mA output over a 40-V range (±20 V) and provide a minimum open-loop dc gain of 250,000 at full load. Model 165A has a maximum voltage drift of 20 μV/°C, while model 165K offers a 5-μV/°C drift. Both units have a 1.5-MHz small-signal bandwidth and a 50-kHz full-power response.

CIRCLE NO. 376

How Do You Get A Custom-Designed Receiving System 'Off-The-Shelf?'

The modular design of W-J's RS-125 Receiving System makes it possible. W-J has supplied many variations of the RS-125--each for a specific application. Yet, in most cases, components have been standard versions, right out of stock.

A wide selection of tuners, demodulators, bandwidths and ancillary devices is readily available. So you can order only those components required for the monitoring job at hand. You eliminate obsolescence by adding units as the needs arise.

The RS-125 processes received signals through a demodulator utilizing plug-in modules available in 10 standard bandwidths ranging from 5 kHz to 8 MHz. This highly versatile arrangement of equipments provides AM, FM, CW and pulse reception over a frequency range as wide as 500 kHz to 12 GHz utilizing W-J tuners.

A system covering the range of 10 MHz and above could include tuners with internal motor drives which feature sector scan, enabling the operator to adjust the upper and lower frequency limits of the sector in which he is interested.

It also could include a frequency extender-counter combination which would provide a direct six-digit readout of the tuned frequency, plus Digital Automatic Frequency Control (DAFC.)

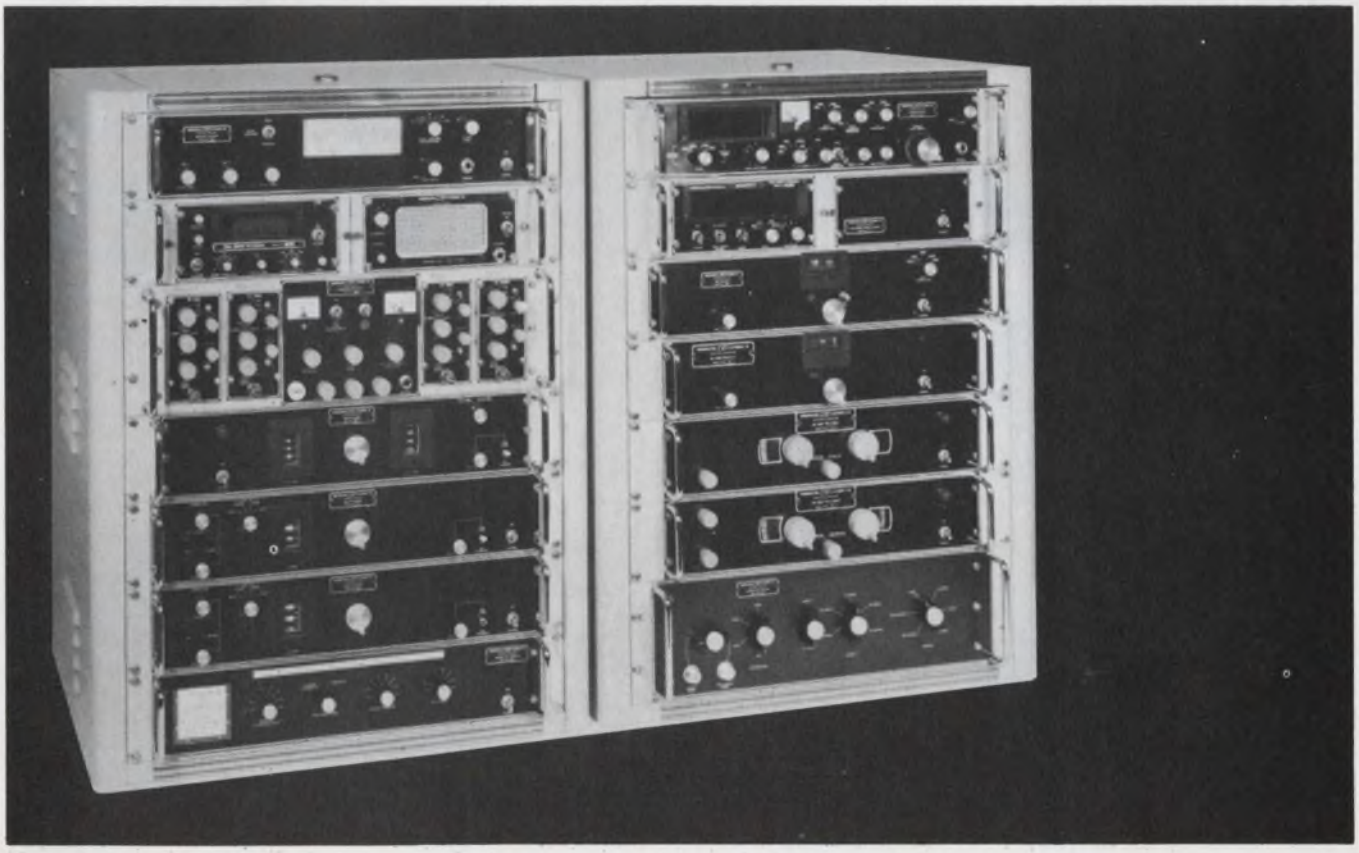
Two basic types of the RS-125 are offered: The "B" system for applications requiring low VSWR, and the "C" system for applications requiring maximum sensitivity.

A W-J representative would be glad to assist you in the selection of components for a system to meet your specific requirements. For details write Watkins-Johnson Company, CEI Division, 6006 Executive Boulevard, Rockville, Maryland 20852, or phone Area Code 301-881-3300.

World's largest selection of receiving equipment for surveillance, direction finding and countermeasures

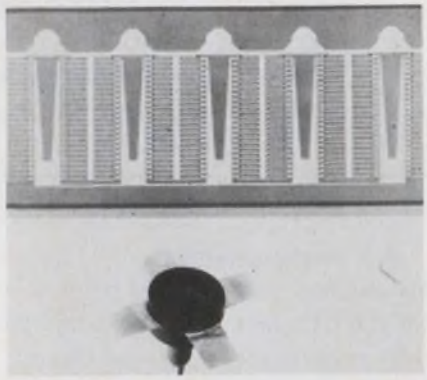
wj WATKINS-JOHNSON

CEI DIVISION



INFORMATION RETRIEVAL NUMBER 113

Rf power transistors perform at 175 MHz



Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. Phone: (415) 962-3563. P&A: $36; stock.

A new rf power transistor is guaranteed to operate in mobile radio communication systems at 12 V and 175 MHz. The MSA8506 provides a combination of higher power output and power gain—25 W and 5 dB—than is available from any other single device operating at equivalent conditions. It can handle continuous collector current up to 5 A, and is packaged in a radial lead stripline unit that contributes to its high-frequency performance.

CIRCLE NO. 377

Sweeper accessories allow multiband tests

Kruse-Storke Electronics, 790 Hemmeter Lane, Mountain View, Calif. Phone: (415) 967-2299. P&A: $1150 and $390; 60 days.

Multiband programed, cw, or swept-frequency testing is simplified by two new products. Both are used with a solid-state sweep generator and oscillator plug-ins operating from below 10 MHz to above 12 GHz. Model 5090 multiband power unit provides dc power for three plug-in oscillators, and the model 5091 multiband controller is itself a plug-in that connects the sweeper with one or more power units.

CIRCLE NO. 378

for intradyne SYSTEMS

At Intradyne, a new generation of microwave devices and sub-systems with superior performance characteristics is being manufactured in **production quantities** and with **high repeatability** using computers in design, evaluation and checkout. Computerized procedures can provide complete printout data including VSWR, reflection coefficient, attenuation or gain, phase linearity, **group delay** and **h, y, s and z parameters---for every unit.** The printed record is positive assurance of compliance with the most exacting specifications. Use of the Intradyne-owned network analyzer allows our engineering staff to make complete multi-octave tests instantly, thereby increasing time available for creativity. The analyzer can complete---**with high accuracy**---the equivalent of 6 man-days of testing in one hour!
Results of this unique approach are illustrated.

SOLID STATE OSCILLATOR
Frequency: — — — — — — — 8 to 12.4 GHz
FM Noise: 50 Hz, 1 KHz bw 10 KHz from f_o.
Power Output — — — — — — — to 100 mW.
Temperature Stability: — — — .05% typical.
Size: See illustrations. Size and weight suitable for flight hardware.
Delivery: Stock to 4 weeks, ARO.

ULTRA LOW NOISE SOLID-STATE AMPLIFIER
Frequency: — — — — — L through S bands.
Noise figure: — — — — — — 1.5 to 2db max.

MICRO-MIN, HI-REL DEVICES
Frequency: — — — — 1 to 12 GHz coverage.
Functions: Customers specified duplexing,
Low noise receiver front ends,
Combining networks,
Switching systems, etc.
Full information on request.

OSCILLATORS---FULL SIZE

(illustration Intradyne-owned Computer-Controlled Network Analyzer (HP-8540)

INTRADYNE
SYSTEMS, INC.
470 San Antonio Road, Palo Alto, Calif. 94306
(415) 328-7840

INFORMATION RETRIEVAL NUMBER 115

Avalanche diode amp boosts power 40 dB

Sylvania Electric Products Inc., Semiconductor Div., Woburn, Mass. Phone: (617) 933-3500. Price: $2000.

An avalanche diode amplifier, SYA3250, features up to 40 dB power gain and 75 MHz bandwidth. The three-stage circulator-coupled power amplifier has cw outputs of 50 to 100 mW in X-band, and is designed for use in microwave relay and transponder systems as a transmitter amplifier. The circulators, together with a load isolator at the output, are fabricated integrally on a single ferrite substrate microstrip circuit. Dc power requirements are approximately 100 V at 60 mA.

CIRCLE NO. 379

Microwave synthesizer features Nixie readout

Micro-Power, Inc., 25-14 Broadway, Long Island City, N.Y. Phone: (212) 726-4060.

An L-, S-, C- and X-band frequency synthesizer that was introduced last year (see "Microwave synthesizer has extended range," ED 27, Nov. 7, 1968, p. 102), has been improved by the addition of a Nixie tube display that provides direct frequency readout in both manual and remotely programed modes. Another new feature is an on-frequency light that indicates that the frequency displayed on the front panel is the actual rf output.

CIRCLE NO. 380

INFORMATION RETRIEVAL NUMBER 117 ►

Anyone can think small.

Frankly, we had something bigger in mind.

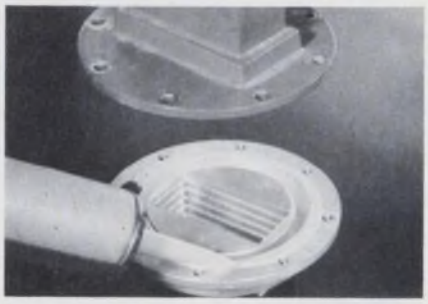
We built our second generation DPM* to fit into seven square inches of panel. *That's less than any other digital panel meter requires.* But we didn't stop there. The Model 1290 mounts completely from the front of the panel. *The entire chassis pulls out from the front for servicing or replacement.* Even the Nixie** tubes are pluggable! Think of the convenience in continuous systems operation. Despite the smaller package, Model 1290 has all the features our original DPM is so widely acclaimed for—3-digit plus 100% overrange display, 0.1% ±1 digit accuracy, circularly polarized window filter, dual slope integration, full-buffered storage display and BCD output. Many of these standard Weston features are still "optional at extra cost" on competitive units. Our new compact is styled for tomorrow, available today, and priced below $200 in quantity. Anything else in the industry is just small talk. WESTON INSTRUMENTS DIVISION, Weston Instruments, Inc., Newark, New Jersey 07114.

a Schlumberger company

WESTON®

*U.S. Pat. #3,051,939 and patents pending.

Conductive gaskets cast in place



Emerson & Cuming Inc., Canton, Mass. Phone: (617) 828-3300. P&A: $35/lb; stock.

Conductive gaskets for rf shielding can now be cast in place or made in simple molds. Eccoshield SV-C is a one-part, silicone-rubber composition containing silver particles. It can be cured to a high quality rubber by heating at temperatures as low as 250°F. When fully cured it has a volume resistivity of 0.08 ohm-cm. Gaskets are made by placing the material around an enclosure opening.

CIRCLE NO. 381

Broadband attenuators are current-controlled

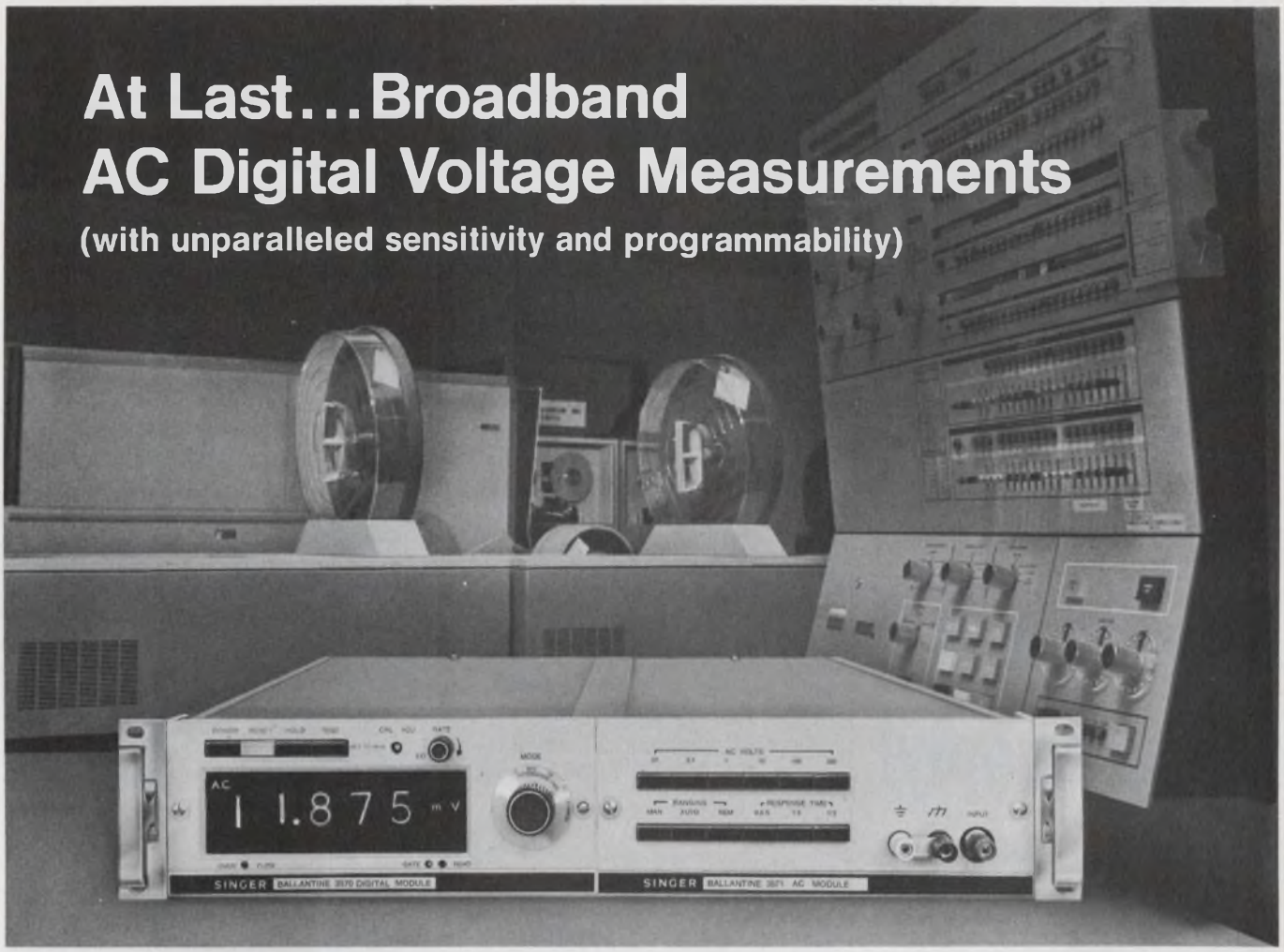
Anzac Electronics Co., 121 Water St., Norwalk, Conn. Phone: (203) 853-9411.

A new broadband current-controlled attenuator, designated model AVH-7860-N, provides low VSWRs at all attenuation settings from 0 to 20 dB at 200 to 2000 MHz. Model AVH-7860-N is a 180° hybrid with the side arms terminated in p-i-n diodes. Input and output impedance is 50 Ω, modulation bandwidth is dc to 80 kHz with 10° phase shift, and operating temperature is −54°C to +85°C.

CIRCLE NO. 382

At Last...Broadband AC Digital Voltage Measurements

(with unparalleled sensitivity and programmability)



and Ballantine made it possible!

Who else but Ballantine, the recognized leader in Broadband voltage measurement techniques could have introduced the New Model 3570 Series Digital Voltmeter . . . featuring complete programmability and exceptional sensitivity and accuracy for AC and DC digital voltage measurements.

Computer and System Interface is assured by the programmability of all operating functions as well as coded outputs for measurement information.

Full-scale AC sensitivity of 10mv combined with a 10 MHz bandwidth offers a measurement capability not previously available. AC mid-band accuracy is 0.2% RDG +0.01% FS. DC accuracy is 0.02% RDG +0.01% FS.

A four digit display with overrange employs dual-slope integration for superior noise rejection.

Optional 20 MHz Frequency Counter capability and Auto-Ranging are also available.

Rack and Stack

Modular packaging makes it possible for system modules to be easily arranged side-by-side for rack mounting or over-and-under for bench use. State-of-the-art versatility is assured as new modules are introduced.

Creative engineering at Ballantine is your assurance that the New Model 3570 Series Digital Voltmeter is more than merely a better voltmeter—for that goes without saying. Ballantine has once more advanced the state-of-the-art in voltmeter technology, and set a new standard in Broadband AC Digital Voltage Measurement.

We invite comparison . . . Write or phone—for additional technical information, The Singer Company, Instrumentation Division, Ballantine Operation, P.O. Box 97, Boonton, New Jersey 07005, (201) 334-1432 or your nearest Ballantine Representative.

SINGER
INSTRUMENTATION

INFORMATION RETRIEVAL NUMBER 118

Mixer-preamplifiers operate at 2 to 8 GHz

Applied Technology, 3410 Hillview Ave., Palo Alto, Calif. Phone: (415) 321-5135. Availability: 60 to 75 days.

Solid-state mixer-preamplifier models MPS-1 and MPC-1 operate at from 2 to 4 GHz and 4 to 8 GHz respectively with an i-f frequency of 500 to 1000 MHz; lower i-f frequencies are available. The MPS-1 and MPC-1 are available with a gain of 17 dB, and with an input and output VSWR of 2.5 maximum. Both units meet MIL-E-5400 and MIL-E-16400 specifications.

CIRCLE NO. 383

Directional couplers have 12.4 GHz range

I-Tel Inc., 10504 Wheatley St., Kensington, Md. Phone: (301) 946-1800. P&A: $220; 4 wks.

Directional couplers for the 1 to 12.4 GHz frequency range are available in five degrees of coupling from 3 to 20 dB. Coupling deviation across the frequency band is less than ±0.5 dB for the 3 dB model and less than ±1 dB for all other models. Directivity is 10 dB min, typically 15 dB, and VSWR (primary and secondary) is 1.3. Miniature 3-mm (SMA) connectors are standard, with fourth port terminated or unterminated.

CIRCLE NO. 384

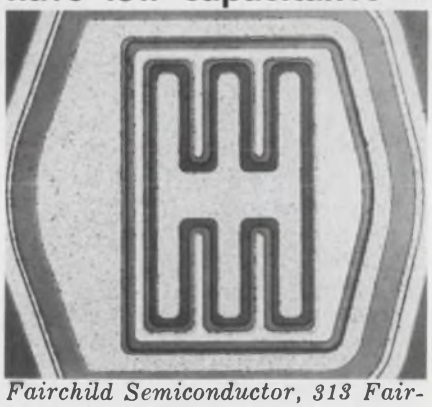
Varactor diodes multiply frequency

ITT Corp., 320 Park Ave., New York City: Phone: (212) 852-6000.

New microwave varactor diodes are available in a wide variety of packages including cartridge-type cases, pigtail-led hermetically sealed units, and stud-mounting packages. The devices are usable for frequency multiplication as doublers giving outputs between 250 and 4000 MHz, as triplers multiplying from 450 to 9000 MHz, as quadruplers with outputs of 240 to 1000 MHz, and as high-order multipliers with outputs of 400 to 6400 MHz. Power outputs range between tenths of a watt to 30 watts.

CIRCLE NO. 385

Video output transistors have low capacitance

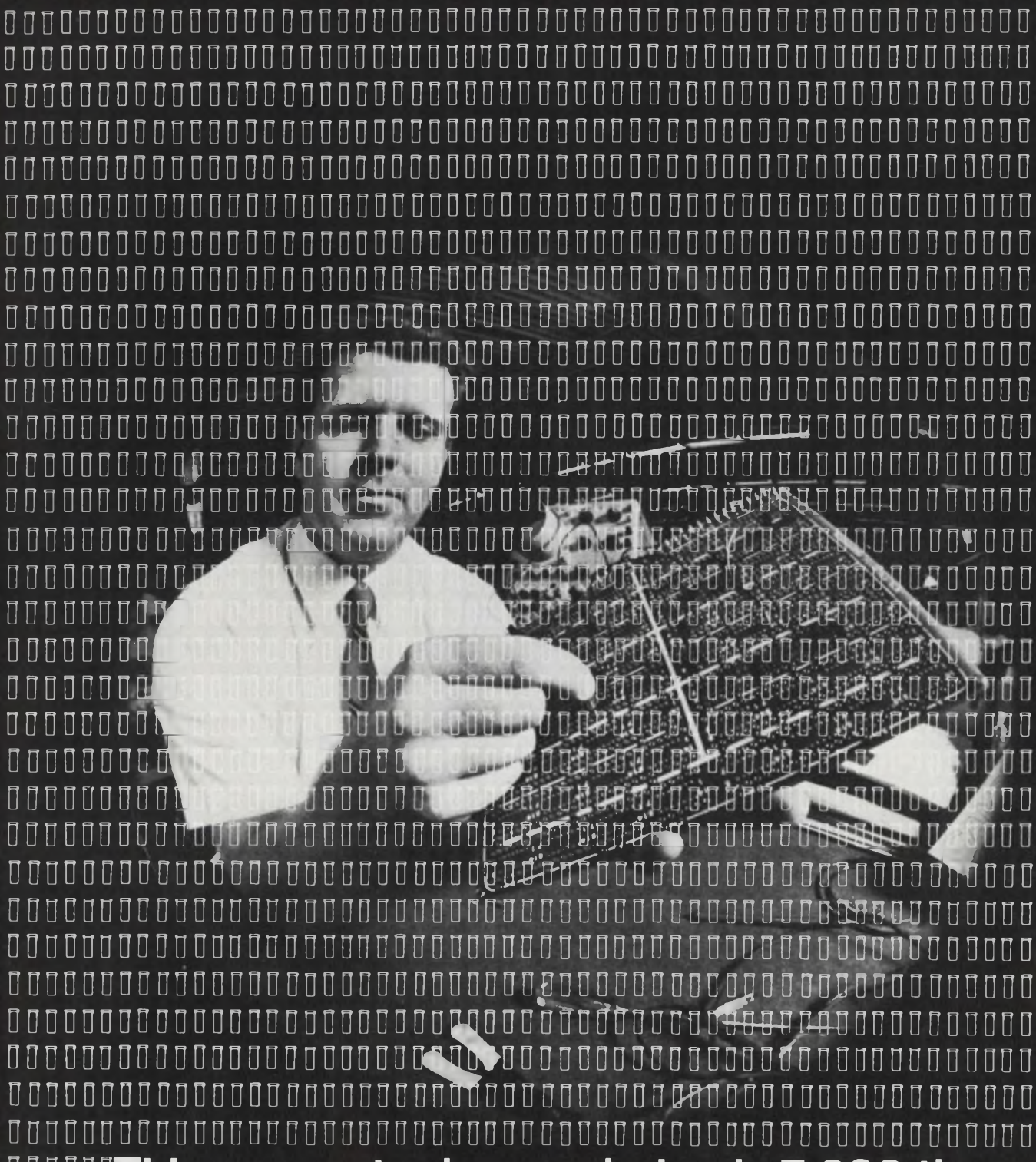


Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. Phone: (415) 962-3563. Price: $1.65 to $15.

Three npn high-voltage video output transistors are available in a standard TO-39 package. They are designated as: the SE7055, a 220-V unit with a low collector base capacitance of 3 pF; the SE7056, a 300-V unit with a 3.5-pF capacitance; and the SE7057, a 450-V unit with a 2.5-pF capacitance. All feature power dissipation of 7 W at 25°C case temperature (or 1 W in a 25°C ambient temperature).

CIRCLE NO. 386

INFORMATION RETRIEVAL NUMBER 120 ►



This connector has cycled only 7,393 times

And for at least another 32,607 trouble-free cycles, the fit will be exact . . . to sustain the electrical integrity of the connection. That's because this is a CAMBION Cage Jack. And even if you don't need to push it that far it's nice to know the proven reliability is always there.

But despite such a positive time-after-time grip, CAMBION Cage Connectors are easy to disengage. And you can pick a style for every rugged need . . . patching, testing, breadboarding, mounting components. We make more than 1500 miniature connectors, available from stock in six different sizes from .025″ to .080″. All with compatible mating plugs.

Our free catalog 700 has all the facts. Write for your copy today. See for yourself how CAMBION's Cage Jack connector can prove to be the **reliable** link in your circuit . . . time after time . . . after time. Cambridge Thermionic Corporation, 445 Concord Avenue, Cambridge, Massachusetts 02138. Phone: (617) 491-5400. In Los Angeles, 8703 La Tijera Boulevard 90045. Phone: (213) 776-0472.

Standardize on

CAMBION®

the guaranteed electronic components

Graphic input devices control CRT displays

Computer Displays Inc., 223 Crescent St., Waltham, Mass. Phone: (617) 899-0480.

Called the Mouse and the Joystick, two new graphic input devices are available for use with CRT display systems. The Mouse is a two-dimensional controller for positioning a cursor on the screen; moving it around causes the cursor to follow in an identical manner. The Joystick, which also provides analog voltage to control the cursor, has switches for selecting solid or dotted line inputs.

CIRCLE NO. 387

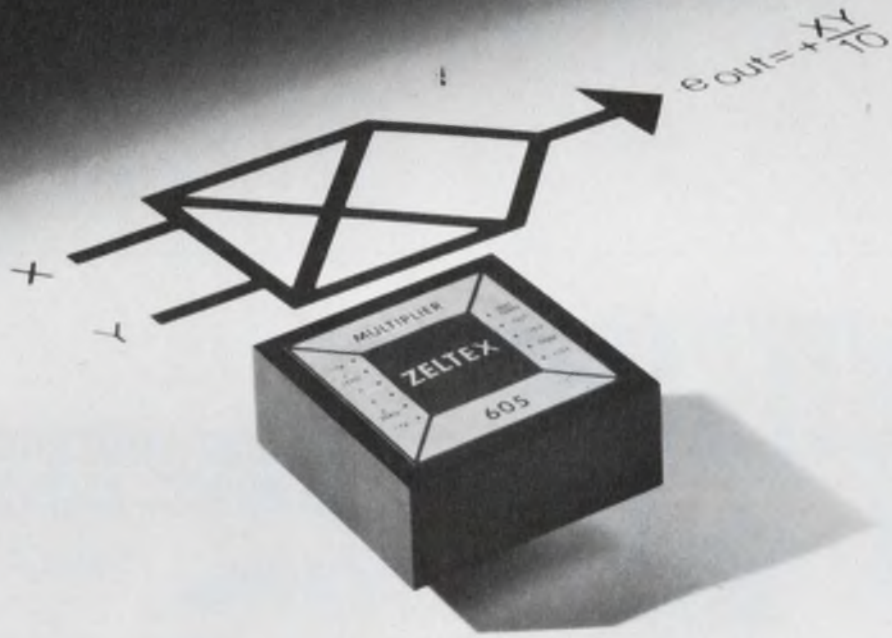
Asynchronous modem works at 1800 bits/s

Rixon Electronics, Inc., 2120 Industrial Parkway, Silver Spring, Md. Phone: (301) 622-2121.

Intended to link peripheral units such as CRT displays or card and tape terminals to a central processor, the FM-18 data set operates asynchronously at any speed up to 1800 bits per second. It is a frequency shift keyed modem for use in full-duplex, half-duplex or simplex operations.

CIRCLE NO. 388

LOW COST MULTIPLIER



New from

ZELTEX!

A four-quadrant modular multiplier that requires no external amplifiers for

$48*

■ 1% Accuracy ■ 10V, 4mA Output ■ 1mV rms Noise ■ 500 kHz Bandwidth ■ 100 kHz Full Output Frequency ■ 6V/μs Slew Rate

The Model 605 comes to you from the makers of the industry's most accurate mulitiplier—the Zeltex Model 601 with accuracy within 1mV (0.005%).

For complete information on these or any other Zeltex electronic products, write or phone today.

*In quantity.

1000 Chalomar Road, Concord, Calif. 94520/(415) 686-6660

INFORMATION RETRIEVAL NUMBER 122

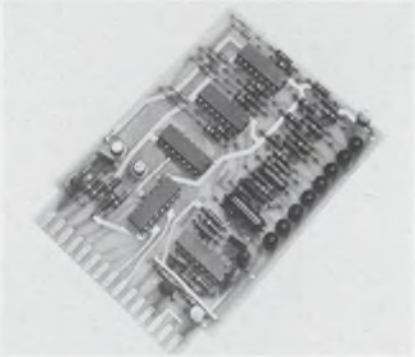
Digital intercoupler aids data processing

Daedalus Computer Products Inc., P.O. Box 248, N. Syracuse, N.Y.

Model 210 digital intercoupler is a versatile integrated circuit unit for coupling electronic instrument outputs to peripheral equipment, such as Teletype equipment, card punches, incremental magnetic tape recorders, printers and line printers, and typewriters. Capable of receiving coded data from standard measuring equipment, the unit translates the data into a computer-compatible form to drive the readout devices. Depending on the output device, typical operating speeds range from 10 to 1000 characters per second.

CIRCLE NO. 389

D/a 8-bit converter downs drive current



Computer Products, 2801 E. Oakland Park Blvd., Fort Lauderdale, Fla. Phone: (305) 565-9565. P&A: $99.90; 3 wks.

Permitting series termination, a new 8-bit digital-to-analog converter requires very low input drive currents—less than 0.2 mA source current and less than 0.1 mA sink current. Model DA231 accepts standard TTL logic levels and offers analog output configurations up to ±10.24 V at 10 mA.

CIRCLE NO. 390

Computer system cycles in 900 ns

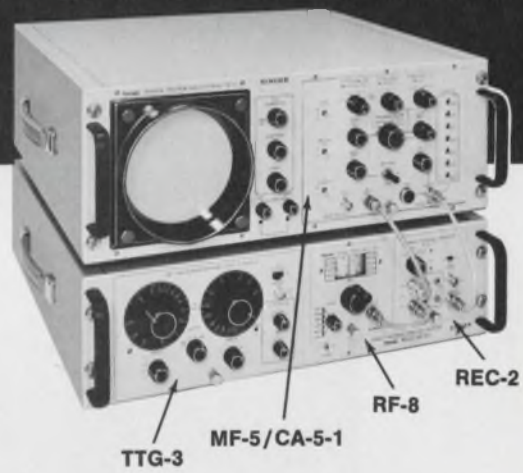
Tempo Computers, Inc., 340 W. Collins Ave., Orange, Calif. Phone: (714) 633-3660.

A new modular computer system, which has a basic 4k by 16-word random-access memory with a 900-ns cycle time, consists of a control processor and an ASR 33 Teletype. The model I control processor handles over 100 one- and two-word instructions with 65k addressability. It has seven accumulator/index registers (expandable to 15), multilevel priority interrupts and a 16-bit I/O bus.

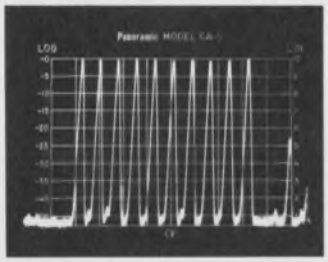
CIRCLE NO. 391

Monitoring tone level in a multiplexed communications system is easy... with a Model SSB-50-1 Spectrum Analyzer

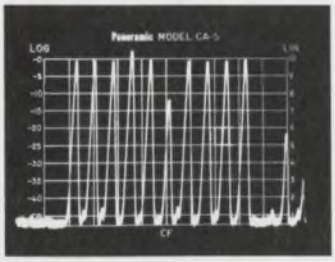
1. A high resolution spectrum analyzer allows monitoring of any number of multiplexed channels without repetitive meter readings or painstaking adjustments. As a first operating step, the analyzer's accurately calibrated frequency dial is precisely tuned to the center frequency of the channel.



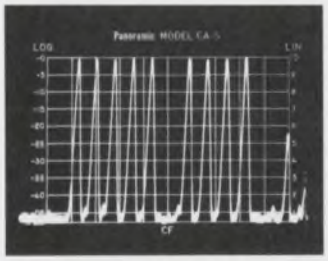
2. A selector knob sets the frequency scale in one of five settings from 15 Hz/division to 1.4 kHz/division. Interlocked circuit functions in the analyzer automatically optimize the display for any setting of the frequency scale.



3. The high resolution of the Singer Model SSB-50-1 provides this clear display of the multiplexed channel. The amplitude of each subcarrier is shown as a function of frequency. The display demonstrates complete operational readiness at a glance.



Subcarrier level changes
Often a subcarrier level changes with a resulting communications malfunction. This display on the CRT shows that one subcarrier's level is down 12 dB. Another is over the predetermined acceptable level.



Lost channel
Because the entire spectrum is continuously visible on the display, a lost channel shows up instantly... A frequency range of 10 Hz to 40 MHz makes the Model SSB-50-1 an invaluable tool for this application and for general laboratory or field use.

Model MF-5/CA-5-1
Spectrum Analyzer display section
features high resolution/low distortion and 70 dB dynamic range.

Model TTG-3 Two-Tone Audio Generator
20-20,000 Hz frequency range and IM distortion of less than 70 dB for testing single sideband transmitters.

Model REC-2 Range Extending Converter
extends the tuning range down to 10 Hz.

Model RF-8 Tuning Head
is a highly stable LO with coarse and vernier two speed tuning from 2 MHz to 40 MHz . . . usable to 200 MHz.

For additional technical information, or for Singer's new Application/Data Bulletin SA-10, contact your nearest Singer Field Representative or write directly to The Singer Company, Instrumentation Division, 915 Pembroke Street, Bridgeport, Conn. 06608.

SINGER
INSTRUMENTATION

INFORMATION RETRIEVAL NUMBER 125

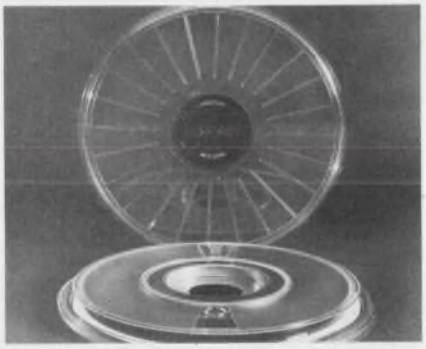
Portable terminal listens and writes

ComData Corp., 7544 W. Oakton St., Niles, Ill. Phone: (312) 692-6107. Price: from $1004.

A new mobile terminal and data set combination for time-sharing and data communications consists of a completely portable modified model 33 Teletype and an acoustic data set. This new mobile console offers a large range of options: paper-tape input-output, automatic control of paper-tape reader and/or punch, 74 or 88 columns per line, and separate or built-in acoustic data set.

CIRCLE NO. 392

Magnetic tape stays error free



Memorex Corp., Memorex Park, Santa Clara, Calif. Phone: (408) 248-3344. Price: $27/2400 ft.

Called Quantum, a totally new magnetic computer tape resists chemical decomposition during storage or shipping. This feature reduces the need to reconstruct information lost by errors, the need for checkpoint restarts on major processing and the lost time of shuttling away transient errors. During accelerated aging tests, Quantum showed a net increase of 2.1 permanent errors per reel, compared with the 6.4 and 6.2 increases of two competitive tapes.

CIRCLE NO. 393

need quality diodes or arrays fast?...

...we ship our guaranteed products the day they're ordered!

The performance of our products — our laser diodes, our laser diode arrays, our pulse power supplies, and our crystal and epitaxial wafers — is the highest in the industry. We guarantee this.
Our prices are the lowest in the industry. Our delivery is the quickest in the industry. And we have the broadest line of gallium-arsenide laser diode arrays.
Performance? You'll find that specifications listed on our data sheets are conservative ratings.
For example, our LD11 single element gallium-arsenide laser diode will, on the average, emit 8 watts. Yet our data sheet cites a conservative 5 watt minimum.
And both our LD11 and LD12 single element gallium-arsenide laser diodes are superior to any other diodes available at operation temperatures ranging from —196 degrees C to 70 degrees C. Typically there is no time delay in the emission of laser radiation with respect to the drive current.
Furthermore, these laser diodes are so rugged you can step on them — without affecting their performance.
What does this high performance, low price, ruggedness and immediate delivery mean to you?
It means you now have a source which supplies you with ruggedly packaged diodes that you can operate with a lower cost pulser — while obtaining higher peak power and higher average power — throughout a longer operating life. At lower cost to you.
With **no** waiting for delivery.

- **Single Element Gallium-Arsenide Laser Diodes**
- **Gallium-Arsenide Laser Diode Arrays**
- **Laser Diode Pulse Power Supplies**
- **Laser Grade Gallium-Arsenide Crystal and Epitaxial Wafers**

TYPICAL PERFORMANCE DATA

		+25°C 1KHZ, 200ns 3 x Ith	+55°C 1KHZ, 200nsec 2 x Threshold
LD11	Peak Power Threshold	8 Watts 25 Amperes	5 Watts 40 Amperes
LD12	Peak Power Threshold	3 Watts 12 Amperes	2 Watts 20 Amperes

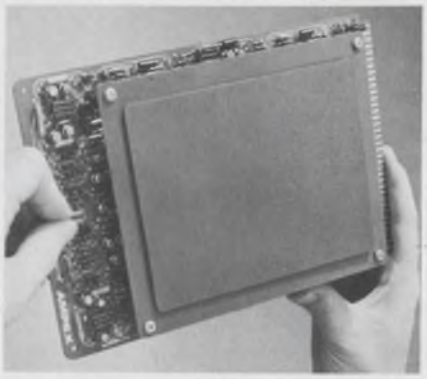
The power at 55°C is typically 60% of the 25°C power value.
For a 5 watt output the derating is 70 milliwatts per °C, while at 10 watts it is 150 milliwatts per °C.

LASER DIODE LABORATORIES

205 Forrest Street, Metuchen, New Jersey 08840
For technical or application information call (201) 549-7700
A Subsidiary of The United Corporation

INFORMATION RETRIEVAL NUMBER 127

Compact core memory uses only one supply



Ampex Corp., 9937 W. Jefferson Blvd., Culver City, Calif. Phone: (213) 836-5000. Price: $330 to $950.

Requiring only one power-supply voltage, a new magnetic core memory is completely contained on one plug-in module that measures 1.2 in. high by 7 in. wide by 12 in. deep. Model 3DM-3000 is designed for use as a buffer memory in data terminals and acquisition systems, and as a data-refresh memory for display devices. It offers an access time of 1.2 μs, a half-cycle time of 1.5 μs and a full-cycle time of 3 μs.

CIRCLE NO. 394

Three data modems satisfy line needs

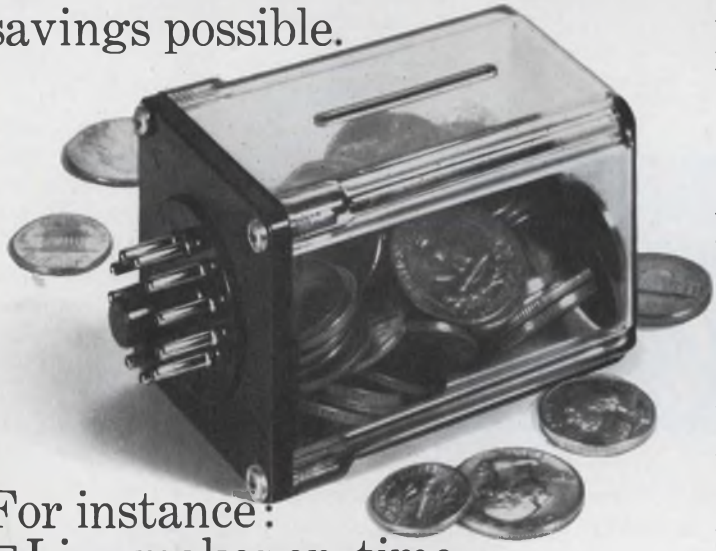
Dynatronics, div. of General Dynamics, P.O. Box 2566, Orlando, Fla. Phone: (305) 838-6161.

Three new data modems meet the varied requirements of modern communication systems. The EDX-1402 offers compatibility between international and domestic data transmission systems at data rates to 600 and 1200 bits/s. Designed for high-speed data transmission, the self-equalizing EDX 1403 operates at rates of 4800 bits/s. The medium-speed EDX 1404 provides two-way synchronous transmission at rates of 2400 bits/s.

CIRCLE NO. 395

How to save on relays

A quotation from Line Electric includes lots of values that add to the total savings possible.



For instance:

☐ Line makes on-time deliveries to meet your production line schedules.

☐ Line offers excellent engineering help free.

☐ Line maintains the highest manufacturing standards in the industry

Add these values together and you get all-round savings on your relay purchases. Not to mention the headaches you can avoid.

Won't you check us out and see how much better you can do at Line? Send for free copy of our new 1969 catalogue containing all the most frequently used industrial type relays. We guarantee you'll learn something to your advantage.

In a hurry, call (201) 887-8200 and ask for Relay Sales Manager. We like to do business by phone.

LINE ELECTRIC COMPANY, U.S. Highway 287, Parsippany, N.J.
Manufacturers of relays and the best service in the business.
SUBSIDIARY OF THE SINGER COMPANY

INFORMATION RETRIEVAL NUMBER 191

Bulk core memory is IBM compatible

Memory Products, Lockheed Electronics Co., Data Products Div., 6201 E. Randolph St., Los Angeles. Phone: (213) 722-6810. Availability: first quarter, 1970.

Compatible with IBM 360/50, 65, or 75 systems, a new multi-million-byte bulk core memory has a cycle time of 3.2 μs with an access time of 2 μs or less. Memory capacities are one-half, one, and two million bytes for system 360 models. A version for the IBM/67 time-share system is also planned.

CIRCLE NO. 396

Modular core memory accesses in 300 ns

Micro Systems, Inc., 644 E. Young St., Santa Ana, Calif.

Model 140 high-speed core-memory module features a full-cycle time of 900 ns and an access time of 300 ns. Capacity of the module is 4096 words by 8, 9 or 10 bits. It also has full-, half-, and split-cycle modes of operation, random address, control line input/output and TTL integrated circuit interface.

CIRCLE NO. 397

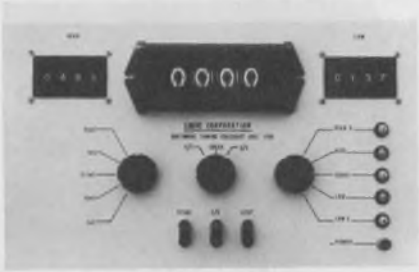
Four-wire 3-D memories vary operating mode

United Telecontrol Electronics, Inc., 3500 Sunset Ave., Asbury Park, N.J. Phone: (201) 988-0400.

A new group of 2-μs full-cycle memories can operate in a full-, half-, or split-cycle mode with any combination of random, sequential or interlaced access modes. Capacities for series 200 memory systems range from 1536 to 147,456 bits in virtually any address/word organization up to 60-bit word lengths. Their configuration is based on four standard plug-in circuit modules.

CIRCLE NO. 398

Real-time system checks software

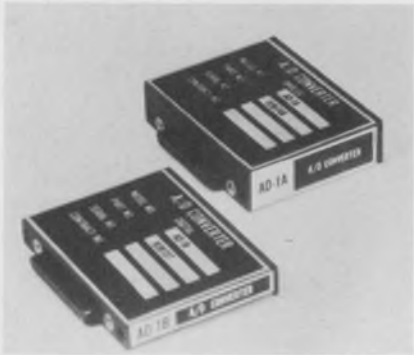


Logic Corp., Haddonfield, N.J. P&A: $5900; 60 days.

Designed for real-time operating systems, the model 1700 software timing checkout unit permits a complete statistical analysis of any program, routine or subroutine. Time is measured in intervals from 1 μs to 10 ms; the longest time that can be measured is 9.999 s. The unit measures five critical parameters: actual time period, longest and shortest time period to date, and the number of times the high and low limits have been exceeded.

CIRCLE NO. 399

A/d converters trim package size



Radix Telemetry Corp., 1600 Orangethorpe Way, Anaheim, Calif.

Designed for airborne applications, a new series of miniature analog-to-digital converters measure only 2 by 2.62 by 2.125 in. with dc-to-dc converter. Final package outline and dimensions are variable to match individual requirements. The units have resolutions from 6 to 10 bits and are either bipolar or unipolar. They can be supplied with a self-contained clock.

CIRCLE NO. 400

Small computer responds quickly

Micro Systems, Inc., 644 Young St., Santa Ana, Calif. P&A: from $2950; 30 days.

Designed for direct integration into control and processing system applications such as data communication and data acquisition, the model 800 small digital computer offers a 1.1-μs full-cycle core memory with 220-ns micro-command execution times. Microprograming (firmware) permits adaptation of internal organization and instruction repertoire to achieve speed and memory efficiency impossible with conventional computers having fixed instructions.

CIRCLE NO. 401

Of all DVM's, only Honeywell Digitest gives you five functions (DC Voltage, AC Voltage, DC Current, AC Current, Resistance), a choice of two models, and

Bench/Rack, Model 333R

Bench/Portable, Model 333

a price tag of only $395!

With ±0.5% accuracy, 100μV resolution, absolutely clear 3½-digit readout, and simple, foolproof operation, the tough, compact little Digitest makes other low-cost DVM's look overpriced and under-engineered. We won't even mention a comparison with conventional meter-movement instruments.

Both models share the same specs, but Model 333 is completely portable thanks to built-in rechargeable ni-cad battery operation. It operates on AC as well. Both instruments give you 3½-digit readout, with Model 333R providing an overrange digit while Model 333 employs an overrange indicator.

Compare features, specs, and prices – you'll see that Digitest is your best DVM value. That $395 price, by the way, is *complete*. There are no shunts or plug-ins to buy, and even leads are furnished. The only option is a set of ni-cad batteries for the portable model at $33.

Order yours today! Call Don Anderson (collect) at (303) 771-4700, or send your purchase order to Don at Mail Station 222, Honeywell, Test Instruments Division, P.O. Box 5227, Denver, Colorado 80217. Both models are in stock for immediate delivery, so order now!

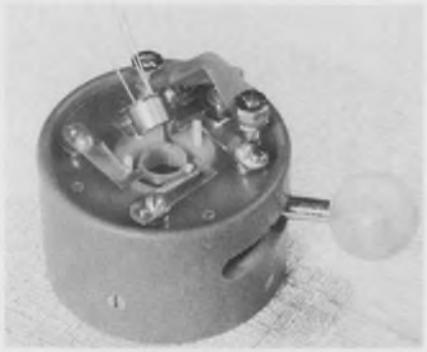
Honeywell

Honeywell engineers sell solutions

INFORMATION RETRIEVAL NUMBER 136

PRODUCTION

Transistor fixture speeds up testing



Monterey Engineering, P. O. Box 3083, Granada Hills, Calif. Phone: (213) 780-6953. P&A: $75; 2 wks.

Able to handle up to 1800 pieces per hour with remote actuation, a new transistor test fixture reduces test time, decreases connection errors and lessens operator fatigue. Transistors are simply dropped into the cup, case down; the fixture is actuated with the slide lever; and lead contact is complete in less than 0.1 seconds. Two models are available, for TO-5 and TO-18 metal cans with three or four leads.

CIRCLE NO. 402

Pivoting magnetic vise chucks 15-mil pieces

Titan Tool Supply Co., Inc., P.O. Box 1682, Dept. 31, Buffalo, N.Y.

A miniature permanent magnet chuck can hold small workpieces as thin as 0.015-in. Called Magna Plate SP-180, the new pivoting tool can rotate 105° in either direction from the horizontal and can be locked in any position by two spring-loaded cam-actuated locking levers.

CIRCLE NO. 403

Tip angle cutter does fine work

ETM Corp., 144 W. Chestnut Ave., Monrovia, Calif. Phone: (213) 359-8102.

Although ruggedly constructed, model 1022 tip angle cutter retains the fine pointed tips needed for close-quarter precision cutting. Able to cut nickel wire up to 0.032-in. dia and nickel ribbon to 0.012 by 0.030 in., the new tool has a stop screw in the shank to prevent overpressure on the tips. It also features tool steel hardened inserted tips and diamond-honed cutting edges.

CIRCLE NO. 404

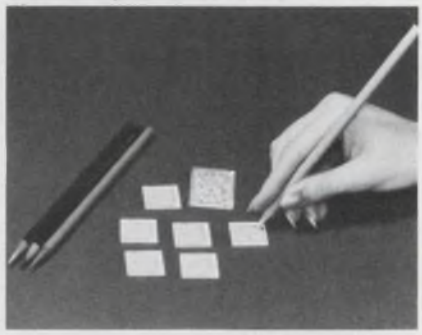
Lightweight heat gun shrinks tubing in 8 s

Kelvin Halogen Ltd., 500 Sansome St., San Francisco, Calif. Price: $59.50.

Drawing only 2.08 A, a new hand-held heat gun goes from 0 to 750°F in 10 seconds and processes shrinkable tubing in about eight seconds, a time cycle said to be comparable with hot air blower units. Weighing only 12 ounces, model A250 uses a high-intensity iodine quartz lamp as its energy source. The tool will operate continuously at constant effectiveness for up to 2000 hours, the normal life cycle of the lamp.

CIRCLE NO. 405

High-temp markers identify ceramics



Starnetics Co., 10639 Riverside Drive, N. Hollywood, Calif. Phone: (213) 769-8437. P&A: $10.75/kit; stock.

Ideal for identifying thick-film substrates, a new line of marking pencils can write on ceramics that are subsequently exposed to high temperatures. Once applied, the pencils' deposit will withstand the high temperatures of print and fire processes. After exposure, the marks are permanent, unable to be removed by any of the commonly employed solvents and cleaners.

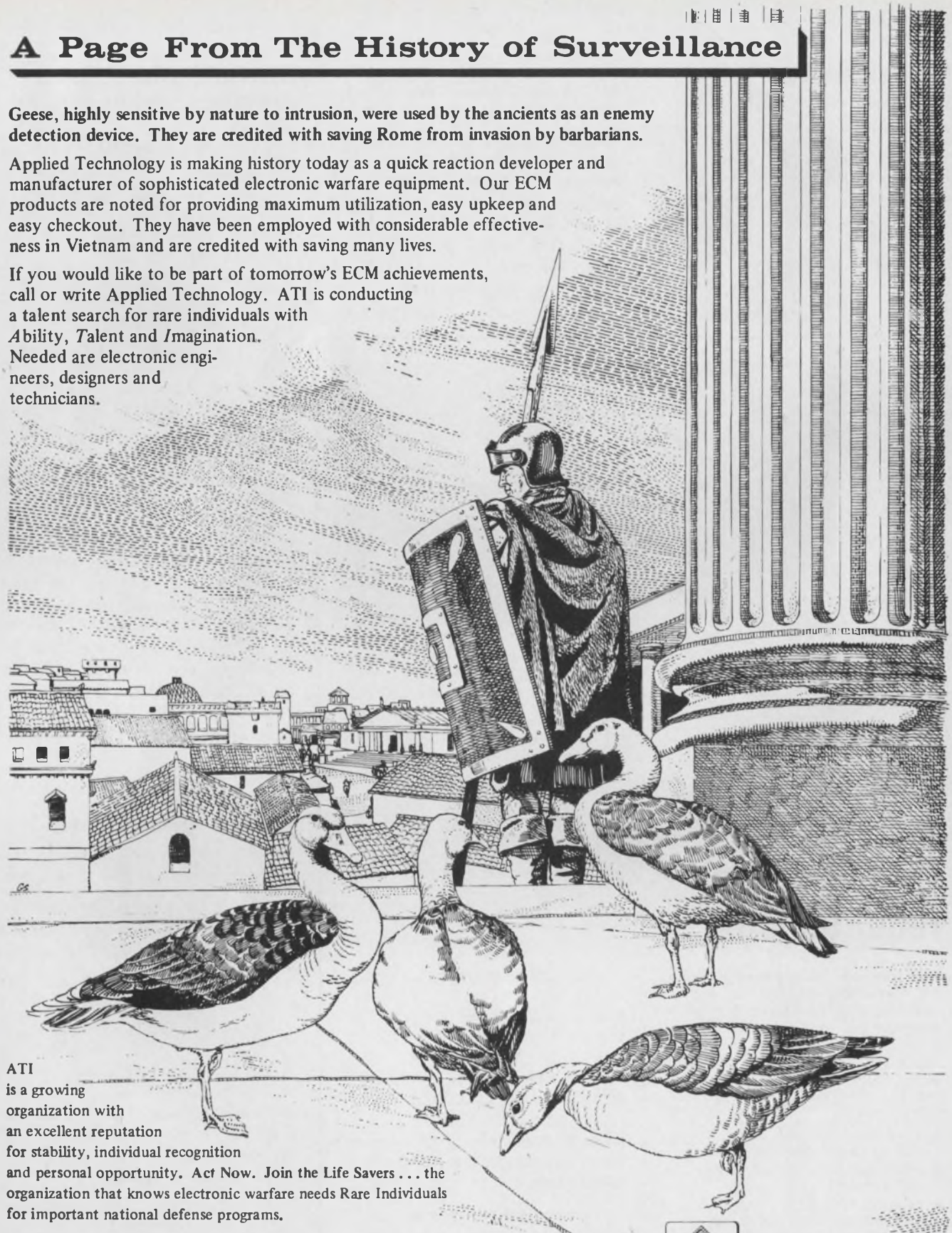
CIRCLE NO. 406

A Page From The History of Surveillance

Geese, highly sensitive by nature to intrusion, were used by the ancients as an enemy detection device. They are credited with saving Rome from invasion by barbarians.

Applied Technology is making history today as a quick reaction developer and manufacturer of sophisticated electronic warfare equipment. Our ECM products are noted for providing maximum utilization, easy upkeep and easy checkout. They have been employed with considerable effectiveness in Vietnam and are credited with saving many lives.

If you would like to be part of tomorrow's ECM achievements, call or write Applied Technology. ATI is conducting a talent search for rare individuals with *A*bility, *T*alent and *I*magination. Needed are electronic engineers, designers and technicians.



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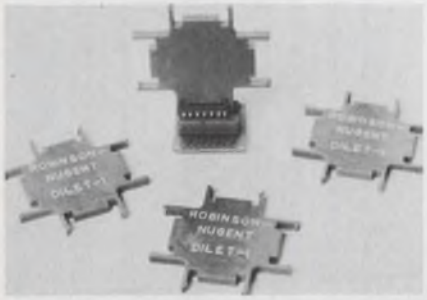
INFORMATION RETRIEVAL NUMBER 143

Four-sided tool removes any DIP



Robinson-Nugent Inc., 802 E. 8th St., New Albany, Ind. Phone: (812) 945-0211.

Called Dilet-1, a new four-way universal DIP extraction tool accepts any 14- or 16-lead dual-in-line package currently available. Each of its four sides is a different size. The device helps keep IC leads from becoming bent or twisted, thereby easing reinsertion.

CIRCLE NO. 407

Thermal wirestripper switches automatically

American Electrical Heater Co., Wassco-Melt Div., 6110 Cass Ave., Detroit. Phone: (313) 875-2505. P&A: $65; stock.

With automatic on-off switching, model 105137 thermal wirestripper features controlled heat and tweezer-type action. The on-off switching is tray activated, controlled by picking up and replacing the handpiece. This tweezer-type handpiece strips up to 18-gauge wire and has an adjustable stop for setting the length of the strip. A potentiometer control allows dialing of exact power needed.

CIRCLE NO. 408

IC wire bonder speeds production

Hughes Aircraft Co., Centinela Ave. & Teale St., Culver City, Calif. Phone: (213) 391-0711. P&A: $4000; 6 wks.

A pulse-heated thermocompression wire bonder has been designed for large-scale production on all types of microelectronic devices. The model HPB-360 bonder passes a current pulse of extremely short duration directly through the capillary tip.

CIRCLE NO. 409

Free DC motor bulletins

72 performance curves on motors and gearheads

Indiana General has released specifications on custom-designed DC motors, available at off-the-shelf prices. Tolerances on these motors are often held to .0001".

They come in 8, 9, 12, 13 and 15 frame sizes, with delivery in 6 to 8 weeks instead of the normal 12.

For technical details, including performance curve data for each, plus information on gearheads, write: Mr. R. D. Wright, Manager of Sales, Indiana General Corporation, Electro-Mechanical Division, Oglesby, Illinois 61348.

INDIANA GENERAL *We make it easy for the design engineer.*

INFORMATION RETRIEVAL NUMBER 145

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can do a lot for your next 5 years.

If you're involved in systems and equipment design, research, production or management . . . five days at one of our Seminars may make your next five years—and many more after that—much more productive.

More and more key management and high-level technical personnel from top companies all over the United States are attending RCA Institutes Seminars. Just as they are doing, you'll acquire information and techniques of immediate value in your work. You will also gain the kind of knowledge that can help build your professional standing in the years just ahead.

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- ☐ Numerical Control Systems

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Title_____

Company_____

Address_____

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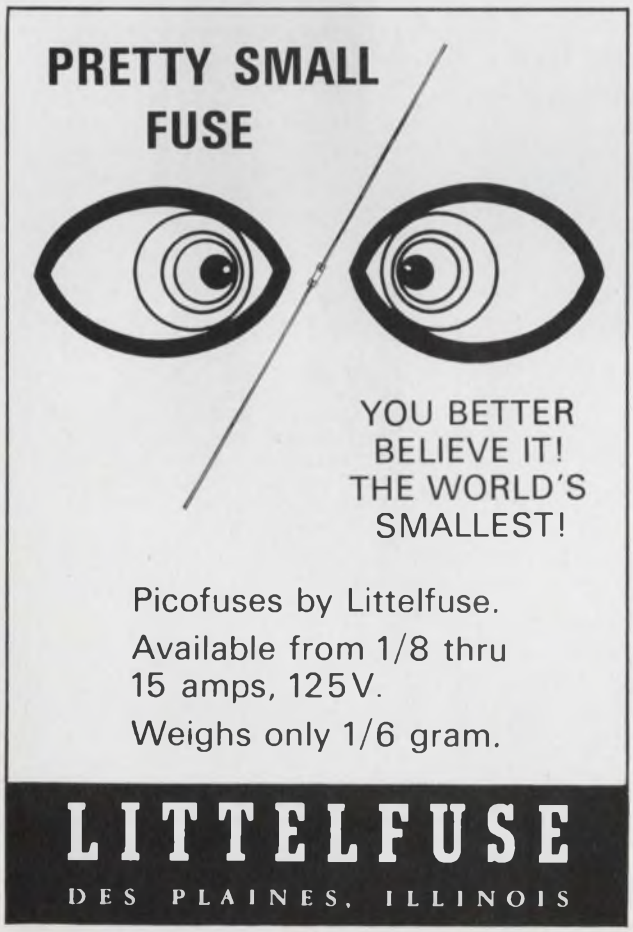
INFORMATION RETRIEVAL NUMBER 147



INFORMATION RETRIEVAL NUMBER 146

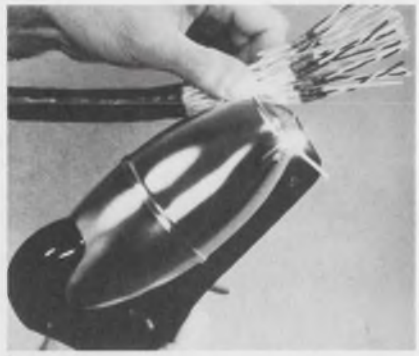
Pneumatic tool ties wire bundles

Kent Corp., 206 Industrial Center, Princeton, N.J. Phone: (609) 924-3800.

An improved, insulated spot-tie and a redesigned hand-operated air tool for wiring-harness and wire-bundle applications reduce costs and improve quality by eliminating the need to spot-tape or lace harnesses. The tie adjusts automatically to the size of the harness or wire bundle (from two #20 wires to seven #16 wires).

CIRCLE NO. 410

Compact heating tool encapsulates terminals



Rayclad Tubes, a sub. of Raychem Corp., 300 Constitution Dr., Menlo Park, Calif. Phone: (415) 324-3333.

Using a modified 500-watt clear tungsten-halogen heat lamp as its energy source, a new tool can quickly create an encapsulated soldered termination of shielded wire. Called the Thermofit Zap Gun, the unit has a solid-state timer that controls the energy cycle and permits adjustments from 1/2 to 4 seconds.

CIRCLE NO. 411

Tantalum Foil

3 ways better than solid in non-polar applications

- smaller than solid tantalum
- more reliable than solid tantalum
- delivers more microfarads than solid tantalum

Design is the big difference between General Electric's Type 29F non-polar tantalum foil capacitor and an equivalent solid tantalum capacitor. A design that's specifically for **non-polar** applications.

GE Type 29F non-polar tantalum foil is about half the case size of an equivalent solid, yet accepts voltage and current variations in either direction. And from one small, single roll that in no way impairs the inherent reliability characteristics of tantalum foil. (Totally unlike its bulky solid counterpart that requires two slugs connected back-to-back and, in most cases, within a single case.)

The difference doesn't end with just size and reliability. Consider microfarads. GE tantalum foil delivers 50 percent more microfarads per case size, in practically all cases, when compared with solid tantalum.

So for your next non-polar application, contact your General Electric Sales Representative and ask to see the Type 29F tantalum foil capacitor. It could make a big difference. In size. In reliability. In microfarads.

Electronic Capacitor and Battery Dept., Irmo, S.C.

430-36

GENERAL ELECTRIC

INFORMATION RETRIEVAL NUMBER 150

Miniature butt splices connect #30 AWG wire

Thomas & Betts, Inc., 36 Butler St., Elizabeth, N.J. Phone: (201) 354-4321.

A new line of miniature butt splices can be used to splice very small wires in single or multisplice operations. The splices are among the smallest manufactured to connect #24- through #30-AWG wires.

CIRCLE NO. 412

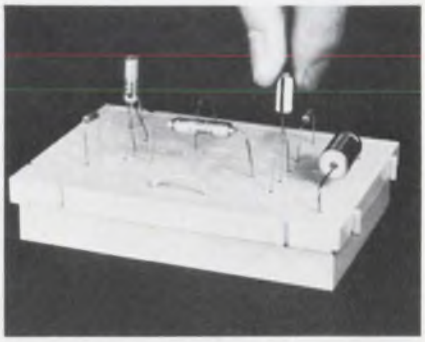
Electrical tapes resist solvents

3M Company, 3M Center, St. Paul, Minn. Phone: (612) 733-7251. P&A: $5.72 to $11.44; 30 days.

Five new electrical tapes, each coated with a quick curing oil and solvent-resistant pressure-sensitive adhesive, have been introduced. All five tapes employ an acrylic pressure-sensitive adhesive. With proper thermosetting, this adhesive system has high resistance to oils and other hydocarbon solvents and will neither corrode copper nor degrade the electrical properties of mineral-type transformer oils.

CIRCLE NO. 413

Solderless breadboard has spring contacts

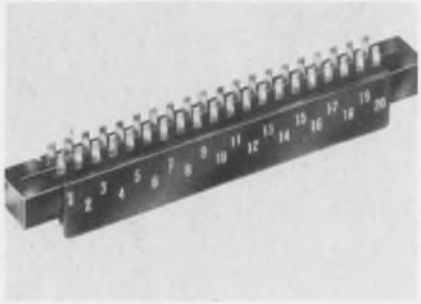


British Aircraft Corp. (U.S.A.) Inc., Intratec Div., 399 Jefferson Davis Highway, Arlington, Va. Phone: (703) 684-6404. Price: $5.50.

This solderless board offers a simple, direct way to assemble experimental circuits. Component leads up to 0.04 inch in diameter are accepted directly by the board's leaf-spring contact points. Wear and tear on components and board is minimal, and flexibility is a main feature of the system.

CIRCLE NO. 414

Slotted connector meets NAFI specs

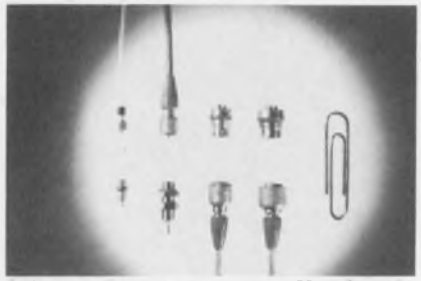


Methode Electronics, Inc., 7447 W. Wilson Ave., Chicago. Phone: (312) 867-9600.

Designed and produced to precise NAFI hardware specifications, the new connector is available with either a 0.3- or 0.06-in. slot, enabling the user to mount a heat sink or printed circuit board suited to his specific needs. The standard part is furnished with a molded insulator of glass-reinforced diallyl phthalate, with the contacts set on 0.1-in. centers.

CIRCLE NO. 415

Miniature connectors simplify assembly



Microtech, Inc., 777 Henderson Blvd., Folcroft, Pa. Phone: (215) 532-3388.

Ultraminiature coaxial connectors and multicontact 4- and 7-pin connectors are designed to meet the needs of high-density packaging applications. To fabricate a coaxial cable assembly, the cable is simply threaded into the plug. To fabricate a multicontact connector and cable assembly, a special multiconductor cable is simply soldered to the socket assembly and snapped into the plug.

CIRCLE NO. 416

Polyimide film tape is temperature stable

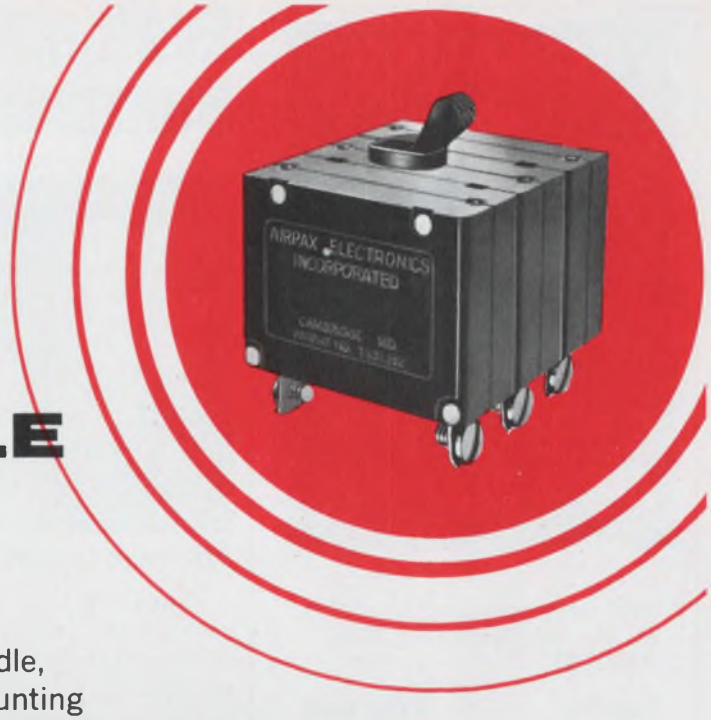
Mystik Tape, Borden Inc., 1700 Winnetka Ave., Northfield, Ill. Phone: (312) 446-4000.

A lightweight Kapton polyimide film tape is designed for critical areas where temperature stability and dielectric strength are essential. Mystik 7360 measures only 1.3 to 1.7 mils in total thickness, yet retains its thermal and electrical properties between −110° and +550°F. The tape has a tensile rating of 17 pounds per inch; dielectric strength is 4800 to 5400 V.

CIRCLE NO. 417

AIRPAX

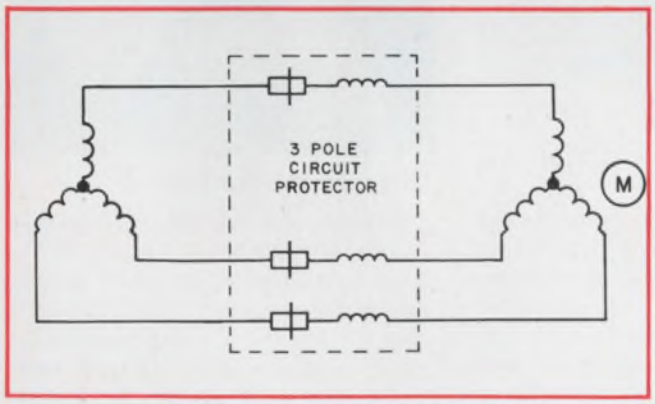
MULTIPOLE PROTECTOR with SINGLE TOGGLE ACTUATION



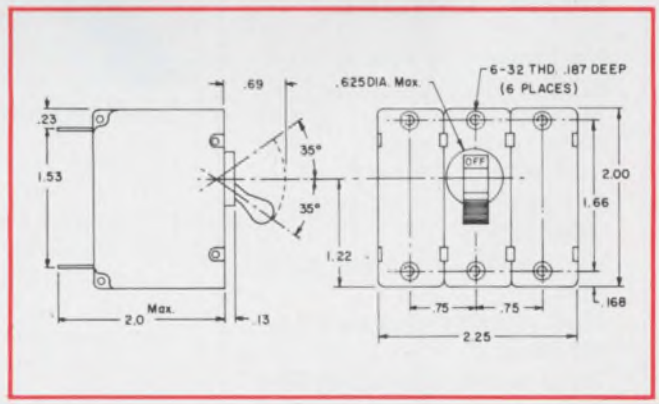
Airpax multipole APG magnetic circuit protectors operate with a single toggle handle, a feature which greatly simplifies panel mounting and provides a lower cost, compact unit with high operating dependability. Internal coupling assures instant action of all protectors should an overload occur in any protected circuit.

FEATURES

- Current ratings from 20 mA to 30A.
- Voltage ratings to 250 volts, 60 and 400 Hz and to 50 volts dc.
- Series, shunt and relay types, auxiliary switch available on series type.
- Choice of trip delays; trip free operation.
- Individual poles need not have identical characteristics.
- Quick connect or machine screw terminals.
- Available with 1, 2 or 3 poles.
- Electromagnetic operation with magnetic-hydraulic delay.



THREE PHASE MOTOR PROTECTION



DIMENSIONAL DRAWING

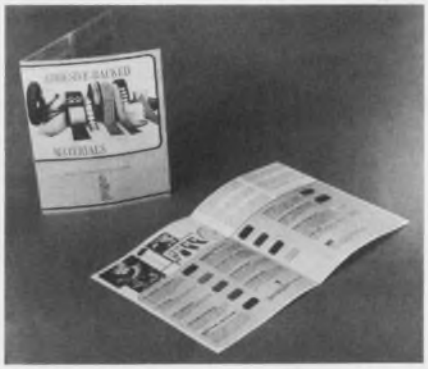
AIRPAX ELECTRONICS

CAMBRIDGE DIVISION, CAMBRIDGE, MARYLAND 21613

PHONE (301) 228-4600 TELEX 8-7715 TWX 710 865-9655

INFORMATION RETRIEVAL NUMBER 156

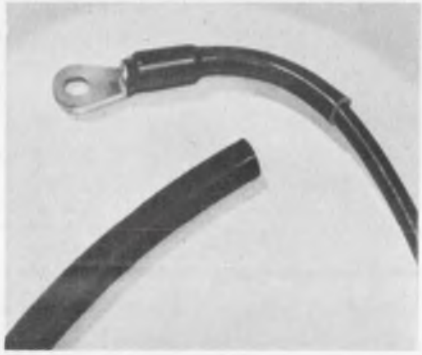
Evaluation Samples



Adhesive-backed materials

Samples of adhesive-backed pressure-sensitive materials are included in a four-page illustrated product catalog. Specifications and suggested uses are listed for each material. In addition, there is a description of the material processing to aid the user in developing new or different applications. Deccofelt Corp.

CIRCLE NO. 418



Shrinkable tubing

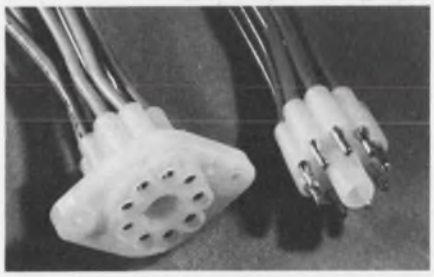
Flexite Shrinkdown HT-105 is a flexible Class A (105°C) extruded tubing with the capacity to shrink 50% in diameter upon application of heat. Supplied in expanded sizes, the tubing can easily be assembled over irregular shapes, such as splices, connectors, components and cables. After shrinking, it forms a smooth tight-fitting insulation covering for both mechanical and electrical protection. Specially compounded Shrinkdown HT-105 meets the requirements of MIL-I-631D, Grade C, and the test requirements of MIL-I-23053A, Grade 5b. Free samples are available. L. Frank Markel & Sons, Inc.

CIRCLE NO. 419

Non-woven fabrics

Containing sample swatches of non-woven fabrics, a multi-page folder outlines the properties, specifications, advantages and applications of these materials. Known as Webloy, the non-woven fabrics have tensile strengths as high as 50 pounds per inch while weighing only three ounces per square yard. Typical fabrics are made with Nomex nylon, polyester, polypropylene or rayon fibers. Binders can be thermoplastic or thermosetting. Kendall Co., Fiber Products Div.

CIRCLE NO. 420



Circular connector

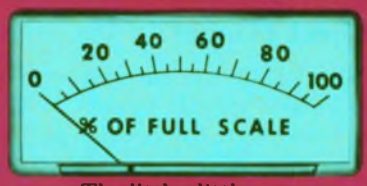
Providing a low-cost dependable circular circuit connector, the 1664-9 plug, coupled to its 1412 socket, has male terminals that snap-lock into their nylon housing and can be easily removed with a simple tool. The socket housing can be screw-mounted, or can be supplied with integrally molded mounting ears for fast snap-in chassis assembly. The plug and socket come in a 9-circuit configuration, but 8- and 11-circuit versions can be provided. Free samples and more information are available. Molex Products Co.

CIRCLE NO. 421

The Readable Little Meters

You can even read the littler little one at arm's length.

(Actual sizes)



The littler little one.

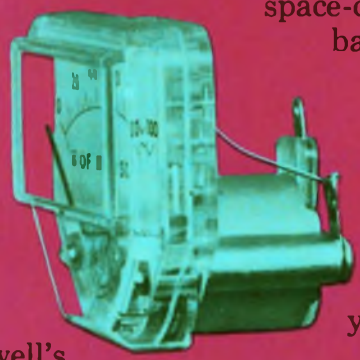
The bigger little one.

Put your left thumb here.

Put your right thumb here.

Honeywell's new Series 80T Panel Meters take up about half the panel space of full-size meters.

But hold this ad out at arm's length and see how easy the meters are to read. (How we ever got such large scales on such small faces without cluttering them, only our designers know.) And we've set the dial up front, so you can see it clearly, even from an oblique angle.



Behind the small face is Honeywell's unique taut-band mechanism – with about 50% fewer parts than a pivot-and-jewel. (One of the parts that's missing is the old space-consuming plastic barrel on the back of the meter.)

The new Series 80T Panel Meters come in 33 standard ranges. And they cost no more than pivot-and-jewel meters. So you don't have to pay a lot to get a little. (We'd like to send you a catalog. Write Honeywell Precision Meter Division, Manchester, New Hampshire 03105.)

It takes all kinds of meters to make the Honeywell line.

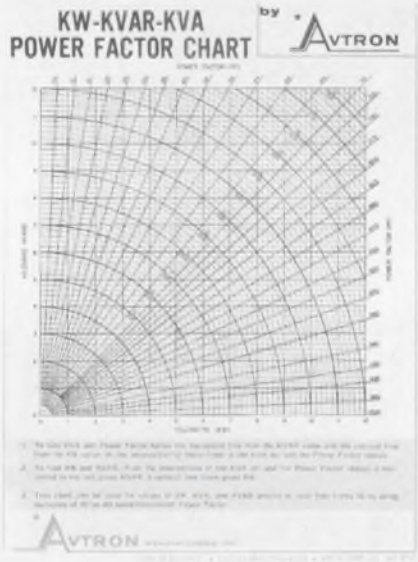
Honeywell

Design Aids

Project planner

The PERT system pioneered on the Polaris missile project in 1958 has been related to smaller projects by a new slide-rule system that directly converts elapsed times into calendar dates. The use of this calculator with its accompanying instruction manual eliminates both tedious hand calculations and expensive electronics. The nominally priced system brings PERT/CPM techniques within the reach of small and medium-size operations. Descriptive literature is available. Halcomb Associates.

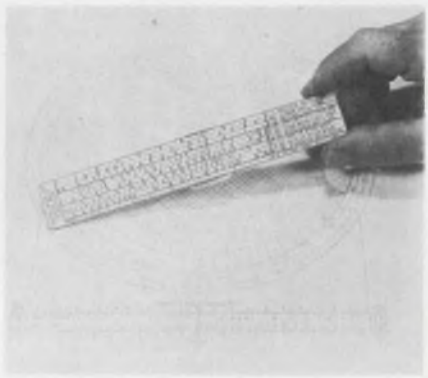
CIRCLE NO. 422



Power-factor chart

A power-factor chart provides a quick, simple means of accurately correlating kilovars, kilowatts and kVA from zero to unity power factor. The chart directly correlates values to 12 kilowatts/kilovars, and may be used for larger values by applying appropriate multiplier factors to each scale. Avtron Manufacturing, Inc.

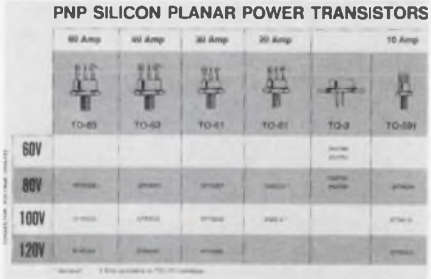
CIRCLE NO. 423



Transmission sliderule

As described in a feature article in the March, 1969, issue of *QST Magazine*, MEGA-RULE—a pocket slide rule—determines transmission-line losses and related quantities by very simple procedures. Ten accurately graduated scales display VSWR, reflection coefficient, return loss, reflection loss, etc., and an attenuation scale, printed in red across the bottom, shows the effect of dissipative losses on all other quantities. The rule is priced at $3.75, and descriptive literature including reprints of the QST article are available without charge. Analog Instruments Co.

CIRCLE NO. 424



Power-transistor chart

Selection of power transistors is simplified by a useful, two-color chart. Over 200 device types are included in the graphic breakdown. The chart features three sections that cover npn and pnp silicon planar power transistors, as well as complementary devices. To use the chart, one simply starts at a given collector voltage and moves across the page to the appropriate column for desired current capability and package configuration. Transitron Electronic Corp.

CIRCLE NO. 425

Space-saving trimmers

DIP construction matches IC size. Cuts assembly costs.

5/16" doubles performance of 1/4" trimmer—cuts cost almost in half.

IRC's new precision wirewound trimmer in dual-in-line package simplifies PC board layout. Pin spacing is the same as the popular TO-116 size integrated circuit. It is fully compatible with high-speed automatic inserting equipment.

The sealed, moisture-resistant units meet the environmental requirements of MIL-R-27208. Maximum height is only .200 inches. 1 watt @ 40°C. 10Ω to 20K. ±10% tolerance. TC is ±50ppm/°C.

Pin spacing of these 5/16" square trimmers matches the 1/4" square unit. Only .062" larger on each side, they can cut your cost almost in half and give you three times the power rating of the 1/4" and 40% better resolution.

Two types are available—precision wirewound and infinite resolution Metal Glaze. Both are fully sealed and impervious to common industrial solvents because of a silicone rubber shaft seal and epoxy bonding at all seams.

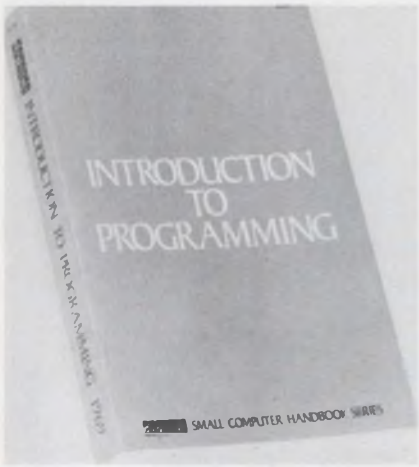
For data and prices, see your IRC Industrial Distributor or write IRC St. Petersburg Division of TRW INC., 2801 72nd Street, North, St. Petersburg, Florida 33733

IRC

DIVISION OF TRW INC.

INFORMATION RETRIEVAL NUMBER 161

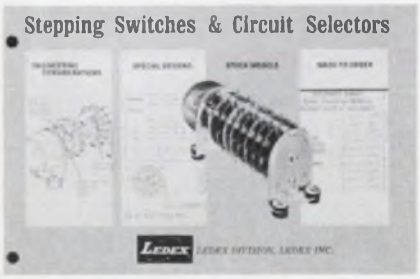
Application Notes



Introduction to programing

A 425-page soft-cover book contains a complete introductory course aimed at university, high school and training school students. Offered free in single copies, the 11-chapter volume includes appendices and index. It is an introduction to programing digital computers, particularly DEC's PDP-8 family. Digital Equipment Corp.

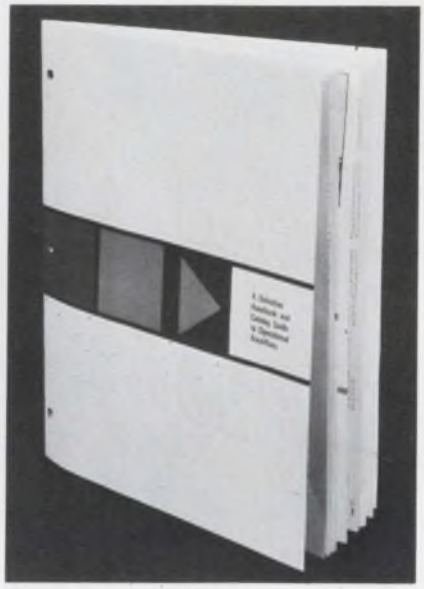
CIRCLE NO. 426



Stepping switches

A 34-page booklet contains extensive data on engineering considerations, control circuits, and the application of basic circuits to solve complex switching problems with stepping switches and circuit selectors. Included are updated specifications for 36 off-the-shelf multipole switches, with choices of 2, 4, 6, 8, 10, 12, 18, 20 and 24 electrical positions. Another section outlines a simplified building block approach for specifying made-to-order switches by part number. Ledex Inc.

CIRCLE NO. 427



Op-amp handbook

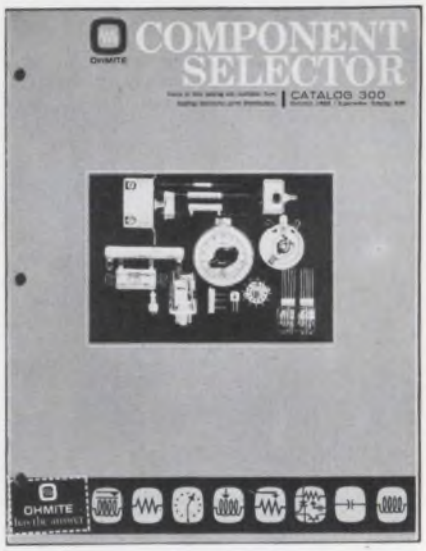
A free 32-page handbook combines application information and comprehensive specifications for some 100 operational amplifiers and function modules. At the same time, it introduces 14 new units not described in previous application handbooks. Of special importance to engineers who select or specify operational amplifiers is a specification glossary. Besides discussing the meaning of the more important op-amp specs, this section includes a full-page review of the often-misunderstood question of temperature drift specifications. The butterfly characteristic, used to define the drift performance of high-stability amplifiers, is included in this examination of temperature stability. Analog Devices, Inc.

CIRCLE NO. 428

Stroboscopy primer

A recently published booklet entitled *A Primer of Stroboscopy* explains the fundamental concepts of stroboscopy. It also describes accessories for the electronic stroboscope, tells how it can be used with a simple camera for high-speed photography, and gives a variety of other applications for the instrument. General Radio Co.

CIRCLE NO. 429



Component selector

A new condensed catalog serves as a quick-reference ordering and application guide. A wide variety of resistors, rheostats, potentiometers, transformers, capacitors, solid-state power controls, light dimmers, rf chokes and relays are described. The relay section is especially detailed, with dimensional drawings, mounting illustrations, etc. Ohmite Mfg. Co.

CIRCLE NO. 430

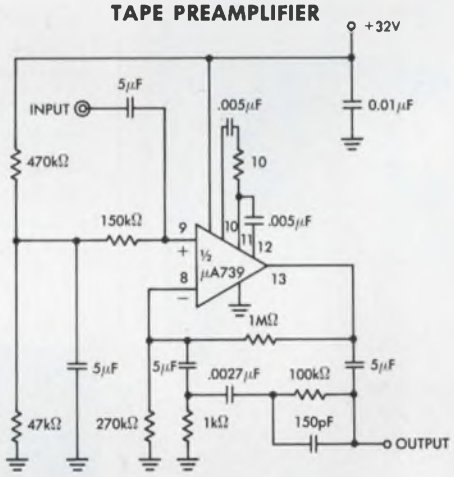
Emi applications

An eleven-page brochure shows how conductive elastomeric gaskets, conductive adhesives, and conductive caulking, potting and coating compounds provide highly effective shielding and sealing in such applications as electronic subassemblies, connectors, waveguides and switches. Also described are unique grounding, contacting, and static discharging applications made possible by these materials. Chomerics, Inc.

CIRCLE NO. 431

Low noise for hi-fi (stereo).

TAPE PREAMPLIFIER



Build your stereo preamps with the Fairchild μA739 Dual Low-Noise High-Gain Op Amp and you've got performance that's as good as any currently available discrete system. Besides getting both amplifiers on a single chip (and at a single chip price), you get channel separation 15dB better than most discrete designs, an output swing high enough to drive the most demanding power amplifier and a power supply rejection ratio so high that you can cut costs even further by relaxing your power supply specs. And check what the high common mode rejection ratio does for distortion.

That's our Second Generation Linear technology in action — proud performance, humble pricing. The μA739 was specifically tailored for improved performance in any application that requires two high-gain amplifiers. Try it now in your modulators, voltage-to-frequency converters, instrumentation amplifiers or integrators and take advantage of its low noise, non-latching and unity gain crossover frequency of 20MHz. And for more flexible low power operation in military and industrial applications, we'll have it available (second quarter of calendar 1969) as our μA749 without the internal output stage collector resistors. The μA739 is available in a DIP; the μA749 will come in a ceramic DIP, a flat-pak or a TO-5 metal can. Information on both is in our data sheets.

ELECTRICAL CHARACTERISTICS

Large Signal Open Loop Voltage Gain:	80dB
Signal to Noise Ratio:	68dB
Bandwidth:	20 to 20,000 Hz
Output Swing:	10 V_{rms}
Power Consumption:	250mW
Input Impedance:	50KΩ
Power Supply Rejection:	75dB
Channel Separation:	60dB
Distortion:	0.025%

*For complete specifications, see data sheets.

Write for them and our application notes now. Or, just check with your stocking Fairchild distributor.

To order the μA739, ask for:

PART NUMBER	PACKAGE	TEMPERATURE RANGE	PRICES 1-24	25-99	100-999
U6E7739393	DIP	0°C to +70°C	$4.85	$3.90	$3.25

FAIRCHILD SEMICONDUCTOR

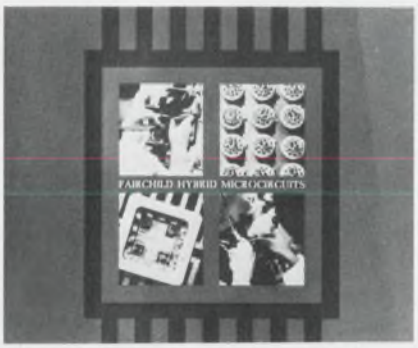
FAIRCHILD SEMICONDUCTOR A Division of Fairchild Camera and Instrument Corporation Mountain View, California 94040, (415) 962-5011 TWX: 910-379-6435

INFORMATION RETRIEVAL NUMBER 162

Logic handbook

The fifth edition of the Digital Equipment Corp. guide to its complete line of logic modules, associated hardware and application information is now available. This 16-page, thoroughly illustrated paperback gives general characteristics of positive logic modules, complete with descriptions of power supplies, hardware and accessories and a discussion on how to use these items. Digital Equipment Corp.

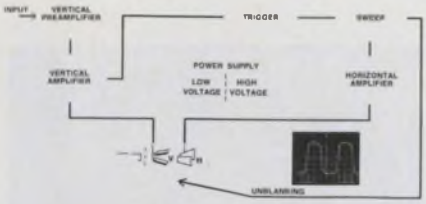
CIRCLE NO. 432



Hybrid design guide

The use of hybrid microcircuits for lightweight and compact packaging designs is the subject of a new 24-page brochure. This illustrated reference guide shows how hybrid technology can achieve design functions that are not possible through monolithic integrated circuitry. The 8-1/2- by 11-inch brochure provides a step-by-step explanation of hybrid manufacture. Featured in the brochure is a hybrid design guide that outlines layout procedures for the creation of special custom products. Fairchild Semiconductor.

CIRCLE NO. 433



Scope news

The oscilloscope is an excellent tool for self diagnosis. In addition to the CRT display, front-panel indicators and calibrator signals often provide sufficient information to isolate the problem. Besides presenting a concise technique for troubleshooting an oscilloscope, a 16-page issue of TEKscope tells of the ins and outs of curve tracing with the 576 digital readout unit. There is also a discussion of pnpn devices. Tektronix, Inc.

CIRCLE NO. 434

Magnetic shields

Helpful hints on magnetic shield design are contained in a 24-page application note. This article takes the witchcraft out of magnetic shield design and shows it to be a science that can be understood by engineers. Hundreds of actual measurements are contained in the booklet and—for the first time—actual measured shielding ratios are published. James Millen Manufacturing Co., Inc.

CIRCLE NO. 435

Frequency-domain method

Methods of performing calibrated frequency-domain measurements using narrowband and wideband signals are discussed in detail in a 12-page note. Methods of calibrating real-time spectrum analyzers are discussed using pure sinewaves and broadband noise to obtain power spectral-density plots. The calibration method described provides accurate, quantitative measurement of noise, vibration, and underwater acoustic signals that have been processed by a power spectral-density system. Federal Scientific Corp.

CIRCLE NO. 436

New Literature

Plastic parts

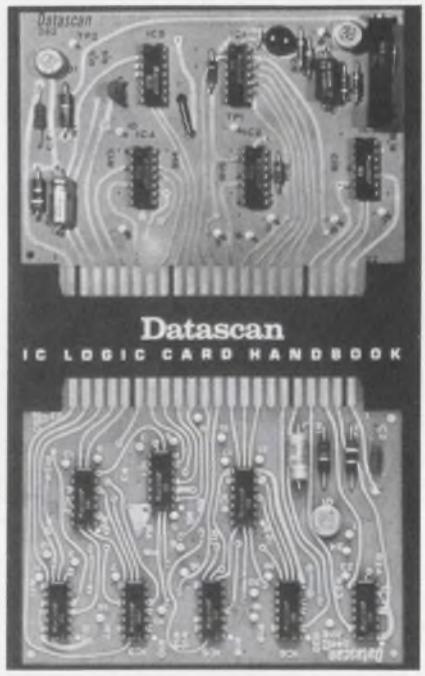
A 72-page illustrated catalog covers a complete line of plastic industrial parts including recessed bumpers, stem bumpers, bushings and bearings, nylon grommets, spacers and washers, wheels and rollers, plugs and caps, indicator lights, wire clamps and ties, etc. Nine sections featuring 36 distinct product lines and representing thousands of different components have listings and illustrations. A special section illustrates special parts made for specific industries that do not fit into general product lines. Additional information includes descriptions of plastic materials, design points for the engineering of industrial plastic parts and information on manufacturing methods. Plastiglide Manufacturing Corp.

CIRCLE NO. 437

Electron-beam equipment

A new catalog includes several data sheets on positioners and manipulators designed especially for use in vacuum chambers and glove boxes. It also shows electron guns and electron-beam power packages. Prices on most items are included. Brad Thompson Industries, Inc.

CIRCLE NO. 438



IC logic handbook

A new IC logic handbook features 208 pages with descriptions of each standard module, plus circuit operations, parts lists, specifications, outline drawings, and prices of each module. Power supplies, hardware and accessories are also presented in detail. Datascan.

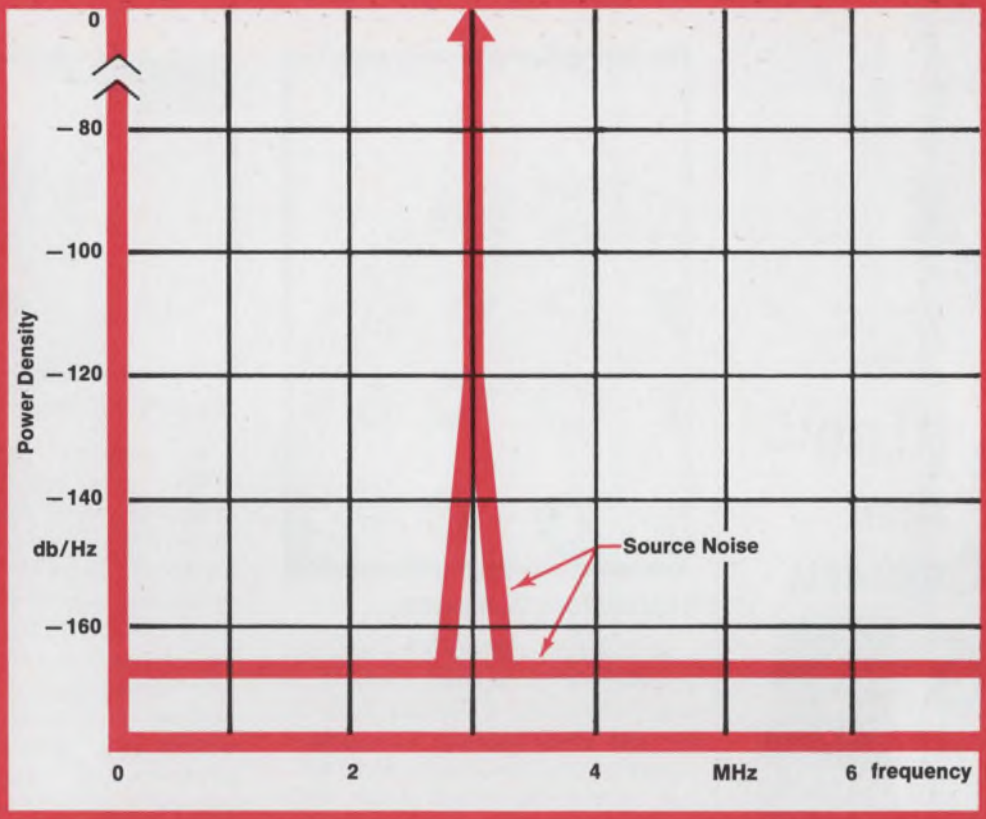
CIRCLE NO. 439

CCTV encyclopedia

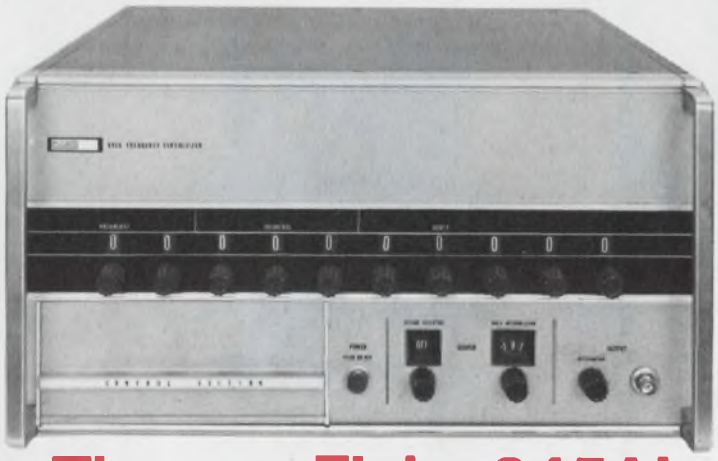
An encyclopedia of closed-circuit TV equipment features nearly 100 pages of CCTV products, helpful technical information, and prices. The catalog includes the latest in cameras, video tape recorders, lenses, and accessories. GBC Closed Circuit TV Corp.

CIRCLE NO. 440

Here's the RF spectrum of an "ideal" synthesizer



and the closest thing to it!



The new Fluke 645A!

The Fluke 645A features symmetrical search oscillator and built-in sweep-marker generator for filter and resonator testing. Automatic remote output leveling for systems applications. Twenty microsecond switching from remote decimal, or BCD program source. Modular design simplifies special configurations to meet your particular needs.

Key Specifications

FREQUENCY: DC to 50 MHz
INCREMENTS: 0.01 Hz
SPURIOUS CONTENT: <100 db
HARMONIC CONTENT: <30 db
NOISE FLOOR: <135 db/Hz at 5 KHz
CLOSE-IN NOISE: <100 db/Hz at 10 Hz offset
PRICE: $13,500.

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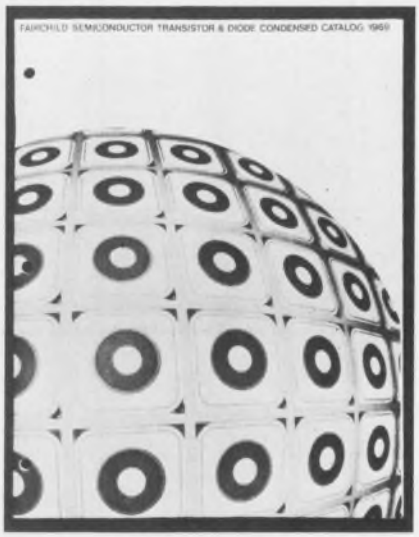


Transistors & diodes

A complete listing of Fairchild Semiconductor discrete devices is now offered in a 64-page transistor and diode catalog. The catalog presents key parameters and package outline dimensions, along with a numerical index that quickly locates the device of interest. Fairchild Semiconductor.

CIRCLE NO. 441

Miniature hardware

Here is a source for miniature taps, dies, screws, nuts, and washers that range in size down to 0000-160. All stock items are listed with prices, including dies, screw gauges, drills, and dowel pins. J. I. Morris Company.

CIRCLE NO. 442

Switch selector

A complete product selection guide lists lighted pushbutton switches, word indicators, fuse holders and circuit breakers as well as unlighted switch assemblies and audio and visual warning and display systems. The six-page guide makes possible a quick selection of the proper switch for a specific application. Included are general descriptions, characteristics, and product and application photographs. Master Specialties Co.

CIRCLE NO. 443

Coax and connectors

Covering miniature coaxial cables and connectors, an eight-page catalog also offers complete descriptions and specifications for miniature cable assemblies and delay lines. In addition, illustrations show how to cut and trim miniature coaxial cable, and other data describes miniature coaxial connectors and SMA miniature microwave connectors. Phelps Dodge Electronic Products Corp.

CIRCLE NO. 444

Time sharing

The use and application of a commercial time-sharing service are described in a new 12-page brochure. The service enables businessmen, engineers and analysts to share economically the full problem-solving capabilities of a central computer over telephone lines from a typewriter terminal in their office. On-line computer service makes computers as convenient and as easy to use as the telephone. General Electric Co.

CIRCLE NO. 445

Lockheed has been making multilayer circuits by the thousands. For years. With the most advanced laminating techniques.

You'll probably want from 3 to 6 layers, but we can make 15 or more layers if you need them. And we'll give you precision flatness—well above industry standards. With all layers perfectly registered. The quality of our lamination will equal or exceed the 2-sided boards you might now be using.

Another comfort. We can provide you with sophisticated multilayer circuits for little more than you're now paying for the standard 2-layer board.

Which means you can get the Lockheed Sandwich for very little bread.

Write for your "Designer's Guide to Multilayer": Printed Circuits, Lockheed Electronics Company, Data Products Division, 6201 East Randolph Street, Los Angeles, California 90022.

Presenting: The Lockheed Sandwich

LOCKHEED ELECTRONICS COMPANY
A Division of Lockheed Aircraft Corporation

INFORMATION RETRIEVAL NUMBER 169

NEW LITERATURE

Electromechanical parts

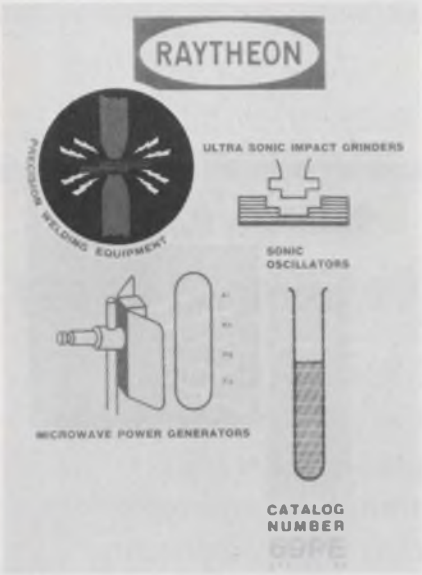
Showing more than 44,000 precision electromechanical components, a 576-page catalog has a 120-page technical section on gear-train design. Another feature is a uniquely arranged series of technical tables that puts at the designer's fingertips information ranging from strength of materials to metric equivalents. Ten product sections cover gears, differentials, speed reducers, clutches and brakes, drive components, shaft accessories, breadboard components, dials, counters, fasteners and electronic hardware. Sterling Instrument, Div. Designatronics, Inc.

CIRCLE NO. 446

Ceramic-metal packages

Ceramic-to-metal components and packages for electronic and mechanical applications are described in a 20-page booklet. These products combine the technologies of ceramics and metallurgy to provide components and assemblies that take advantage of the thermal dielectric and mechanical properties of beryllium oxide in combination with the conductivity and assembly characteristics of metals. Specific information is given on transistor headers for plastic encapsulated devices, hermetic headers and packages, and packages for diodes, logic elements, and other microelectronic circuits. National Beryllia Corp., Cermetrol Div.

CIRCLE NO. 447



Production equipment

Describing a line of production equipment, an illustrated 16-page catalog lists principal specifications and prices. Included are precision welding equipment, ultrasonic impact grinders, sonic oscillators and microwave power generators. Raytheon Co.

CIRCLE NO. 448

Relay catalog

Providing data on miniature solid-state opto-electronic and reed relays, a 28-page catalog also describes time-delay, time-interval and frequency-sensitive relays. All units utilize a miniaturized strengthened design, and are recommended for military and industrial applications. Solid State Electronics Corp.

CIRCLE NO. 449

NEW LITERATURE

Ferrite devices

Outlining a complete selection of coaxial and waveguide ferrite devices for airborne, shipboard and ground-based radar and communication systems, a 12-page catalog covers devices ranging in frequency from uhf to Ka band, handling up to 20 mW of rf power and operating over broad temperature ranges. Included are complete electrical and mechanical specifications and outline drawings representing subminiature circulators, uhf circulators, uhf miniature circulators and gyrators. Microwave Associates.

CIRCLE NO. 450

Relay handbook

Doubling as a useful engineering design handbook, a four-color 36-page catalog covers a broad line of power, rf and signal relays available in over 40 basic design types. The publication contains photographs, line drawings, oscillographs, electrical characteristics and mechanical specifications for all configurations. Besides contact code data for determining size, material and resistive rating, the catalog has a relay parameter selection guide that completes the information necessary for finding the right relay for any given circuit application. Oak Electro/Netics Corp.

CIRCLE NO. 451

Hafnium brochure

An eight-page brochure on hafnium discusses the physical and mechanical properties of hafnium and hafnium-base alloys. The purpose of the brochure is to show that hafnium is available in reasonable supply and on a continuous basis, and to point out to design engineers in many fields where research and development have indicated exciting possibilities for the application of hafnium. Amax Specialty Metals, Inc.

CIRCLE NO. 452

Battery sockets

Thirty-nine representative laminated battery sockets and connectors are depicted by dimensional drawings in an eight-page technical bulletin. Bulletin 39B illustrates an extensive line of sockets for commercial and military applications. Contacts and insulations to meet MIL standards are available. Connector Corp.

CIRCLE NO. 453

Springs and strips

A newly revised 24-page precision spring catalog contains complete up-to-date information on beryllium-copper flat and compression coil springs, as well as standard finger-contact strips, rings and rfi/emi-shielding hardware. Characteristics of beryllium-copper alloys used for springs are discussed along with design suggestions. Intrument Specialties Co., Inc.

CIRCLE NO. 454

Microwave instruments

A new 16-page catalog describes a line of microwave oscillators, phase-lock synchronizers, and radar test equipment. Over 100 different models are described, first by major series characteristics, and then by detailed model specifications. Prices are included on the back cover. Sage Laboratories, Inc., Instrument Div.

CIRCLE NO. 455

NEW LITERATURE

Power systems

A new five-section, 40-page technical catalog covers an extensive line of battery chargers, inverters and converters, dc supplies, ringing and tone supplies and power systems for the communications industry. It presents detailed information on special features, applications, and electrical and mechanical specifications. Electronetics Div., North Electric Co.

CIRCLE NO. 456

Power supplies

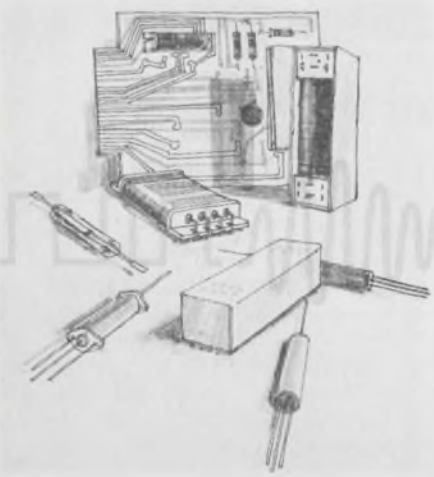
A 1969 catalog lists over 82,000 ac-to-dc all-silicon plug-in power supplies. Any of these power supplies are guaranteed to be shipped within three days after receipt of order. The 24-page catalog describes and gives prices of regulated single and dual supplies, unregulated supplies, and high-isolation units for strain-gauge applications. Also included is a guide to power-supply selection. Acopian Corp.

CIRCLE NO. 457

Fluidics manual

A new manual offers full information on a complete line of fluidic switches as well as details on their varied applications. The manual offers designers, engineers and builders complete details on the advantages of fluidics—simplicity, reliability, small size and low cost. Complete specifications are also given on switch designations, minimum actuation pressure, maximum continuing pressure, bellows diameter and switch standards. Gagne Associates, Inc.

CIRCLE NO. 458



Reed relays

Covering over 160 relays, a 24-page catalog contains detailed information on life and reliability characteristics. The catalog lists detailed electrical, mechanical and environmental specifications, dimensional drawings, photographs, applications and ordering information. Wheelock Signals, Inc.

CIRCLE NO. 459

HV rectifiers

A 20-page bulletin discusses direct plug-in replacement of high-voltage high-current rectifier tubes with stackable rectifier modules. Direct-replacement information on over 120 rectifier tubes is given including maximum tube ratings and recommended module-type replacement. Unitrode Corp.

CIRCLE NO. 460

Power supplies

A 32-page power-supply catalog supplement announces several new products. Described are a new line of militarized integrated-circuit power modules for airborne, shipyard and vehicular requirements; three new power-supply assembly systems accommodating up to 16 multiple dc outputs; and a new line of high-efficiency high-current rack-size power instruments. Also included is a new family of commercial, industrial and military transformers. Lambda Electronics Corp.

CIRCLE NO. 461

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.

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NEW 68-PAGE DRAFTING CATALOG – FREE

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Miniature Self-clinching fasteners

PEM miniature self-clinching fasteners are made for permanent mounting on thin panels. Dimensioned to fit into minimum space, they provide strong, self-locking threads equal to MIL-N-25027C. Available in four types for panel thickness as thin as .020", they are always flush with one surface when squeezed into pre-punched or drilled holes. They are offered in thread sizes from #0-80 to ¼-20 in 303 stainless steel for optimum hardness to imbed into most panel materials coupled with good ductility for smooth, non-galling self-locking characteristics.

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Manufacturers

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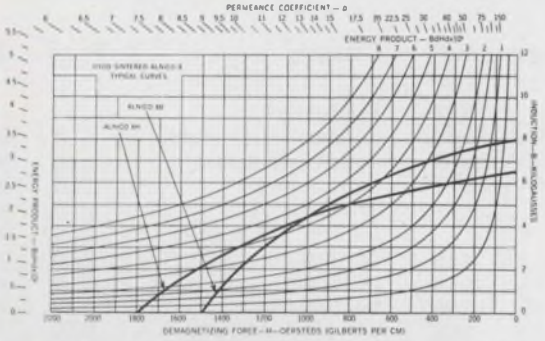

You might be able to get sintered alnico 8 somewhere else —but not like this. Our HyCo 8 has the greatest coercive force of all sintered alnicos. Typically, 1500 oersted for HyCo 8B, and 1800 oersted for 8H.

Sintered alnico 8 is well suited for miniaturized applications requiring a high coercive force. Typical uses include motors, TWTs, polarized relays, reed switches, pick-up cartridges, core meters, and holding and torque transmitting devices. And sintered has it all over cast alnicos when it comes to smoother surfaces, closer tolerances, physical strength, and flexibility of shapes.

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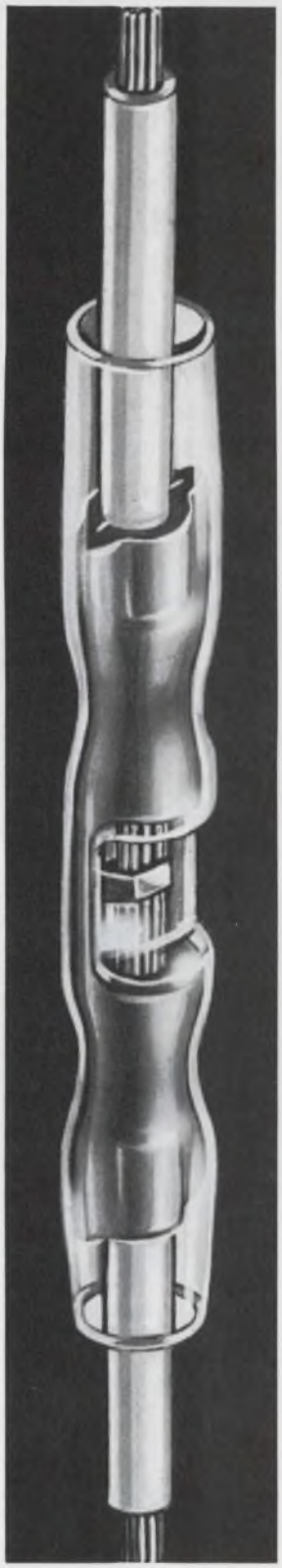

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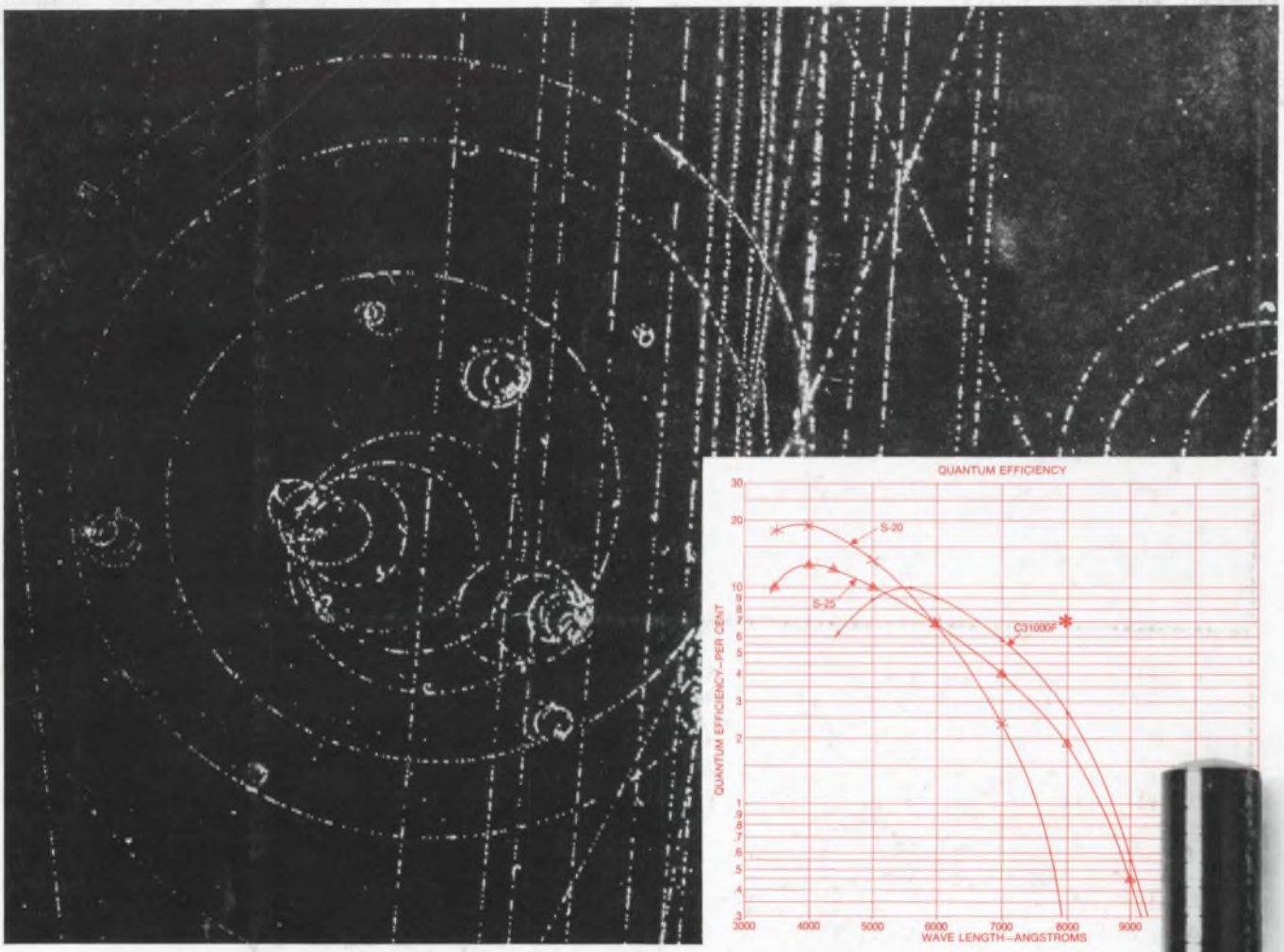

NEW! EXTENDED RED RESPONSE RCA-C31000F QUANTACON PHOTOMULTIPLIER

The C31000F is new! It's an extended-red, multi-alkali cathode version of the previously-announced C31000D. C31000F is recommended for applications in the red area of the spectrum, particularly laser detection and Raman spectroscopy. The latest addition to the RCA QUANTACON photomultiplier family, it is characterized by the use of Gallium Phosphide as the secondary emitting material on the first dynode.

Gallium Phosphide boosts the single electron resolution of this newest RCA QUANTACON photomultiplier as much as 10 times over that of tubes using conventional dynode materials. As a result, it is possible for this 2" dia. light detector, whose prototype is the industry-famous 8575, to discriminate between light-producing phenomena that generate one, two, three, or four photoelectrons.

Developed by RCA, the use of Gallium Phosphide places the C31000F and other RCA QUANTACON photomultipliers at the forefront of devices that can reveal nuclear, astronomical, and biochemical events never seen before.

For more information on this 12-stage device, and other RCA QUANTACON photomultipliers, including the C31000D and the 5-inch C70133B, see your local RCA Representative. For technical data on specific types, write: RCA Electronic Components, Commercial Engineering, Section E18P-1, Harrison, N. J. 07029.

* Minimum Q.E. at 8500 Å is 1%, corresponding to a radiant sensitivity of 7 mA/W. C31000E is the flat-faceplate version of the C31000F which has a curved faceplate.

RCA