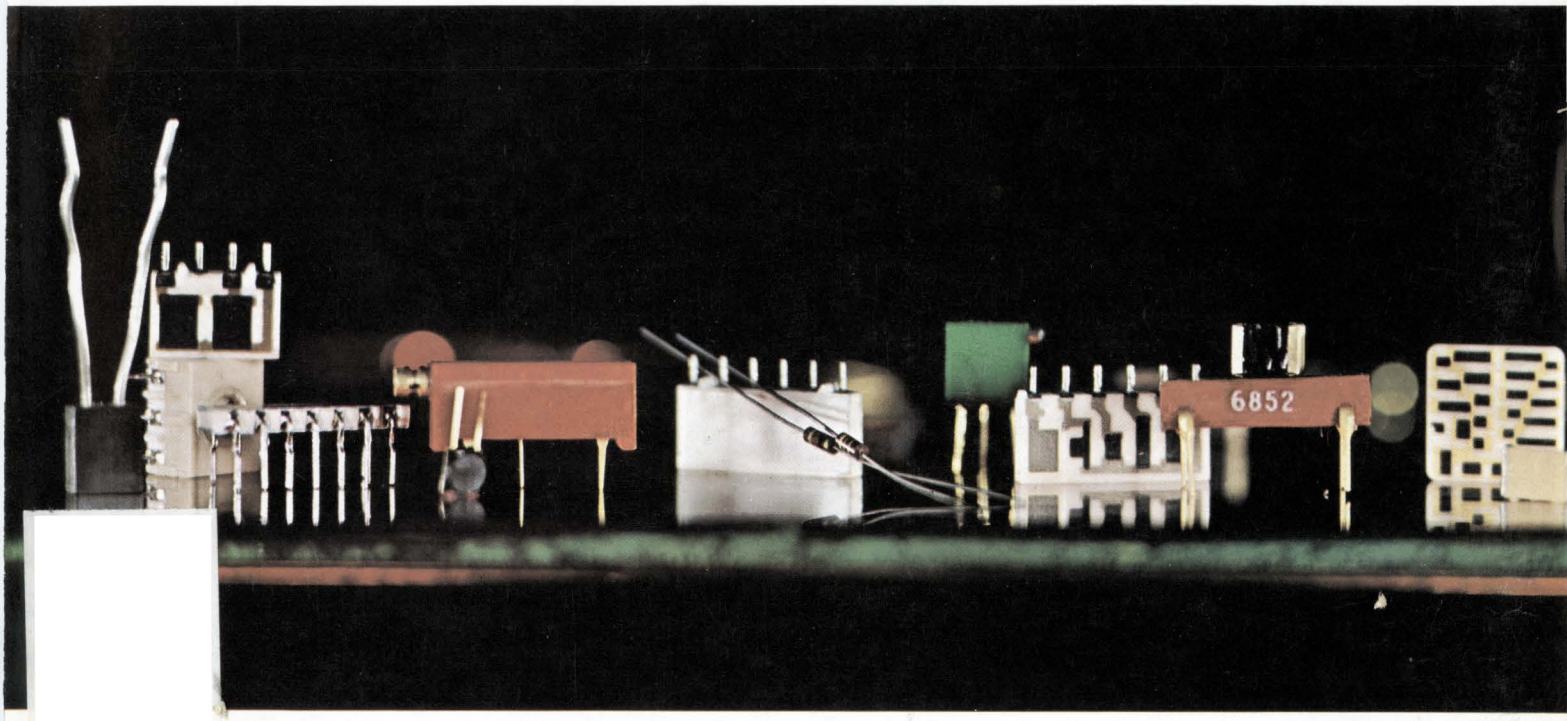
VOL. 28 NO. 3
MARCH 1969

THE ELECTRONIC ENGINEER



We furnish the building blocks... you design your system. You can go from a single generator to a complex system simply by connecting the building blocks.

The new HP 1900 pulse system is a new generation of plug-in pulse generators—a new all-around bench instrument that solves both high and low voltage rise and fall problems. It is especially suitable for testing magnetic memory devices where high current output is required, or testing MOS logic devices requiring high voltages.

The HP 1900 now provides 50 V, 1 amp pulses into 50 Ω up to 100% duty cycle, variable rise and fall times from 7 ns to 1 ms, 25 Hz to 25 MHz rate, delay from 15 ns to 10 ms—all for a total price of $2750. For 2 to 16-bit word format, add the 50 MHz HP 1925A Word Generator. You can use this plug-in to create pseudo-random noise or get a word or its complement in return-to-zero or non-return-to-zero modes. An option makes the 1900 system electronically programmable.

And the new 1900A system is no paper tiger! All its specifications are *working* specs — if anything, conservative.

Plug-in design of the 1900A system allows you to select the best performance combination for your requirements — and modify later to meet your changing needs. Soon-to-come are new modules providing sub-nanosecond rise and fall times, lower power output stages at much lower prices — and more exotic modules with excitingly new state-of-the-art specifications.

Start designing your pulse generator system today with the *expandable* HP 1900A system. Call your nearest HP field engineer for complete specifications. Or, write to Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland.

Circle 1 on Inquiry Card

It's expandable—the new HP 1900 pulse system for clean, controllable, high-power pulses!

089/1

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SIGNAL SOURCES

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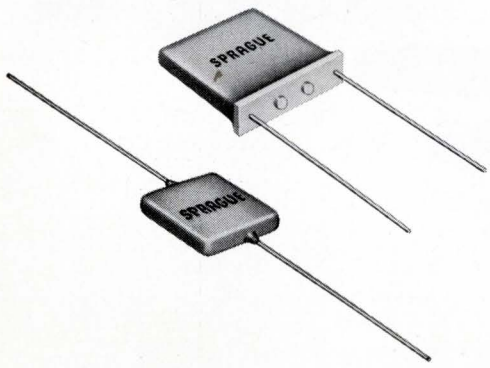
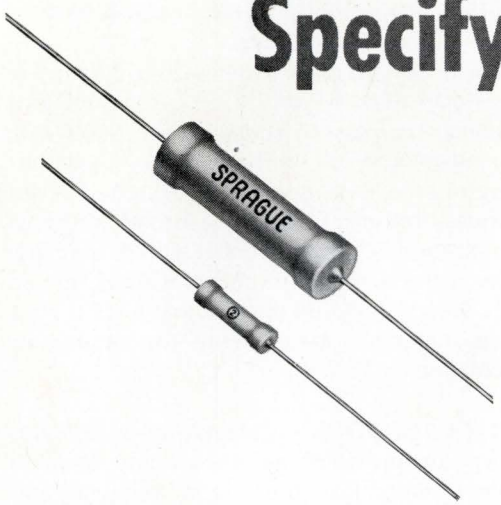


Made with alternate layers of sprayed ceramic dielectric material and screened metallic electrodes, fired into a solid homogeneous block. Coated with tough phenolic resin. Available in four formulations—082(N030), 075(N750), 067(W5R), 023(Z5U). Your choice of axial-lead or improved radial-lead construction. Radial-lead capacitors have new bossed terminal base which prevents resin run-down on leads, maintains uniform lead spacing, eliminates dirt and moisture entrapment around leads, permits degreasing fluid to flow freely between capacitor and board.

4SC-9105

...need a reliable wirewound resistor?

Specify ACRASIL® PRECISION/POWER RESISTORS



Excellent stability and reliability, even under extended load life, extremely high humidity, and other adverse operating conditions. Expansion coefficient of silicone coating is closely matched to that of ceramic base to insure against damage to resistance winding. Coating provides exceptional protection against moisture, shock, vibration, fungus. Available with standard and non-inductive windings. Resistance tolerances as close as ±0.05%.

4SR-8118

For engineering bulletins on Monolythic® Capacitors or Acrasil® Resistors, or both—write to: Technical Literature Service, Sprague Electric Company, 233 Marshall St., North Adams, Mass. 01247.

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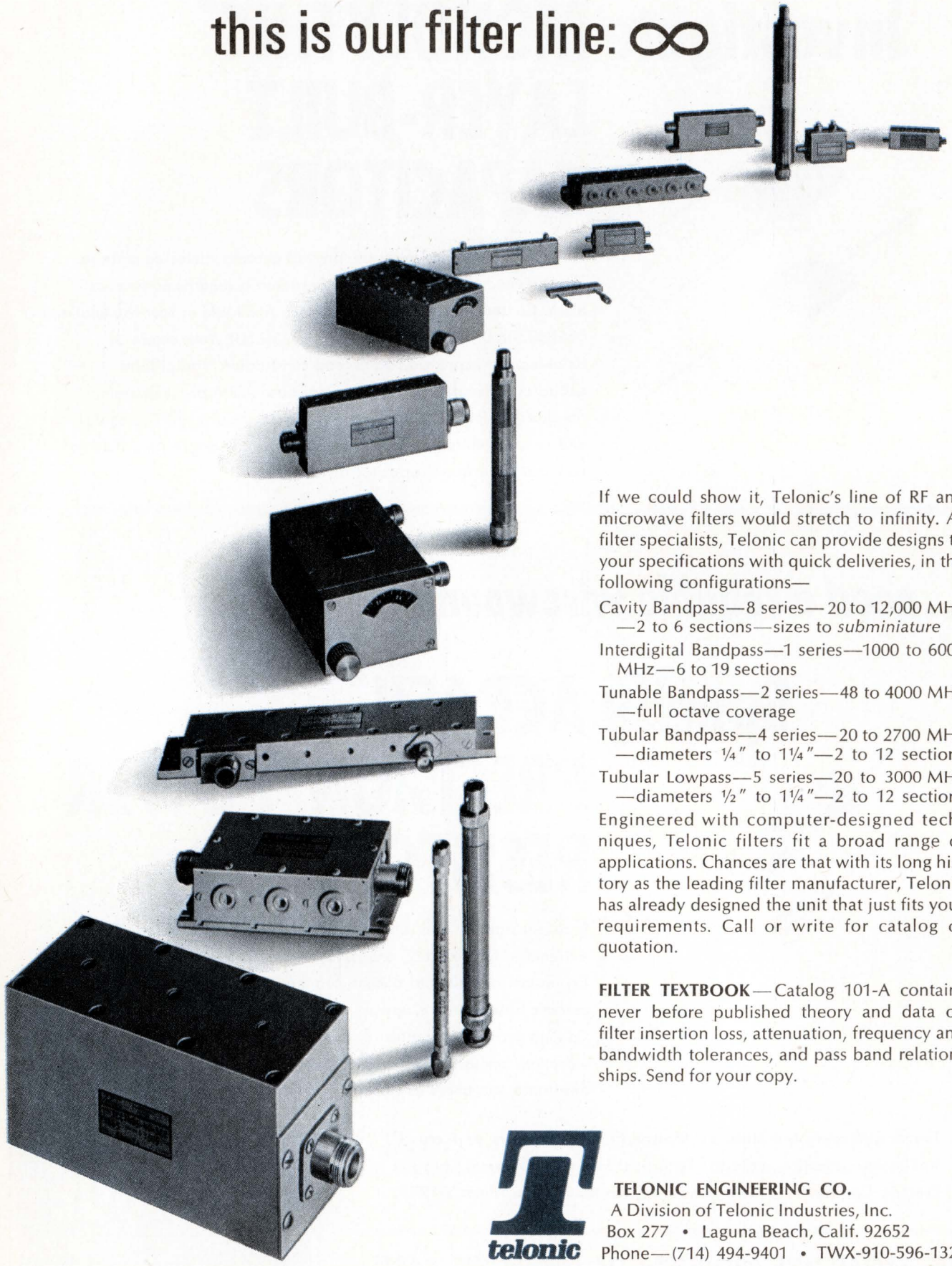
***THE* BROAD-LINE PRODUCER OF ELECTRONIC PARTS**

this is our filter line: ∞



If we could show it, Telonic's line of RF and microwave filters would stretch to infinity. As filter specialists, Telonic can provide designs to your specifications with quick deliveries, in the following configurations—

Cavity Bandpass—8 series—20 to 12,000 MHz —2 to 6 sections—sizes to *subminiature*

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Tubular Bandpass—4 series—20 to 2700 MHz —diameters ¼" to 1¼"—2 to 12 sections

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Engineered with computer-designed techniques, Telonic filters fit a broad range of applications. Chances are that with its long history as the leading filter manufacturer, Telonic has already designed the unit that just fits your requirements. Call or write for catalog or quotation.

FILTER TEXTBOOK—Catalog 101-A contains never before published theory and data on filter insertion loss, attenuation, frequency and bandwidth tolerances, and pass band relationships. Send for your copy.

telonic

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EE

The Electronic Engineer

March 1969 Vol. 28 No. 3

COVER
Some people believe that components will pass into oblivion with the increased use of integrated circuits. This is not likely to occur because today's components are changing to meet new needs associated with ICs. Our cover shows products from CTS, IRC, Delevan, Nytronics, JFD, and Amphenol which typify the new breed of components available. See page 73 for more details.

The Electronic Engineer

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(right...today and tomorrow)

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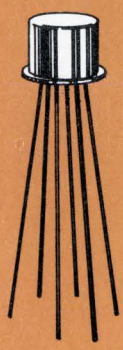
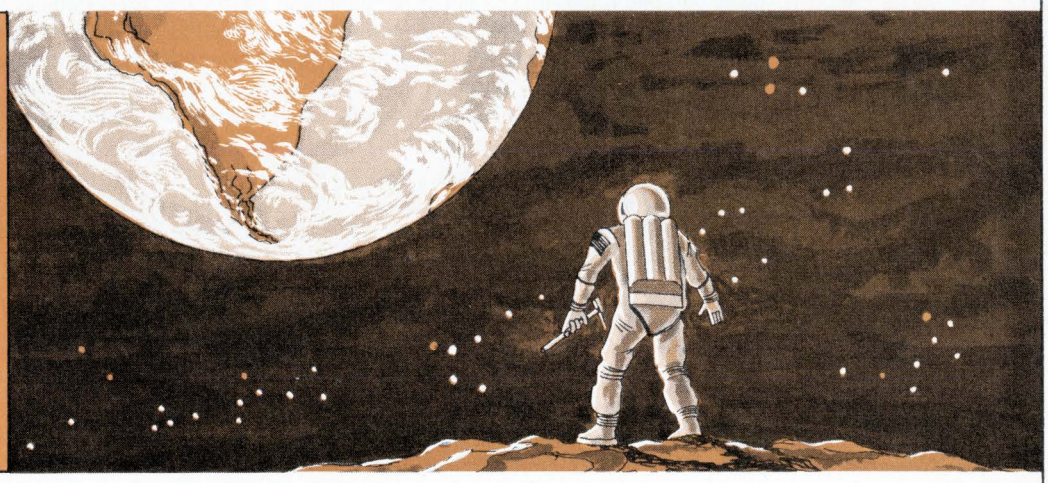


TO-5 Relay



Teledyne's reputation for quality demands adherence to the right specifications, the right delivery schedule, the right experience and facilities and the right Q.C. system to eliminate human error.

Right you are, that Teledyne, the originator and world's most experienced producer of quality TO-5 Relays, can meet the needs and standards of tomorrow's designs.

The price is right.

Send for further information and complete catalog.

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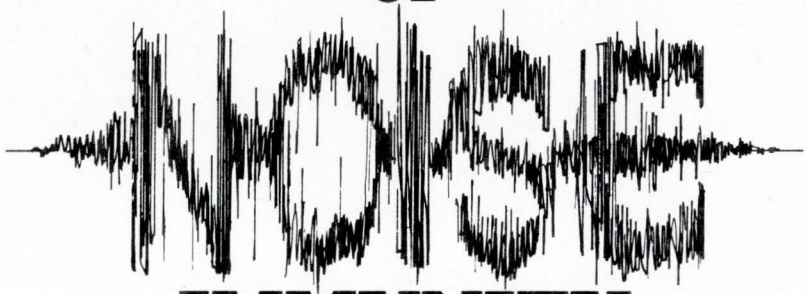

IMMUNITY

~~$2.90~~ $1.85 per quad gate

Now you can have High Noise Immunity Logic (HNIL) with no penalty in cost! In fact, considering all the fringe benefits like throwing out the low voltage supply, direct lamp and relay drive, elimination of interfacing circuitry, etc., you're bound to save money. If you're already using HNIL, just lower the prices. If you're new to HNIL, compare the following functions and prices:

301	Dual 5 Buffer	2.05	312	Dual JK	4.80
302	Quad 2 'Or'able Buffer	2.25	370	Quad D Flip Flop	4.80
321	Quad 2 Gate	1.85	303	Quad Input Interface	2.25
325	Dual 2, Dual 3 Gate	1.85	371	Decade Counter }	available
342	Dual One-Shot	4.80	380	BCD Decoder }	March
323	Quad 2 'Or'able Gate	1.85	+	8 more	

The prices are further enhanced by a complete logic family with 16 pin packaging. For example, instead of a Quad two we offer a Quad two with expanders on two of the gates, or a Dual 3 Dual 2, etc. We also have a complete applications report covering not only the logic, but the entire noise problem. We're not so naive that we believe noise immunity ends with volts, so we've given it complete coverage in terms of power. So if you want to learn about noise and forget about it at the same time, design with 300 Series HNIL and ask for our new 300 Series Application Note.

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EE EDITORIAL

Are you still waiting for all the facts?

During the von Neumann Lectures at the IEEE Winter Convention on Aerospace and Electronics Systems, Dr. James C. Fletcher, president of the University of Utah, indicated that knowledge is doubling every 12 years, and expressed the fear that if the time constant gets much shorter, whatever a college student learns will be obsolete by the time he graduates. Therefore, more time will have to be spent in acquiring knowledge, leaving less time for applying that knowledge.

The president of Harvey Mudd College, Dr. Joseph B. Platt, delineated the three methods that have been used efficiently since the renaissance for applying available information. These methods are: educating more people, teaching them longer, and having them specialize. All three will be mathematically exhausted by the year 2000, if knowledge keeps doubling at the present rate.

First, we can *educate more people.* The percentage of college-age population who attend college has risen from 4% in 1900 to 43% today. But, even if everyone could attend college, this percentage can only double once more.

Second, we *teach people longer.* Some people are now being educated for over 20 years. Still more take courses long after graduation. How much more of a person's life can be devoted to formal schooling?

Third, we assign each person only partial responsibility; i.e., we ask him to *specialize.* Back in 1776, in his book "The wealth of nations," Adam Smith called specialization as the key to productivity. When the supply of a particular specialist becomes either exhausted or overpriced, engineers devise machines to keep productivity accelerating. This has happened before with telephone operators, and is happening in data processing now. There simply are not enough people to do it all.

Relating these problems to management, John R. Moore, vice president of North American Rockwell Corp., thinks that the hallmark of this age is increasing complexity, a complexity that forces us to make decisions based on less than full knowledge of facts. In this environment of rapid progress and cascading information generation, one who always waits for complete information before acting will soon be hopelessly far behind.

Certainly more and more engineering talent will be spent in devising machines that will distill and impart information efficiently. As a technical magazine in the vital electronics field, we are in the vortex of this mass of information. Our job is to analyze this information and present it in perspective so that it serves you, instead of drawing you into the whirlpool.

Stephen A. Thompson
Western Editor

To those of our readers who volunteered to help the doctor

We are sending your name, with a list of your skills and availability, to the New York Academy of Medicine, which has expressed a great interest in your response. The Academy will make your name available to its members, who will contact you directly on a personal basis.

In case you are wondering what this note is about, look for a November 1968 issue of The Electronic Engineer and read the article "Is there an EE in the house,?" by Roger Kenneth Field, which appears on pages 50-56 of that issue.

Closing the isolation gap

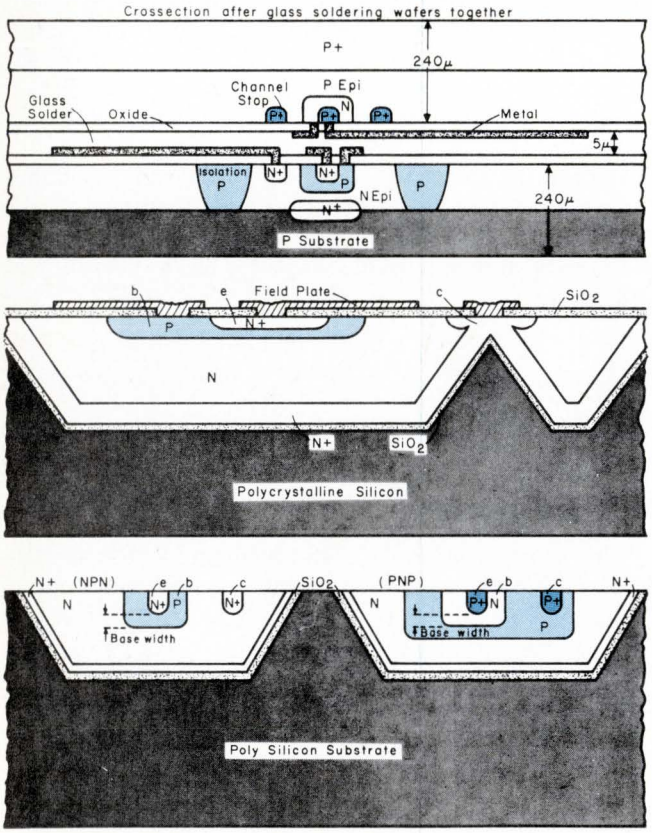
The growing demand for radiation-hardened semiconductors and high-performance linear ICs for consumer applications is spurring activity in the premium isolation technology. Radiation Inc., Microelectronics Division, has a modest, but profitable specialty in dielectric isolation. (**The Electronic Engineer,** Aug. 1968, p. 12). Signetics has just announced an updated version of dielectric isolation, and Fairchild's R&D Labs have come up with a novel means of processing high-quality monolithics. These are measures designed to obtain (compared to conventional junction-isolated ICs) higher resistance to radiation bombardment; higher breakdown voltages and cutoff frequencies; and equal, high-quality npn and pnp elements.

Dishing it out

Signetics mainly wants to increase the high-voltage capability in linears (**The Electronic Engineer,** Sept. 1968, p. 14). Reducing contamination during oxide growth and adding a field plate to neutralize troublesome surface-charge effects shifts voltage problems away from the surface. Breakdown is forced to occur in the bulk material, where higher voltages can be accommodated. The company uses an anisotropic etch—instead of Radiation's splash etch—to facilitate deep device structures in high-resistivity material. Signetics also uses FET current sources and thin-film resistors in its new linear ICs.

The Signetics networks have breakdown limits ranging from 275 to 350 V. Among these circuits are a video amplifier, an op amp gain block, and a line-operated voltage regulator. Also headed for market—probably by mid-1969—are monolithic CRT deflection stages, line drivers, and line-operable audio amplifiers.

In contrast, Radiation's dielectrically-isolated linears, constructed with its established, less-exotic process, have breakdowns of about 200 V. "We welcome the addition of a respectable firm like Signetics to the active dielectric isolation ranks," says a spokesman for Radiation. "They will help stimulate the field, which has moved too slowly because of the lack of alternate suppliers, and there's plenty of business to go around."



Etchings. The industry "norm" (almost viable alternative to standard pn-junction isolation) is Radiation Inc.'s dielectric isolation (left). Modified form is newcomer from Signetics (center) that uses anisotropic etch instead of splash etch for sharp depth control. Both techniques yield a number of electrical advantages, among which are higher breakdown voltages and high, equal-quality npn and pnp transistor elements. Fairchild's npn-pnp "wafer sandwich" (top) is a lab development aimed at co-producing equal, high-quality complementary transistor elements in ICs.

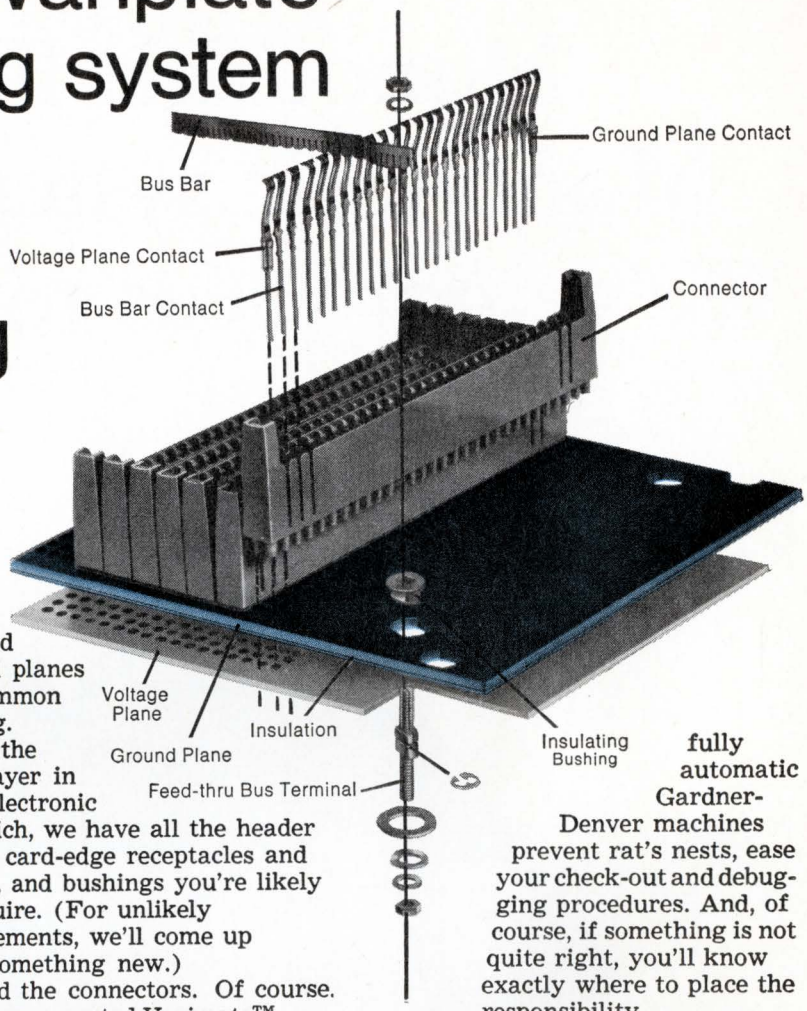
Squeeze play

In Fairchild's case, equal quality elements are obtained by a "sandwich" processing technique. Initially, the npns and pnps are fabricated on separate, matching wafers. The two wafers are then glass soldered together, face to face. Bumps on the pnp are fitted into pockets in the npn to achieve perfect alignment. Then the pnp portion is backlapped and mesa isolated. Finally, the wafers are oxidized, masked, metallized, and interconnected.

David Oberlin, research engineer at Fairchild's R&D Labs in Palo Alto, says the technique will be applied to get high-voltage, high-frequency, and radiation-hard ICs. He cites such pnp characteristics as leakage of 15 nA breakdowns of 65 V, current gains of 300 at 100 μA, and cutoff frequencies of 175 MHz.

In contrast, the lateral pnp elements in pn-junction isolated ICs have gains of unity and cutoffs of about 1 MHz. In radiation's ICs the pnp elements have current gains of 50 to 150 and cutoff frequencies of 200 to 300 MHz. Breakdown is typically 40 V and I_{CBO} is 1 nA.

How our Variplate™ connecting system keeps your fifty-cent IC's from becoming four-dollar headaches.



IC's don't cost much. Until you use them. You can buy, say 20,000 IC's for the innards of a compact computer, packed in the transistor cans, flat packs, or Dual-in-Line (DIP) packages, for a unit cost of less than fifty cents.

Great.

But then you have to connect them.

Not so great.

Because those 20,000 IC's have anywhere from 200,000 to 280,000 leads waiting to be connected. Fine leads. Closely spaced. And, of course, you want to pack the IC's as densely as possible. So it's really no surprise that your *in-place* cost of an IC can climb to $4.00.

Fortunately, we have a system that can keep your in-place cost down: the Variplate interconnection system.

With the Variplate system, you can pack those IC's—and all the pc boards and other components you have—as densely as the application demands. You can do it on automated equipment—and we'll even do the wiring for you.

All the components you need.

The system begins with the base plate, a self-supporting structural member. It carries the insulated contact modules, accommodates secondary components and hardware, and provides for mounting to support framework.

The plate can be a single metal sheet that provides a ground plane, or it can be a sandwich that provides both voltage and ground planes for common bussing.

For the next layer in your electronic sandwich, we have all the header plates, card-edge receptacles and guides, and bushings you're likely to require. (For unlikely requirements, we'll come up with something new.)

And the connectors. Of course. Our own respected Varimate™, Varicon™, and Varilok™ connectors, or standard fork-and-blade, terminal stud, card-edge, or bus strip contacts. Your choice.

No holes barred.

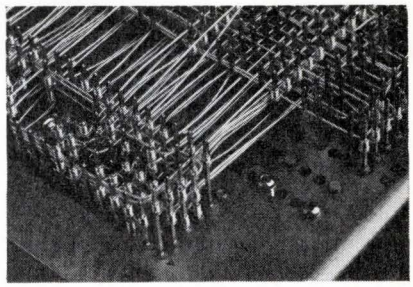
We put all these components together in any size, any shape, and almost any density of package you require. Plates can be any size. Contacts can be spaced on .100″, .125″, .150″, or .200″ centers, in square or offset grids—on non-standard configurations where you need them.

What you get is a solid electrical and mechanical foundation for your electronic network, so precisely made that any automated assembly equipment can take over from there.

However.

You'll save time and money if you let us go one step further and wire your network for you. Our fully automatic Gardner-Denver machines prevent rat's nests, ease your check-out and debugging procedures. And, of course, if something is not quite right, you'll know exactly where to place the responsibility.

Altogether, it's quite a system. And worth all the work we've put into it. Because if we can save you just a nickel on the cost of installing each of your 20,000 IC's you can add a thousand dollars to



your company's profits.

We're sure we can save you that nickel, and more. For more information, write, wire, call, or TWX us for our Variplate interconnecting systems catalog. Elco Corporation, 155 Commerce Drive, Fort Washington, Pa. 19034. 215-646-7420; TWX 510-661-0

ELCO Variplate Connectors

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Monolithic logic today.
Monolithic systems tomorrow.
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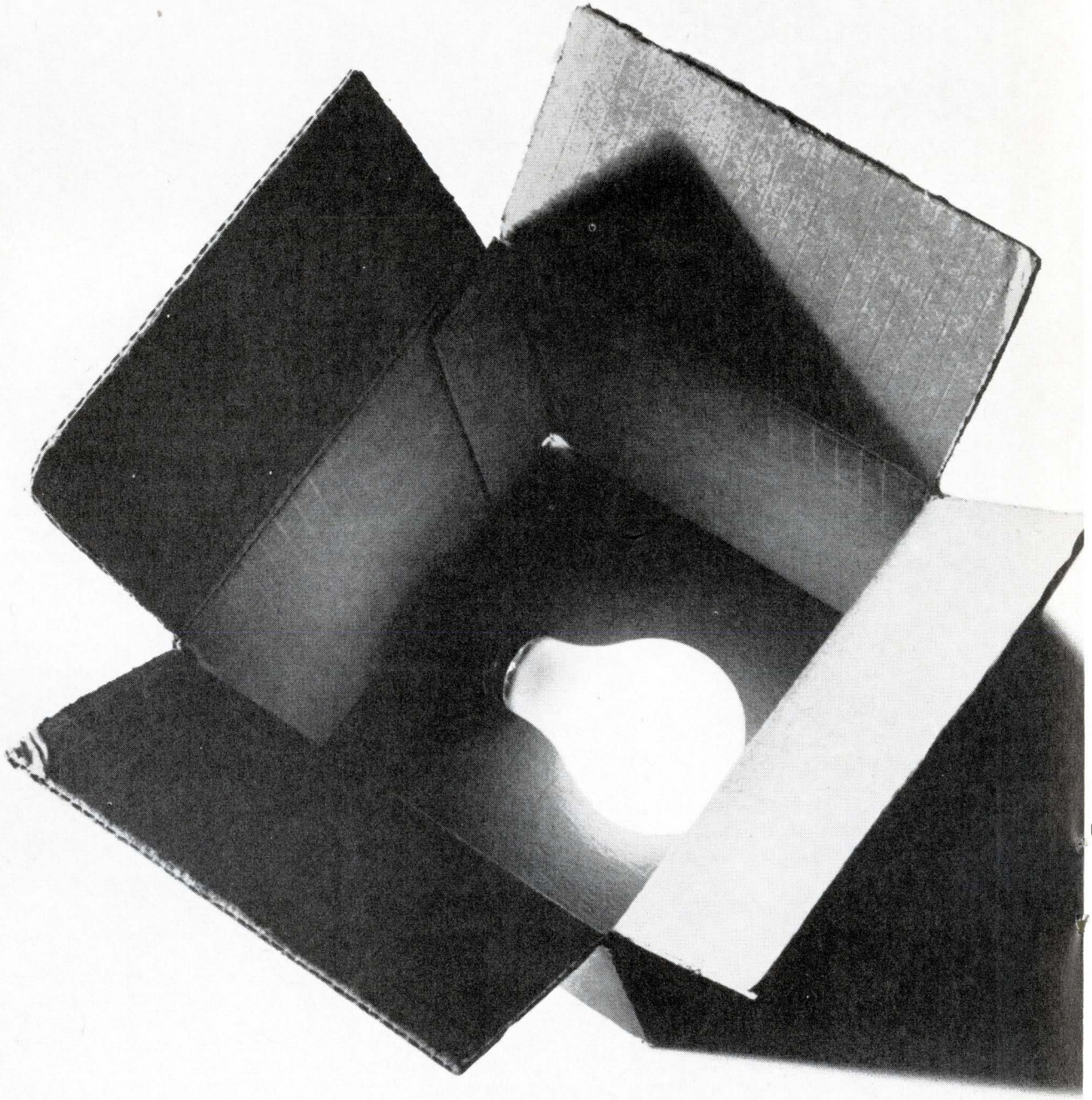


Many wafers ago Raytheon drafted a blueprint for success in the semiconductor industry. It's drawn around some very sharp idea men to nudge the state-of-the-art ever forward. Plus a production line that can turn ideas into products and pour them out en masse and on time. Here's a roll call of results, delivered and on the way.

Products for now

DTL: Over 95 circuits in Series 200, 930 and 1000.
TTL: More than 100 circuits in our industry's-fastest Ray III, and our SUHL-equivalent Ray I and II.

MSI: We're booming in TTL types, with 18 production circuits based on Ray I and II, 54/74 and 64/84 logic. And more coming fast.

Linears: Industry's broadest line of popular types. 17 circuits, including standard and 'A' versions of 100, 4100, 700 and 4700 Series.

Transistors: More than 400 standard and high-rel mil types. Switches, drivers, choppers. And amplifiers—general purpose, low level, high frequency, differential, dual and Darlington.

Diodes: 1800 types of switching and general purpose diodes, ranging from IN91 to IN4308, at speeds down to 1.0 nanoseconds.

And ideas for tomorrow

But the best is yet to come. Here's what's cooking for delivery within one year. Beam lead, of course. Plus 2-layer metal interconnects. 64-bit random access memories. 256-bit read-only memories. Multi-chip memory arrays. Very high speed logic. High speed NPN and PNP single and quad core drivers. Monolithic diode arrays. RF transistors.

And we've got even brighter things docketed for a little more distant delivery. Advanced packages—up to 78 leads, using beam lead and multi-layer substrates. Bipolar and MOS LSI. Computer-controlled LSI design. Radiation hardened circuitry. Low power ECL MSI.

Just promises? Not so. We're working on everything on that list, logging day-by-day progress toward production. So keep your eye on us. Because we intend to be getting the ideas—and delivering them—for a long time to come.

Browse through one of our detailed, just-completed catalogs. Yours for the asking. Raytheon Semiconductor, Mountain View, California, (415) 968-9211.

RAYTHEON

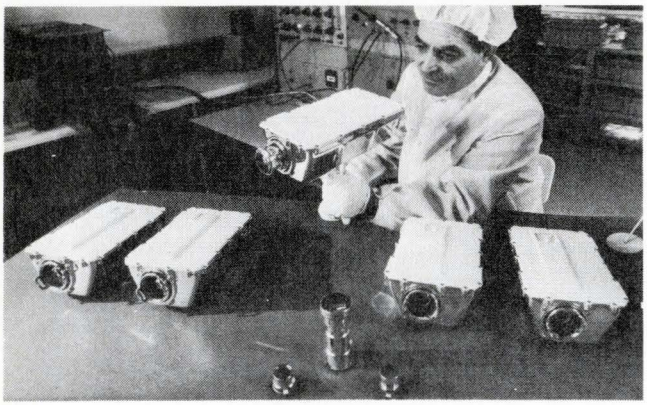
Circle 10 on Inquiry Card

Cat's eye TV sees in moon darkness

When the Apollo 9 astronauts take a space walk and later crews land on the moon, they will have a portable TV camera with them. This camera can produce pictures, even in lunar darkness. Developed by Westinghouse Defense and Space Center, it can produce good pictures at night, here on earth, when we have only a half-moon producing light.

Operating with a secondary electron conduction (SEC) imaging tube, light level can range from 0.007 to 12,000 foot-lamberts for pictures. The "see in the dark" camera will require the astronauts to make only two changes—a lens change (four available) and a scan mode (normal or high resolution) selection. A normal frame scan is 10 fps; a high resolution scan is 0.625 fps.

Ten frames of scan will provide acceptable motion rendition without breakup at the slow speeds at which the astronauts will move. This scan rate can be easily converted to 60 fps for viewing on home TV receivers. A 320-line scan was chosen to obtain nearly equal vertical and horizontal resolution. The 10 fps mode will provide about 250 discernible lines on a home TV set, good enough for viewing.



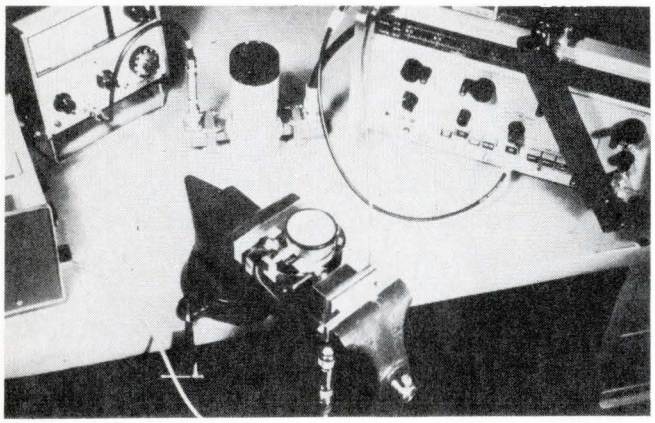
Eighty percent of the camera is made with integrated circuits, and the low power unit is equipped with two handles—one with a 9-ft. cord for cabin use, and the other with a 100-ft cord for use on the moon's surface. The price to NASA is $7.7 million for 17 cameras.

Camera parameters

Power	6.5 W, 24 to 32 Vdc input
Weight	7.25 lb
Video bandwidth	2 Hz to 500kHz
Scene illumination	0.007 to 12,000 ft-lamberts
Automatic control range	1000 : 1
Scan parameters	10 frames/s 320 lines/frame ⅝ frames/s 1280 lines/frame
Aspect ratio	4 : 3
Resolution	500 TV lines
Operating temperature	0° to +130°F
Temperature extremes	−300° to 250°F
Linearity	2%

Laminates can be tested at X-band

The 3M Company has been making copper-clad glass-cloth PTFE laminates for X-band (8 to 12.40 GHz) applications. But they have had some problems—how to test for quality control, and how to certify the material's parameters.



X-band stripline test. Vise applies a constant clamping force to the test fixture, which is a critical factor in obtaining reproducible results. For accuracy, a force gage is used.

A good method was needed for testing the relative dielectric constant (permittivity) and loss tangent (dissipation factor) of laminates at X-band. Most laminates are only tested at 1 MHz.

After spending several months in the lab, 3M researchers have come up with an easy, repeatable test setup. Called resonant transmission cavity X-band test method, it measures 1/32-in. and 1/16-in. laminates, and can be adapted to other substrates. Measurements are made under actual stripline conditions, with a resonant strip circuit separated from the ground plane by sheets of the material under test. One of the keys to this test is the test fixture, which can be made in any lab.

For a copy of the test method, write to Dept. Di8-34, 3 M Company, 3 M center, St. Paul, Minn. 55101, or

Circle 277 on Inquiry Card

Electronized Chemicals Company, South Bedford Street, Burlington, Mass. 01803 also has a test procedure which they will send to anyone contacting them. Direct your requests to W. L. Kierstead, or

Circle 278 on Inquiry Card

Circle 11 on Inquiry Card ⟶

SSPI announces the world's first high-voltage transistors designed for power switching.

Now, let's make something out of it.

Like, say, a high-voltage circuit with about half as many components.

Because we now offer you power-switching transistors that sustain up to 325 volts, guaranteed high speed switching (total turn-on turn-off time of less than a microsecond) and throw in saturation voltages less than .4 volts at three amps in the bargain.

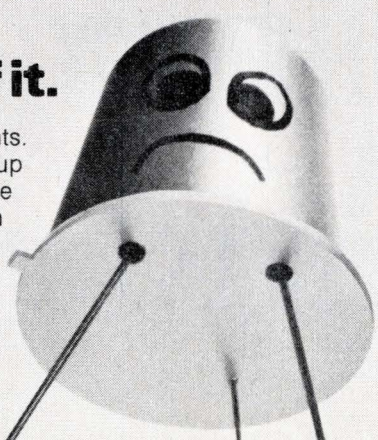
Which means this:

In one fell swoop you can get rid of a whole passle of transformers in the typical aerospace high-voltage circuit. End up with a much-simplified circuit design, in things like pulse modulators, switching regulators, converters, and inverters.

Choose the 2N 5660 (up to two amps), or the 2N 5664 (up to five amps) in either TO-66 or TO-5 packages. Try them for new designs and as a replacement in existing high voltage circuits.

Add in the longevity factor of planar oxide passivation, to keep the thing from crackling itself to death, and you've got one of the most exciting transistors that ever came down the pike.

So. If you'd like to make something out of it, just call Alex Polner at (617) 745-2900 and tell him to send you back the HVST Data Kit. It'll help.



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NPN/PNP COMPLEMENTARY POWER TRANSISTORS

Fairchild's newest complementary power transistors handle more power than any other comparable devices.

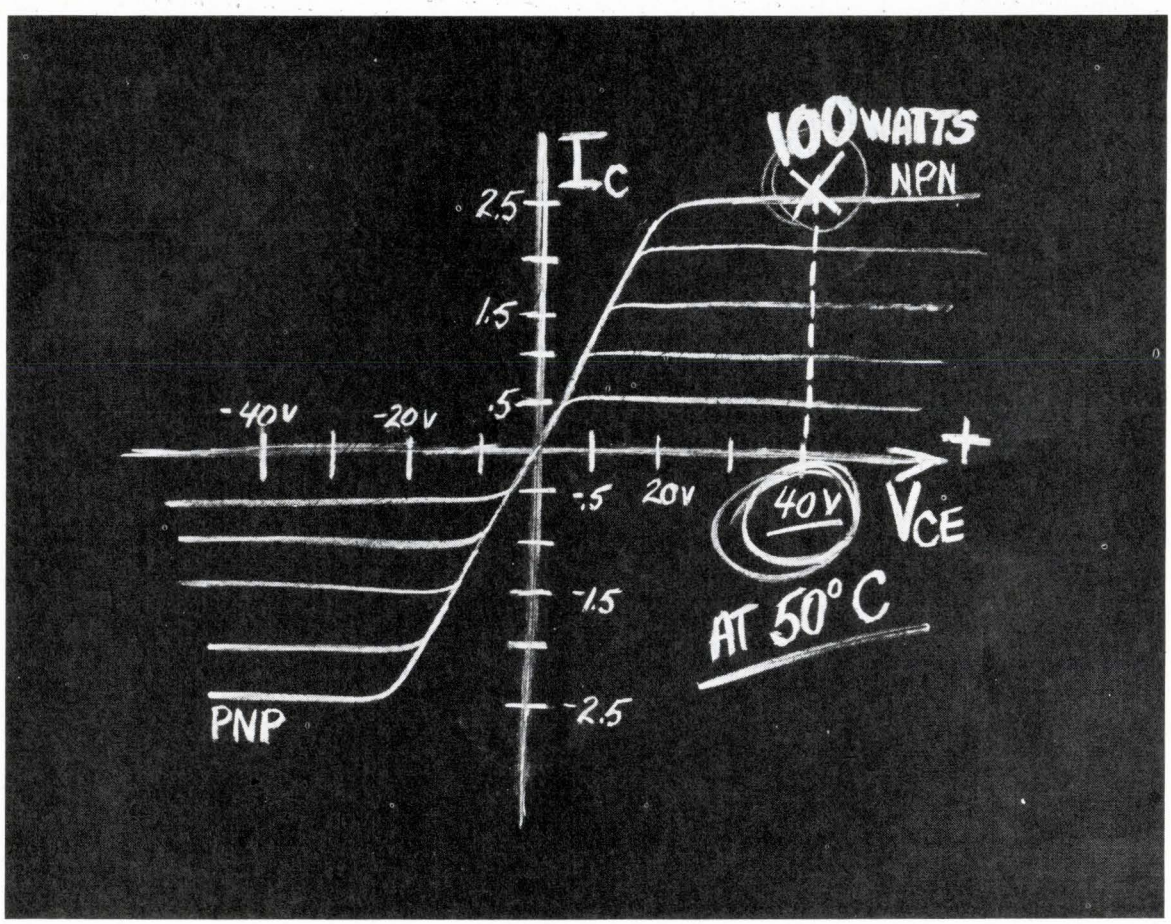
They're rated at collector currents of 2, 5 and 10 amps, but current doesn't tell the power story. In the Fairchild series, power dissipation is 30W-100W at 40V (50°C case temperature). That's five to ten times the power handling capacity of similar transistors on the market.

We haven't traded power for performance, either. The transistors are all designed to minimize mismatch and crossover distortion in Class B and complementary symmetry audio amplifiers. f_T is a minimum of 40MHz, and the beta-linearity shows it. Your amplifier power output is linear over an extremely wide frequency range. These same characteristics make the devices the best choice available for servo amplifiers and high-speed switching applications (such as military dc-dc converters).

The operating range for all devices is from −65°C to +200°C, and there's a variety of packages available to suit specific applications. Write for our spec sheets and applications information.

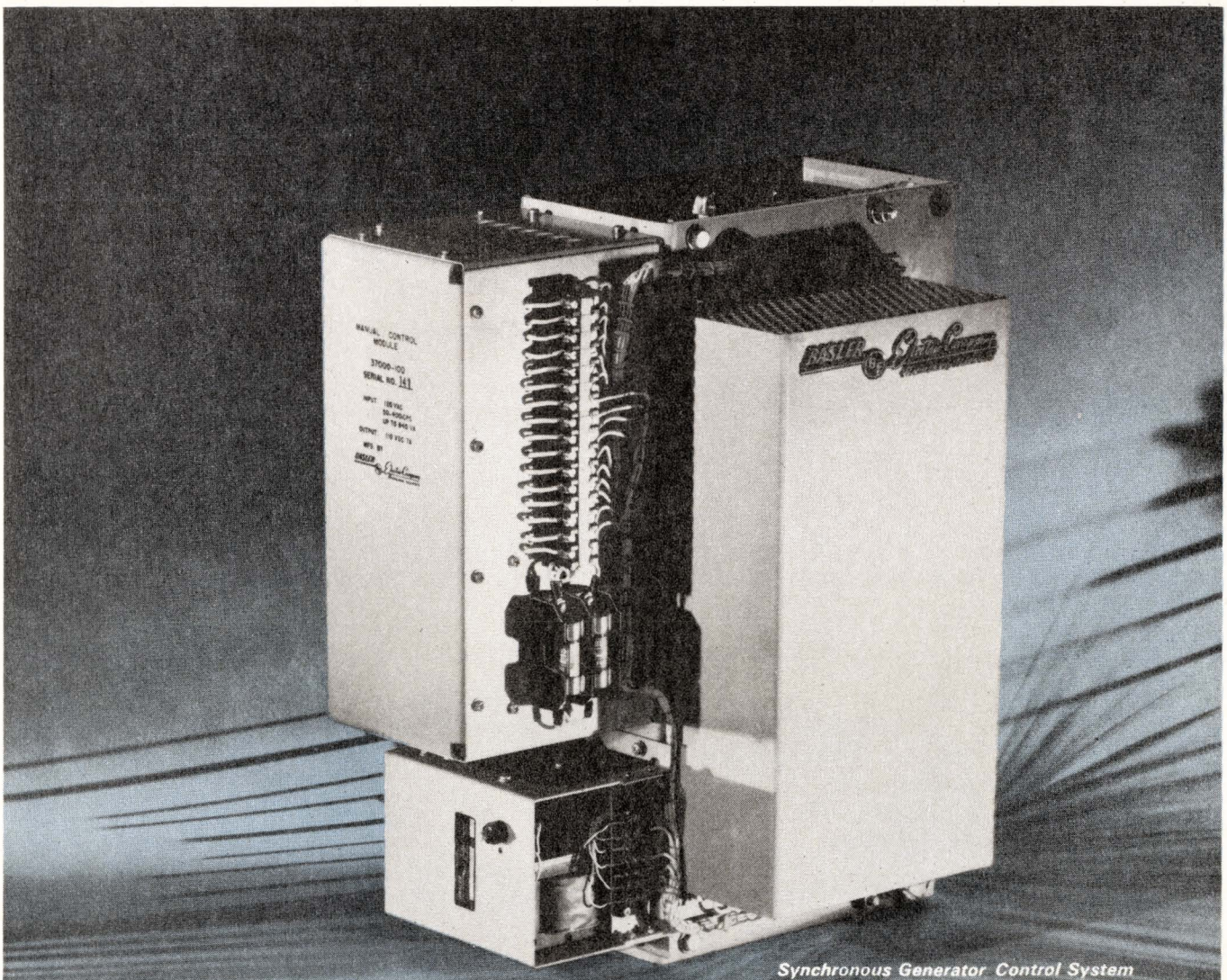
Collector Current / Maximum Power Dissipation*	NPN Part No.	PNP Complement Part No.	NPN Price (1-99)	PNP Price (1-99)
2A/30W	2N4998	2N4999	$22.50	$28.50
	2N5000	2N5001	27.00	33.00
5A/50W	2N5002	2N5003	30.00	36.00
	2N5004	2N5005	45.00	54.00
	2N5284	2N5286	52.50	60.00
	2N5285	2N5287	60.00	75.00
10A/100W	2N5006	2N5007	60.00	90.00
	2N5008	2N5009	75.00	112.50
	2N5288	2N5290	90.00	135.00
	2N5289	2N5291	105.00	157.50

*50°C case temperature



FAIRCHILD
SEMICONDUCTOR

FAIRCHILD SEMICONDUCTOR A Division of Fairchild Camera and Instrument Corporation Mountain View, California 94040, (415) 962-5011 TWX: 910-379-6435



Synchronous Generator Control System
Single package approach to total generator control for brushless exciter equipment from 350KW to 7,000KW.

PRODUCT CAPABILITIES IN MODERN POWER TECHNOLOGY...

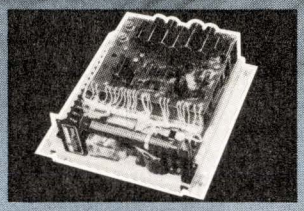
At Basler Electric, product capabilities are more than a mere possibility . . . they're a reality.

Quality "input" from engineering, design and manufacturing experience make Basler your obvious supplier of Magnetic Components, Power Control Equipment and Electronic Systems.

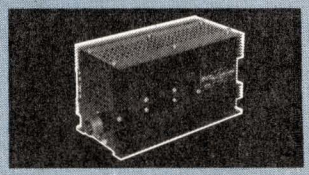
The units illustrated here are only representative of the broad range of electric and electronic products "on line" at Basler Electric.

Got a "hot" question? CALL . . . John Bellinger, Director of Sales . . . 618-654-2341.

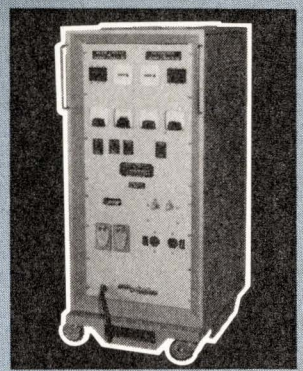
Got time for an answer? Circle the "bingo" number. We'll send data on all illustrated lines. ■



SR-Static Voltage Regulator
Solid state regulator responds in 16 milliseconds . . . Regulation better than ±½% . . . withstands 5 Gs from 20 to 500 Hz.



Static Inverter
Airborne Inverter. Built-to-drawings or Standard Designs.



Static Power Unit
Does your 400-cycle and D.C. power source have portability, power isolation, power quality, electrical ruggedness and low noise level? Basler's does.

BASLER Electric Company
HIGHLAND, ILLINOIS

E-H leads the pulser field in price...

E-H MODEL 137

and performance.

If you decide to buy a pulser just because it costs less and it solves your immediate problems, your problems may have just begun. Before you know it, that pulser has become obsolete and you're out shopping for another one. Need a better solution? E-H offers it.

Every E-H instrument is designed to give you the most advanced solution to your problems today. And to take care of tomorow's problems, each instrument has a built-in margin of performance you never see in the written specs. That's the extra that makes an E-H pulser extra useful in years to come.

Here, for example, is one of our newest problem solvers — the **E-H Model 137.** This all solid-state pulser has rep rates of 10 Hz to **100 MHz,** pulse amplitude of up to ±**5V** into 50 ohms (±10V open circuit), DC offset of up to ±**5V** into 50 ohms (±10V open circuit), transition times of <**2ns** to 200 μs, leading and trailing edges independently variable up to ratio of **10:1,** external drive requirements **1.2V pos or neg.** Price, **$1,950.** f.o.b. Oakland.

Call your E-H representative for a demonstration now. And if our new Model 137 doesn't quite fit your needs, ask about E-H's eighteen other advanced problem solvers.

E-H RESEARCH LABORATORIES, INC.

515 11th Street • Box 1289, Oakland, California 94604 • (415) 834-3030 • TWX 910-366-7258
In Europe: E-H Research Laboratories (Ned) N.V., Box 1018, Eindhoven, The Netherlands, Telex 51116
In Japan: Iwatsu Electric Co., Ltd., No. 710, 2-Chome Kugayama Suginami-Ku, Tokyo, Japan

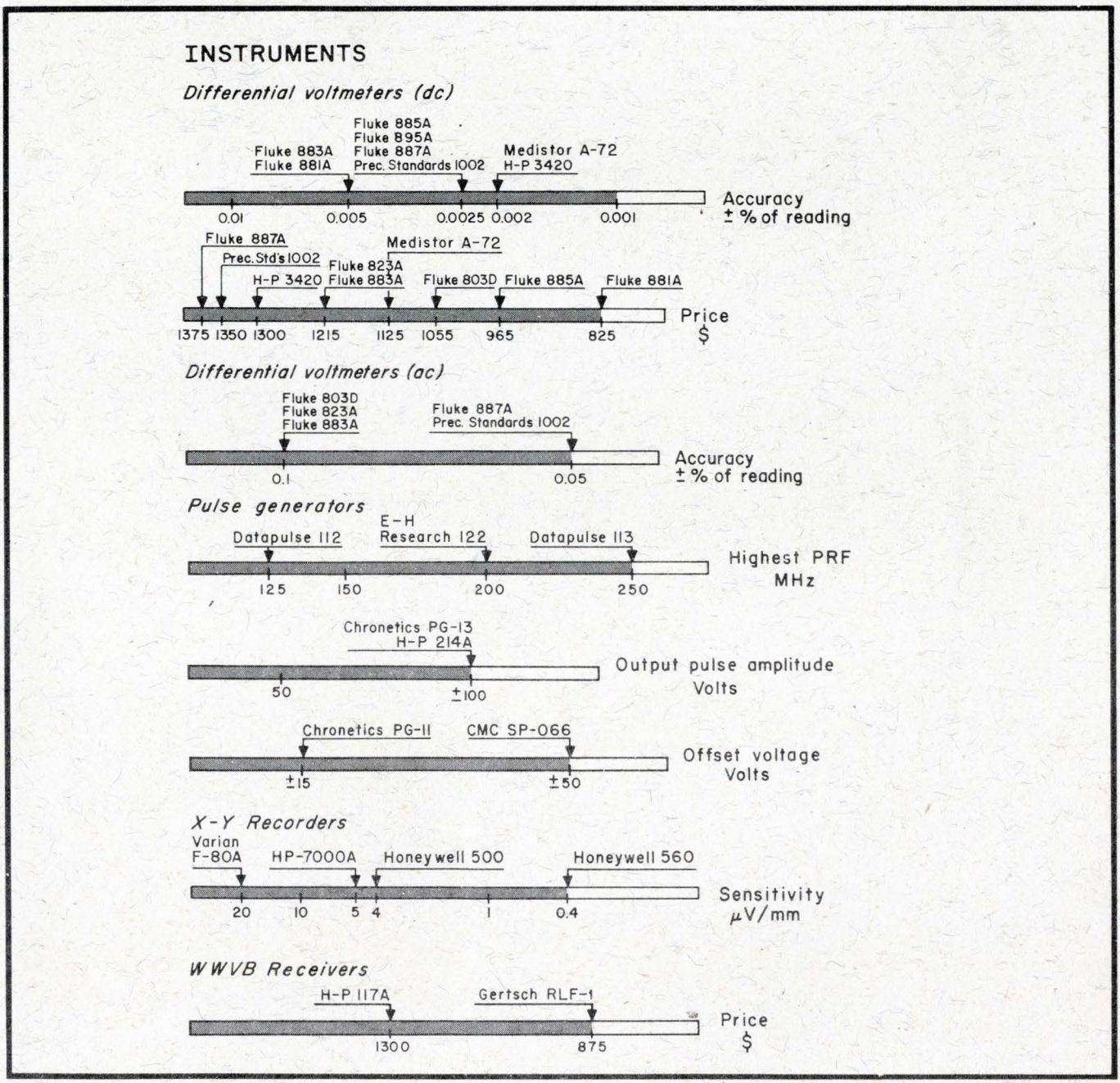
EE FOREFRONT

The EE Forefront is a graphical representation of the practical state of the art. You will find here the most advanced components and instruments in their class, classified by the parameter in which they excel.

A word of caution

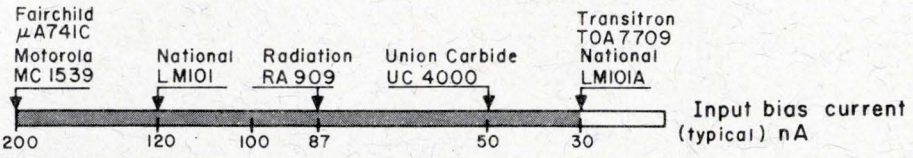
Keep in mind the tradeoffs, since any parameter can be improved at the expense of others. If there is no figure-of-merit available, we either include other significant parameters of the same products, or we provide additional bar graphs for the same products.

Do not use these charts to specify. Get complete specifications first, directly from the manufacturers.

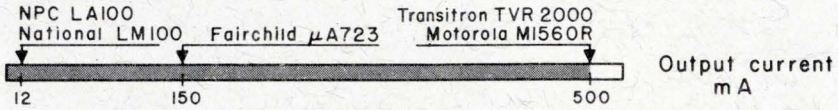


INTEGRATED CIRCUITS

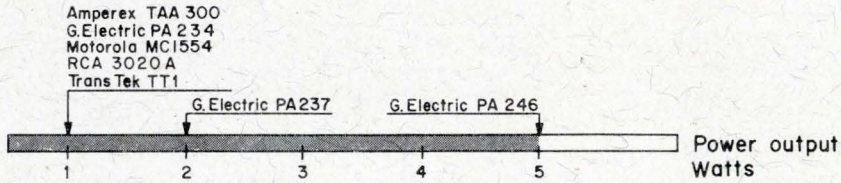
Operational amplifiers



Voltage regulators

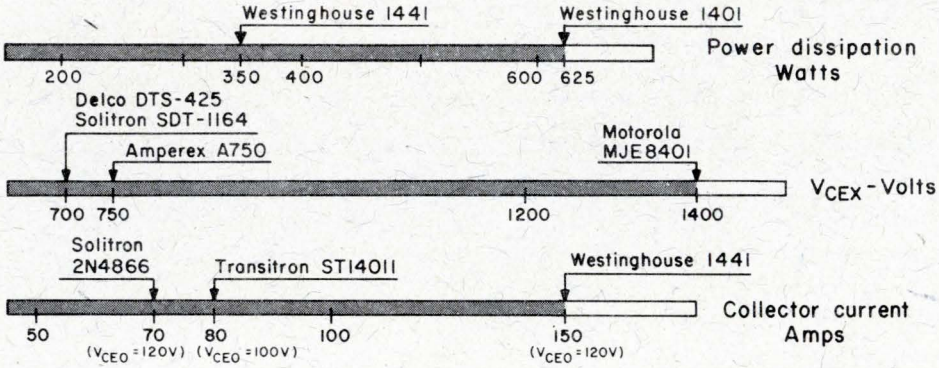


Power amplifiers

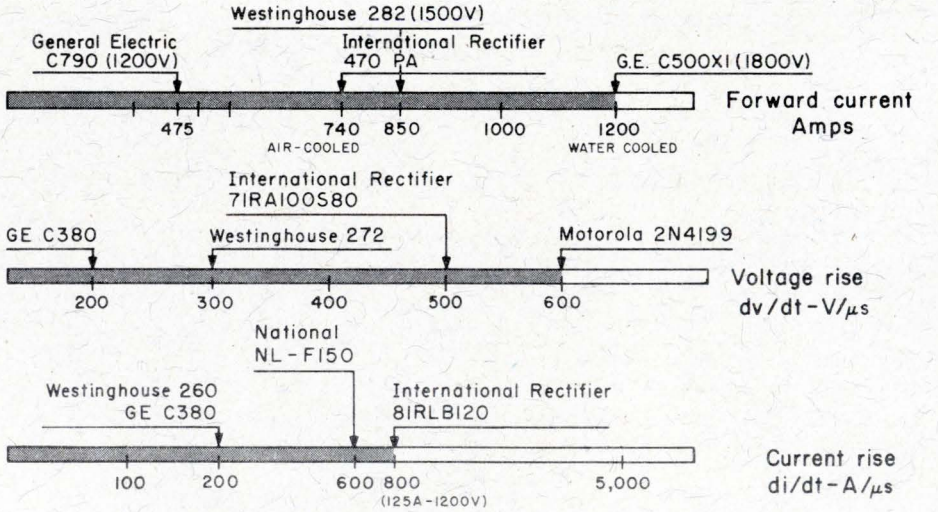


SEMICONDUCTORS

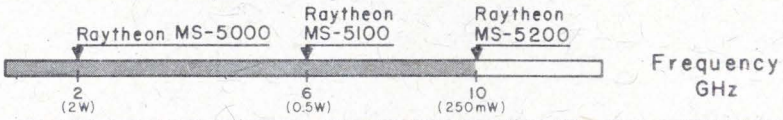
Silicon power transistors (npn)



Thyristors



Microwave multiplier diodes



Foxboro engineers select A-B hot molded potentiometers

"Best repeatability—component-to-component and setting-to-setting"

Foxboro Model 62H electronic controller for process regulation. The control mode adjustments use Allen-Bradley Type J hot molded variable resistors with values of 10, 100, and 200 megohms.

A-B Type J hot molded variable resistor rated 2.25 watts @ 70°C. Available in single, dual, and triple units. Standard total resistance values from 50 ohms to 5 megohms. Special resistance values and tapers can be supplied.

Widely used throughout the process industries, the Foxboro Model 62H Universal Controller is a highly dependable precision instrument. During the years of painstaking development, Allen-Bradley engineers worked closely with Foxboro to provide a potentiometer having unusually high resistance values, which would provide the precise performance required.

Allen-Bradley Type J potentiometers were the answer. They have a solid hot molded resistance track which is produced by an exclusive A-B molding technique that assures extremely long operating life. Accelerated tests—exceeding 100,000 revolutions—show very slight resistance change. Control is smooth at all times with adjustment approaching infinite resolution. There are none of the abrupt turn-to-turn resistance variations inherent in wirewound controls. Furthermore, Allen-Bradley Type J potentiometers are—for all practical purposes—noninductive, permitting their use throughout the frequency spectrum.

Whether your particular circuit design can be best satisfied with one of the millions of standard Type J variations or whether it calls for unusual resistance characteristics, it will pay you to look first to A-B Type J potentiometers. Their more than 25-year history of providing superior performance is your guarantee of complete satisfaction. For full details, please write for Technical Bulletin 5200: Allen-Bradley Co., 1201 South Second Street, Milwaukee, Wisconsin 53204. Export Office: 1293 Broad St., Bloomfield, New Jersey, U.S.A. 07003. In Canada: Allen-Bradley Canada Limited.

867E-2

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

EE CALENDAR

MARCH

9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

March 12: Plastics Powders-III, Sheraton Motor Hotel, Akron, Ohio. Addtl. Info.—Robert G. Hills, c/o NRM Corp., 47 W. Exchange St., Akron, Ohio 44308.

March 24-27: IEEE Int'l Conv. & Exhbt., Coliseum & N. Y. Hilton Hotel, New York, N. Y. Addtl. Info.—J. M. Kinn, IEEE, 345 E. 47th St., New York, N. Y. 10017.

APRIL

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6	7	8	9	10	11	12
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27	28	29	30			

April 8-10: Cleveland Electronics Conf., Cleveland Eng'g Center, Cleveland, Ohio. Addtl. Info.—Mike Lapine, Conf. Director, 1610 Euclid Ave., Cleveland, Ohio 44115.

April 8-10: Image Display and Recording Symp., Air Force Avionics Lab, Wright-Patterson AFB, Ohio. Addtl. Info.—Don Learish, Information Office, Wright-Patterson AFB, Ohio, (513) 255-5771.

April 15-18: Int'l Computer Aided Design Conf., Univ. of Southampton, Southampton, England. Addtl. Info. —IEE, Savoy Pl., London, W.C. 2, England.

April 22-23: 17th Annual Nat'l Relay Conf., Oklahoma State Univ., Stillwater, Okla. Addtl. Info.—Dr. Monroe W. Kriegel, Director, Eng'g and Industrial Extension, Oklahoma State Univ., Stillwater, Okla. 74074.

April 23-25: Southwestern IEEE Conf. & Exhibition, San Antonio Conv. Ctr. & Palacio Del Rio Hotel, San Antonio, Tex. Addtl. Info.—S.W. Seale, S.W. Res. Inst., Box 2296, San Antonio, Tex. 78206.

April 30-May 2: Electronic Components Conf., Shoreham Hotel, Washington, D. C. Addtl. Info.—Electronics Ind. Assoc., 2001 "I" St., N.W., Washington, D. C. 20006.

MAY

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May 5-8: Int'l Microwave Symp., Marriott Motor Hotel, Dallas, Tex. Addtl. Info.—Julius Lange, Texas Instruments Inc., Dallas, Tex. 75222.

May 5-8: Design Eng'g Show and Conf., Waldorf-Astoria Hotel and Coliseum, New York, N. Y. Addtl. Info.—Banner & Greif, Ltd., 369 Lexington Ave., New York, N. Y. 10017.

May 6: Digital Communications Symp., Los Angeles, Calif. Addtl. Info.—IEEE Office, 3600 Wilshire Blvd., Los Angeles, Calif. 90005.

May 6-8: 23rd Annual Frequency Control Symp., Shelbourne Hotel, Atlantic City, N. J. Addtl. Info.—Director, Electronic Components Lab., U.S. Army Electronics Command, Att: AMSEL-KL-DT (Mr. M. F. Timm), Fort Monmouth, N. J. 07703.

May 14-16: Spring Joint Computer Conf., Sheraton Boston Hotel, War Mem. Audit., Boston, Mass. Addtl. Info.—Norman Bryden, Honeywell EDP, 60 Walnut St., Wellesley, Mass.

May 19-21: Aerospace Electronics Conf. (NAECON), Sheraton Dayton Hotel, Dayton, Ohio. Addtl. Info.—M. G. Coleman, Gen'l Precision Inc., 33 W. 1st St., Dayton, Ohio 45402.

'69 Conference Highlights

IEEE—Institute of Electrical and Electronics Engineers Int'l Convention & Exhibition, March 24-27; New York, New York.

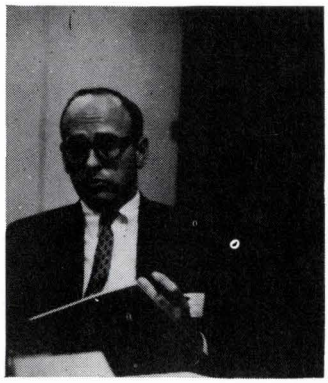
WESCON—Western Electric Show and Conv., August 19-21; San Francisco, Calif.

NEREM — Northeast Electronics Research and Eng'g Meeting, Nov. 5-7; Boston, Mass.

Call for Papers

April 30-May 2, 1969: Electronic Components Conf. Submit four copies of 100-300 word abstract before **April 1, 1969** to Dr. J. O'Connell, ECC Technical Program Chairman, Electronic Industries Assn., 2001 Eye St., N.W., Washington, D.C. 20006.

SWITCH CRAFT FORUM



on the new DW "Multi-Switch®"*

I can tell you right now, if the new DW "Multi-Switch" doesn't save on space and cost, and offer plenty of versatility it's going to be a dud!

That's the point. Switchcraft designed this compact pushbutton switch to do both. It's not just a scaled down version of an existing "Multi-Switch".

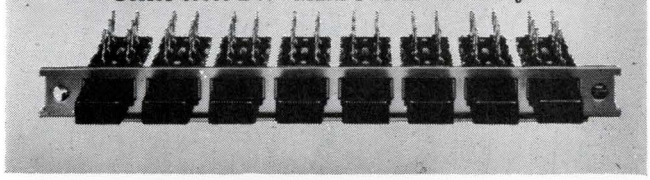
I'll buy your design philosophy so long as you haven't sacrificed the versatility and quality we've been accustomed to on your larger switches. And, don't forget economy.

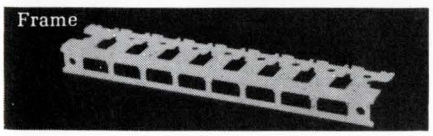
Let's tackle your points one by one, and see how the new Series 65000 DW "Multi-Switch" shapes up!

We've guaranteed versatility by using simplified modular construction. Essentially, the switch consists of a frame up to 18 stations long, latch bar for function control and switching modules that provide up to 2C (DPDT) circuitry.

Fig. 1

Series 65000 DW "Multi-Switch" assembly





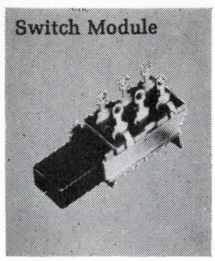


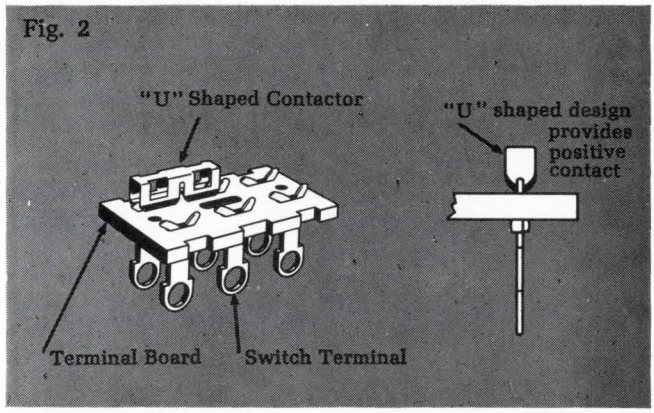
Fig. 1 shows how these elements are combined to complete the switch. The latch bar and mating actuator configuration determine the functional operation, such as: Interlock, All-lock, Non-lock, and even special functions. The push-to-lock, push-to-release function is also available and can be combined with Interlock, All-lock, Non-lock on the same switch frame without any interaction between the various functions.

We don't have space to cover all the versatility details, such as, printed circuit terminals, pushbutton engraving, accommodation for mounting with Tinnerman nuts, etc. JUST CIRCLE THE READER SERVICE NUMBER FOR NEW PRODUCT BULLETIN #174.

*Patent applied for

An example of quality construction is the rigid frame, and double-wipe contactors used for extreme reliability. Fig. 2 shows how the 'U" shaped contactor provides positive contact and minimizes "bounce". Also, the molded nylon pushbutton actuators are an integral part of the module. They can't be lost or pilfered. Our quality story ties right into economy. You can't buy a better made, compact multiple-station pushbutton switch for the money.

Fig. 2



We'll accept the commercial, only because you have the reputation to back it up. The design looks great, but what about ratings and special circuit applications?

Typical ratings for silver-plated contactors would be 3 amps. A.C., 0.5 amps. D.C. 125v. non-inductive. For dry circuit applications, gold flashed contactors and terminals could be furnished. As usual, we're glad to engineer specials to accommodate your volume requirements.

I'll probably have more questions after we get a few samples on test. In the meantime, I'd like certain members of my staff to get complete engineering details on the DW "Multi-Switch" switch.

Just have them drop us a request on your company letterhead for complete technical scoop. Also, we'll add their name to our TECH-TOPICS mailing list to receive this engineering-application magazine every-other month. Over 10,000 engineers find the application stories very interesting and useful in their work.

*Patent applied for

SWITCHCRAFT® INC.

5539 North Elston Avenue • Chicago, Illinois 60630

Circle 17 on Inquiry Card

EE SPEAK UP

Gallium arsenide with pos. TCR

Sir:

Dr. Zverev, in his recent article "Microwaves are going solid" The Electronic Engineer, Nov. 1968, p. 61, had reference to the negative temperature coefficient and lack of reproducibility in bulk Gallium Arsenide, as being factors holding up the development of solid state microwave devices.

Semicon Electronic Materials can supply Gallium Arsenide with positive temperature coefficient and good control of carrier concentration as the following figures show.

Semicon Gallium Arsenide

Sample 1

	Room	70°C	
Temperature			
Resistivity	0.310	0.362	Ω–cm
Mobility	5154	4149	$cm^2/V-s$
Carrier Conc.	$3.9x10^{15}$	$4.2x10^{15}$	cm^{-3}

$$\frac{\text{Resistivity (70°)}}{\text{Resistivity (Room)}} = 1.18 \text{ (Positive TCR)}$$

Sample 2

	Room	70°C	
Temperature			
Resistivity	0.911	1.014	Ω–cm
Mobility	5587	4537	$cm^2/V-s$
Carrier Conc.	$1.2x10^{15}$	$1.4x10^{15}$	cm^{-3}

$$\frac{\text{Resistivity (70°)}}{\text{Resistivity (Room)}} = 1.11 \text{ (Positive TCR)}$$

R. I. Stearns
Semicon Electronic Materials, Inc.
8810 Frost Avenue
Saint Louis, Missouri

Yes, there is an EE in the house

Sir:

After reading the article 'Is There an EE in the House' [**The Electronic Engineer,** November 1968, p. 50], I feel that I should acquaint you with a new service to the hospital industry and the medical profession that this unit of The Bendix Corporation is offering. We are operating a Medical Equipment Service Center for hospitals in Beltsville, Maryland serving the Baltimore-Washington area and, just this week, opened a Center in Chicago. Subsequent Centers are planned in Houston, Los Angeles and in the other major population areas of the country.

The Medical Equipment Service Center provides an annual engineered maintenance concept to hospitals. It is a 24-hour a day, 7-day a week service covering a broad spectrum of medical equipment in hospitals and doctors' offices. Initially, we evaluate every piece of equipment under the

(*continued on page* 26)

Only AMP has this: MIL-C-39012 all crimp no solder BNC and N series coax connectors

AMP was the first to get rid of the solder in coax connectors.

All of it.

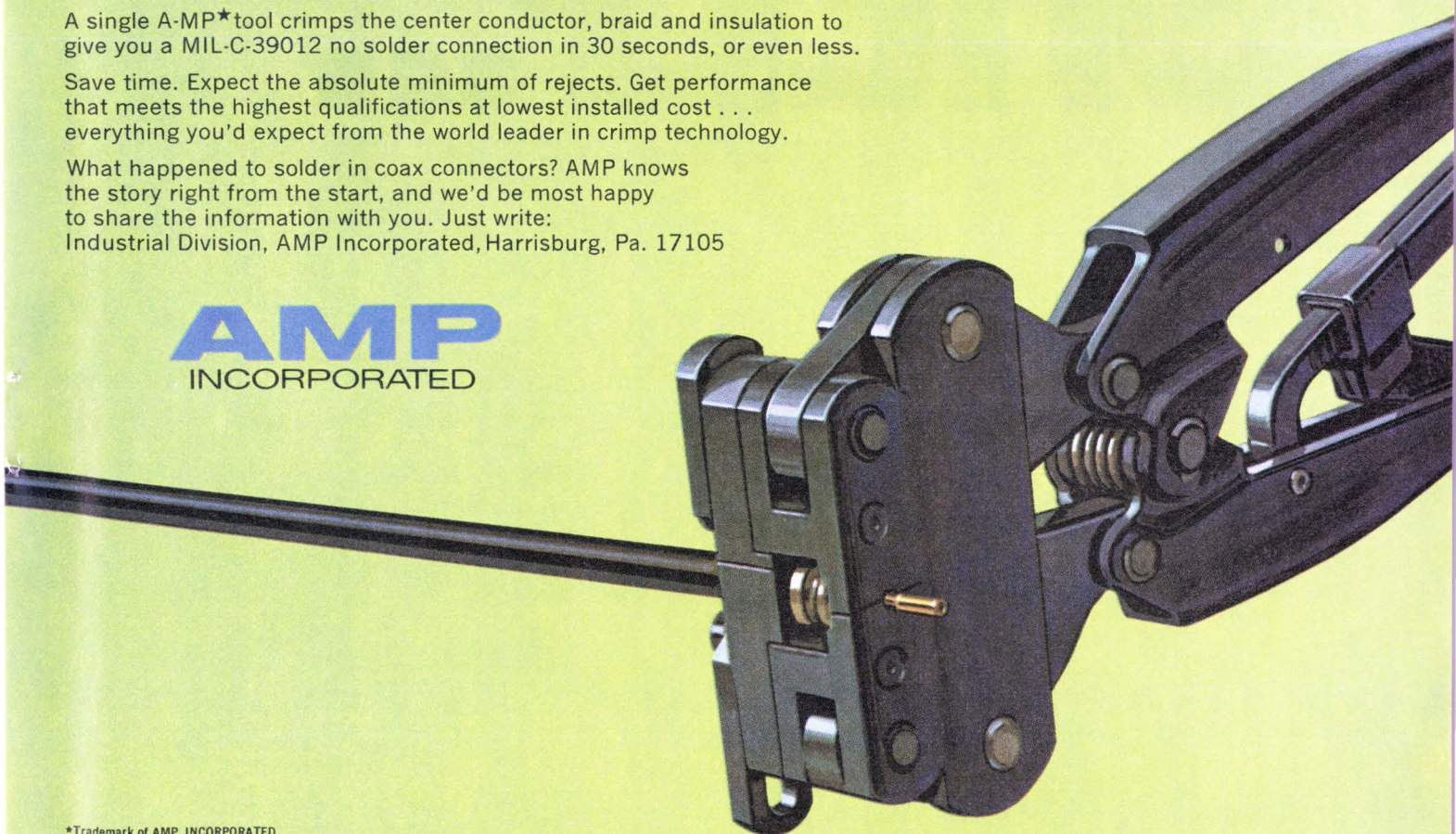
We replaced it with an all-crimp method.

A single A-MP★ tool crimps the center conductor, braid and insulation to give you a MIL-C-39012 no solder connection in 30 seconds, or even less.

Save time. Expect the absolute minimum of rejects. Get performance that meets the highest qualifications at lowest installed cost . . . everything you'd expect from the world leader in crimp technology.

What happened to solder in coax connectors? AMP knows the story right from the start, and we'd be most happy to share the information with you. Just write: Industrial Division, AMP Incorporated, Harrisburg, Pa. 17105

AMP
INCORPORATED



*Trademark of AMP INCORPORATED

CUSTOM CIRCUITS OFF-THE-SHELF...

EE SPEAK UP

(*continued from page* 22)

plan and restore it to manufacturer's standards and maintain it at that level during the life of our contract. Obviously, we are learning about all of the equipment in hospitals and may be able to assist "The Electronic Engineer" and the medical profession in some way not now obvious to us.

A. S. Pawling
Vice President, Marketing
Bendix Commercial Service Corp.
Owings Mills, Md.

EDITOR'S NOTE: Readers who wish more information on Bendix's service can request the brochure "Medical Equipment Service" from Mr. Pawling at Bendix Commercial Service Corp., Reisterstown Road and Painter's Mill Road, Owings Mills, Md. 21117.

Standards for IC diff'l amps.

Sir:

With reference to the article, "Let's standardize linear ICs," (The Electronic Engineer, Jan. 68, p. 60), I believe it would be helpful to add a few important circuit specifications for operational amplifiers not listed in the article.

First, differential amplifiers which are not driven from strictly symmetrical sources (this applied, in particular, to general-purpose computer amplifiers) require specification of the input-bias-current drift, rather than the off-set-current drift with temperature: bias-current drift is the most serious source of temperature drift in many operational amplifiers with bipolar-transistor input.

Second, a simple bandwidth specification is a −3dB frequency is frequently misleading or insufficient in the case of amplifiers intended for high-gain feedback operation. Actually no single number is sufficient for this purpose, and most manufacturers give a frequency-response curve; what must then be standardized is the set of conditions under which the frequency-response is taken, especially source and load impedances. The highest frequency at which full-rated voltage and current output can be obtained is also of interest.

Finally, it would be very useful to have not just the static dc value of the common mode rejection ratio, but also its frequency response; this is now found in very few amplifier specifications. Nevertheless, this quantity is decisive in determining high-frequency noise rejection.

Granino A. Korn
Professor
The University of Arizona
Tucson, Arizona

Choose the colorful EMCOR team you'd like to have working for you.

EMCOR has all kinds of pretty models, including our standard Enclosures. The captivating colors are new. ■ Of course, we all know colors can be beautiful. They can also be useful. "Color-engineered" EMCOR® Modular Enclosure Systems are both. ■ By applying color psychology, you can create the effect you want with EMCOR cabinets. Olive Green and Blue are relaxing and thoughtful, Gold is rich and elegant, Black is dignified, White pure and clean, Tan soft and warm. ■ You can use our colors functionally to codify operations or to identify areas of operator responsibility. However you use them, they're beautiful and contemporary. And, of course, the cabinets are EMCOR quality. ■ "Human engineering" is another EMCOR asset. Our engineers "watch" people so that your people can make optimum use of equipment, both visually and manually. Enclosures that are designed with "human engineering" in mind help eliminate mental and physical fatigue. ■ Write for full details on how EMCOR offers enclosures that are more than just enclosures. EMCOR Reg. U.S. Pat. Off.

EMCOR/colorful cabinetry

EXPORT SALES: BORG-WARNER INTERNATIONAL, 36 S. WABASH, CHICAGO, ILLINOIS 60603

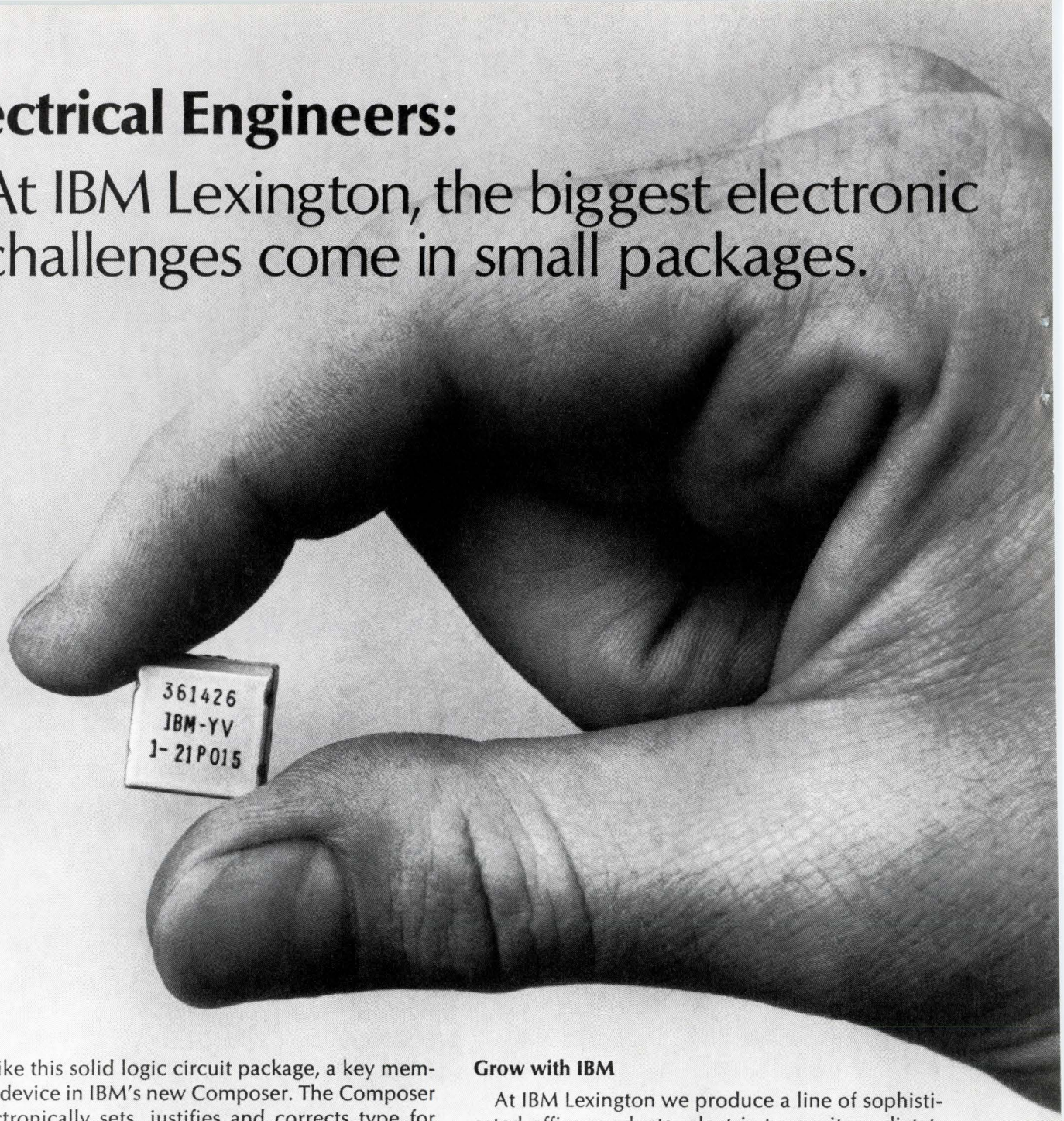
Ingersoll Products 1035 W. 120th St., Chicago, Ill. 60643 DIVISION OF BORG-WARNER CORPORATION

BORG WARNER®

Circle 21 on Inquiry Card

Electrical Engineers:

At IBM Lexington, the biggest electronic challenges come in small packages.



Like this solid logic circuit package, a key memory device in IBM's new Composer. The Composer electronically sets, justifies and corrects type for printing. It was developed at IBM Lexington, Kentucky, and is just one example of the electronic challenges and opportunities you'll find here.

What you'd do

We have immediate openings for electrical engineers with a B.S. or M.S. degree. If you qualify, you could go into one of several areas:

Semiconductors: You'd work with solid state semiconductor devices, optimizing their capabilities in practical applications.

Design: You would be involved with logic design, logic circuit design, analog and digital circuit design, and digital logic design.

Testing: You would test electronic and electromechanical equipment—both manufactured products and the test equipment itself.

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Get the right technical data: Know where to look for it

The accompanying chart will make your life as an engineer simpler. It tells you where to go to get the specific type of information you need.

By Joel J. Shulman,
Specialist in Technical Communications, Plainview, N. Y.

"Gentlemen:
I am currently working on a project which requires your Model 87B, or equivalent, in my system. Please send me your latest catalog for hook-up data.
Very truly yours . . ."

Looking for data? You've come to the right company. The girl at the mail desk reads the letter, gives it to a clerk to send you a catalog. You get the catalog. No hook-up data. You're annoyed. The company sent you the wrong information.

Whose fault? Your fault!

What has gone wrong?

You went to the right place for the wrong information. You pre-selected the type of data you wanted and then decided, on your own, that it should appear in that company's catalog.

The company you wanted the information from could easily have processed your request correctly if it wasn't so specific. Most likely, a qualified engineering representative would even have helped develop your data to become compatible with his data. And, not at all unlikely, he might have helped you develop your data to become compatible with sources competitive to him as well.

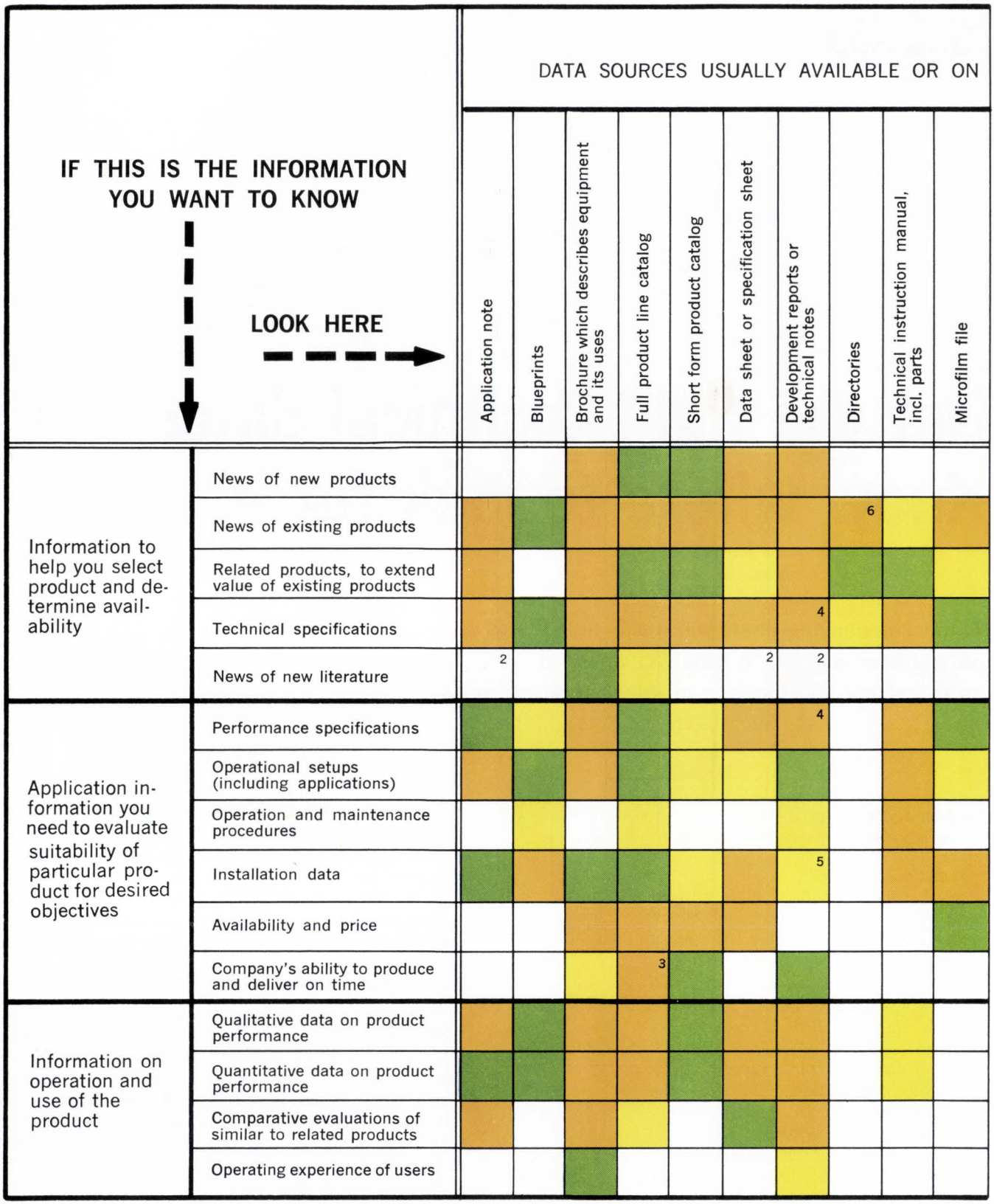
If, on the other hand, the company did not make the product you sought, it could help you by recommending a probable source. Since goodwill is an important part of a company's ability to do business, anything which generates goodwill is welcome. Nevertheless, since you wish to obtain specific information, asking the right question of the wrong company is wasteful. You will get greatest value if you go directly to the data you require.

Presentation patterns

Most companies conform to similar patterns in publishing their technical literature. For example, annual reports of companies in like industries usually contain the same types of information. This is an advantage which many engineers overlook. In some cases, data must be sought from a different industrial field. Unless you know what type of data sources to consult, you may find it hard to get the right information.

What types of data are you looking for? What types of data sources carry such information? Where and how can you find them? The table on the next page is a grid listing of information type vs likely source. It cannot cover all possible conditions but it will do for most.

Basically, the chart groups *data types* into three major categories: information on the existence of a product (or process or system); application data involving methods, locations, conditions; and evaluation data. In each of these categories there are many specific types of information you might want.



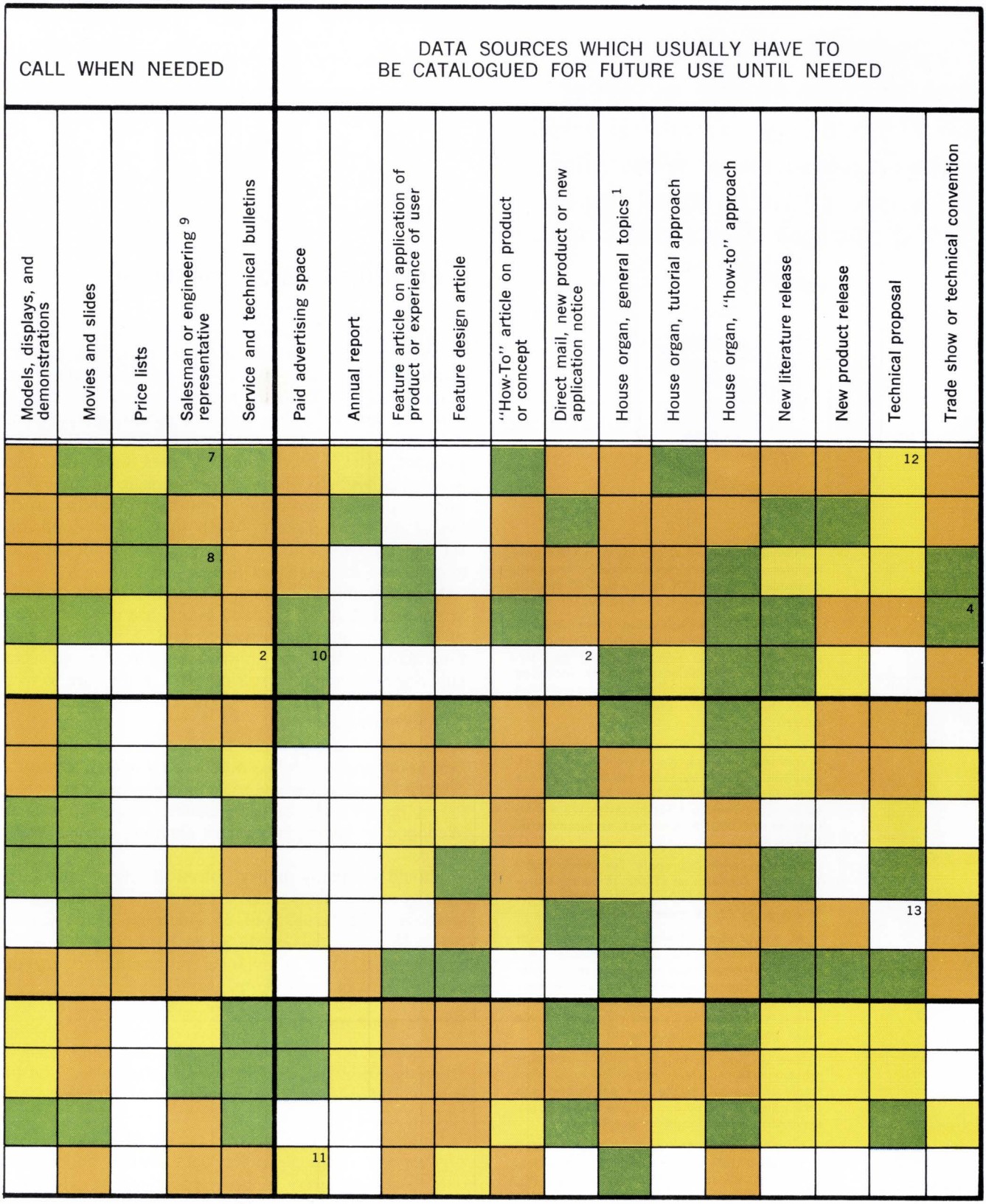
Excellent likelihood of finding data sought

Good likelihood of finding data sought

Poor likelihood of finding data sought

Almost no likelihood of finding data sought

1. Reference is only to technical house organs (or company magazines), not to general types going to non-technical audiences.
2. This is the new literature itself, as cited in other literature, such as in trade journals or newsletters.
3. Generally lists only standard production items.
4. May be tentative specifications.
5. Except if the development involves installation improvements.



6. Because directory editors must rely heavily on statements by manufacturers, such directories tend to be less than 100% accurate. To overcome this failing, directory compilers insist that they receive printed (not just typewritten) catalogs and data sheets on those products listed by the manufacturer.
7. Many sales personnel learn of the new product at the same time as it is publicly announced. Managements are reluctant to give sales people information on products under development for fear that salesmen may sell a partially designed product.
8. Sometimes overstated and optimistic.
9. Field sales personnel cannot know everything about a product because of their remoteness from the engineering location and function.
10. May be news about existing older product.
11. If it appears at all, it is part of a particular publicity campaign.
12. Excluding price proposal.
13. The proposal presumes the unavailability of the product.

Technical data (concluded)

As for the *data sources* themselves, they cover the widest possible range of published materials, physical hardware, visual aids, and even oral presentations and demonstrations. There is, however, some overlapping. For instance, a full-line product catalog may contain a bound-in price sheet. Application data appear in application notes, service bulletins, data sheets, catalogs, brochures, and elsewhere. Information in an annual report may be a more reliable indicator of ability to deliver than a price sheet. Much material is duplicated since a company would be unwise if it did not continue to reinforce its best sales points.

Special training seminars, "caravans," display and instruction trailers, and special events are not the normal channels for obtaining primary data. Since these combine showmanship and informationship they are often superior as information sources. But, if they are to work best, they will still rely upon conventional, "leave-behind" literature.

From the table you can see that certain sources are rich in information, while others, although rich, are too difficult to get. When you seek information, it may help to set up an order of precedence, based upon your likelihood of having trouble in reaching certain useful sources.

Should company policy, physical plant layout, or security requirements make salesmen's visits and demonstrations difficult, use sources which can reach you by mail. If secretarial assistance is hard to get, use the telephone. If there is no local representative, try the "bingo" card in the trade magazine.

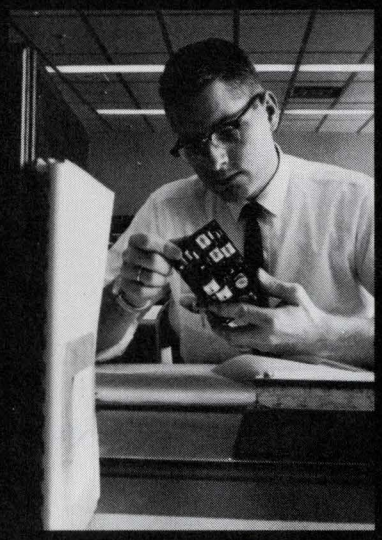
What's your objective?

A search for information is like any other project. It needs objectives. Just to collect information and file it is worthless—you become merely a "literature collector."

Once you have an objective, decide what specific type of data you need, go to the data source, and get the data. Take into account time, space, urgency, intended use or reference, cost of getting information, likelihood of finding sufficiently complete and useful data. Evaluate your project to select the best way to get the technical data.

Need data? Know what to look for, where to look for it, and how to find it. To make your job much easier, see that chart on pages 30 and 31.

INFORMATION RETRIEVAL
Careers



Mondays never look the same to Bob Byse

When you're breaking ground on a new idea at Delco, you don't see a lot of your own desk. For Bob Byse, design engineering means work with two dozen solid professionals . . . people whose specialties range from microelectronics to model making to production. Wherever the project leads, Bob Byse is on his way. And every skill is at his disposal. Right through full production.
And beyond. If there's trouble shooting under dealer warranty three years from now, Bob Byse is still the man we'll call for. That's why no two Mondays ever look alike to Bob Byse and his colleagues at Delco.
The question is . . . can you say the same? Take a good hard look at how your responsibility shapes up, compared with Bob's. In fact, why not discuss it with us. By letter or telephone. Collect. Area Code 317/459-2808.
Contact: Mr. C. D. Longshore, Supervisor, Salaried Employment, Dept. 305, Delco Radio Division of General Motors, Kokomo, Indiana.

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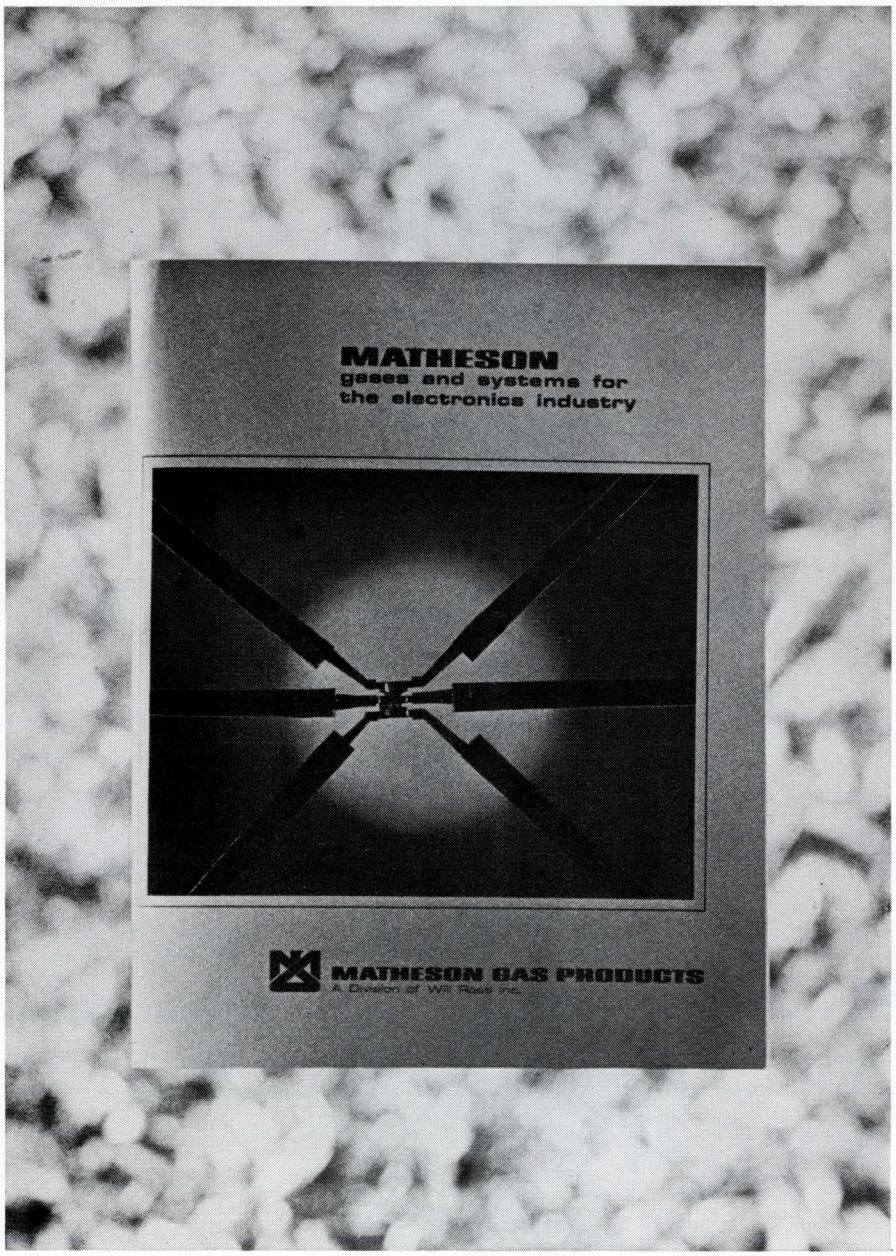

The first gas catalog for the electronics industry is now ready

A new gas catalog from the leading producer of gases for laboratory and scientific applications: • Basic Epitaxial Materials • Doping Gases • Organo Metallic Compounds • Pyrophoric Compounds in New Safety Dispenser Cylinder • Regulators, Valves, Equipment • Complete Gas Systems.

In addition to general catalog information, this new publication, "Gases and Systems for the Electronics Industry", contains an extensive technical data sheet for each gas. For your copy, write: Matheson Gas Products, P.O. Box 85, East Rutherford, N. J. 07073.

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Here is your copy of a brand new reference chart

HEAT-SHRINKABLE INSULATION Guide

Tear it out,

NOW

. . . and mount it on your wall

If the chart has been removed, Circle Number 40 on the Inquiry Card for a copy.

Circle 24 on Inquiry Card

EE WELCOME

Here we welcome new companies or new divisions in the electronics industry. For more information, circle the appropriate numbers on the reader service card.

Intramural communications. Astrocom Corp., a new company based in St. Paul, Minn., will soon be producing private, short distance data communication systems. Its first product, presently in the breadboard stage, is a low-cost digital system that will communicate over a range of two miles at rates of 10,000 bits/s to 100,000 bits/s, and with up to 16 stations. Its second product will be similar, except that it will use coax cable for multichannel communication.

According to Robert E. Rife, vice-president of marketing, Astrocom will be going into production around the first of April.

Circle **400** on Inquiry Card

Standard adapters for connectors Electro Adapter, Inc. is making a line of standard adapters for terminating cables to circular electrical connectors. The adapter line includes both EMI/RFI environmental and non-environmental types. By offering standard, off-the-shelf (one-week delivery) products, the North Hollywood, Calif., firm will be competing with the custom adapters made by Sunbank and Glenair. Its principals, Ray Fish (president) and Edward Pierce (marketing vice president), were both previously with Sunbank.

Circle **401** on Inquiry Card

Standard thick-film hybrid circuits. Cermetek, Inc., located in Mountain View, Calif., at a former Fairchild facility, is taking a new approach to the design of thick-film hybrid ICs. Instead of making circuits with a particular customer in mind, the new firm will design standard circuits for a particular field and then try to sell them to appropriate users. (Cermetek will, however, assemble and produce custom circuits also.) Among its initial products will be teletype interface circuits and telephone communications circuits.

"We plan to make circuits to interface MOS," says Dr. Bernard Jacobs, president of the firm. Specifically, he cites a high-speed, high-current clock driver for MOS arrays, and a relay and lamp driver which will interface with either TTL or DTL. Production of its MOS circuits has just begun.

Circle **402** on Inquiry Card

EE PRODUCT SEMINARS

As a service to you, this new column will list product seminars that electronic companies offer to users of their products. For more details, simply circle the appropriate reader service number on the inquiry card.

"Battery Seminar," Mar. 17, International Hotel, Los Angeles. H. S. Burker, Jr., Marketing Services Manager, Clevite Corp., 17000 St. Clair Ave., Cleveland, Ohio 44110.
Circle **403** on Inquiry Card

"Residual Gas Analyzer Spectra Interpretation," Mar. 24-26, Monrovia, Calif. $150. Emphasizes the spectra of materials found in vacuum systems. Technical Publications, Bell & Howell, 1500 S. Shamrock Ave., Monrovia, Calif. 91106.
Circle **404** on Inquiry Card

"Data Analysis Seminar," Mar. 25-28, New Haven, Conn. Signal classification, filters, amplifiers, recorders, transducers, and digital conversion of analog signals. $200. Robert H. Morse, MB Electronics, Box 1825, New Haven, Conn. 06508.
Circle **405** on Inquiry Card

"CEC 21-490/491 Mass Spectrometers," Apr. 7-11, Monrovia, Calif. $225. Theory, applications, operation, and maintenance of these single focusing and double focusing mass spectrometers. Coordinator of Training and Technical Publications, Bell & Howell, 1500 S. Shamrock Ave., Monrovia, Calif. 91106.
Circle **406** on Inquiry Card

"Seventh Annual Vacuum Technology Seminar," Palo Alto, Calif. Apr. 14-16. Auger spectroscopy, thin film deposition, principles of sputtering, automatic ion pump vacuum systems, advances in diffusion pump systems, achieving and measuring very low pressures, gas sampling systems, automatic data acquisition for gas analysis, vacuum materials, and fabrication techniques. Seminar Registrar, Varian Vacuum Div., 611 Hansen Way, Palo Alto, Calif. 94303.
Circle **407** on Inquiry Card

"Process Automation," Apr. 21-May 2, Phoenix. Theory, application, and operation of automated process control systems. Tuition-free and open to anyone in the processing industries. Motorola Instrumentation and Control Inc., Field Service Office, Box 5409. Phoenix, Ariz. 85010.
Circle **408** on Inquiry Card

Gain an extra stockroom at no additional cost! Let a P&B distributor carry your relay inventory.

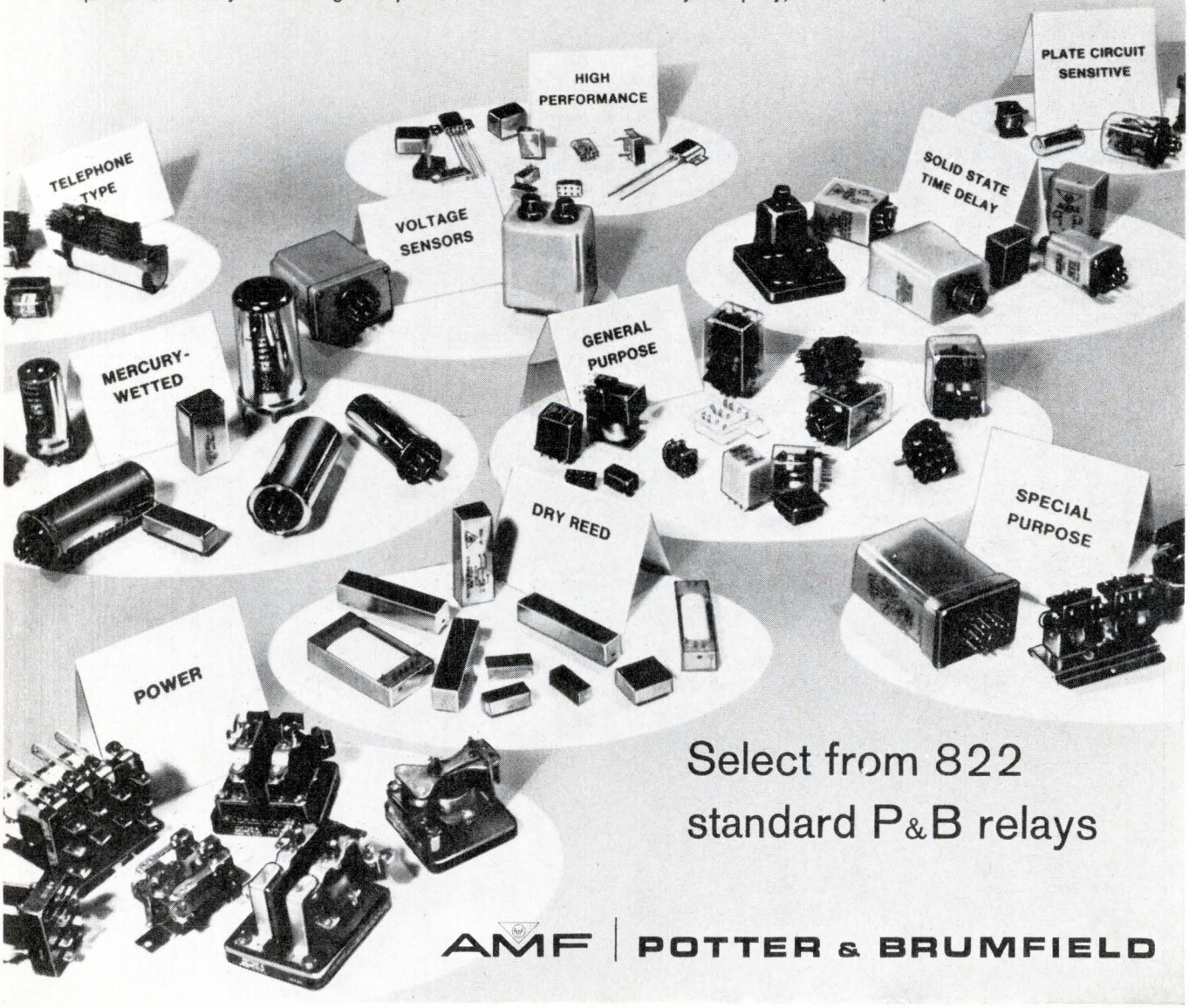
Authorized distributors will deliver your choice of 822 standard P&B relays. In almost any quantity, daily, weekly or monthly. Isn't that like having another stockroom?

In addition to the convenience, you actually save in several ways. The cost of owning inventory, for example. Factory shipping charges. You also save the time required for factory scheduling and production.

Often an order for P&B relays can be combined with one for other electronic components. That's another saving.

Order standard relays from your Potter & Brumfield distributor. Prototype or production quantities. He's in business to save you time and money.

Potter & Brumfield Division American Machine & Foundry Company, Princeton, Indiana 47570.



EE COURSES

"Critical Path Method Workshop," Mar. 25-28, Milwaukee. Introduction, fundamentals of planning, developing the logic diagram, identifying the activities, timing the plan, finding the critical path, the nature and types of float, workday, computer demonstration, critical path method research at the University of Illinois. $130. Engineering and Science Short Courses, University Extension, The University of Wisconsin—Milwaukee, 600 W. Kilbourn Ave., Milwaukee, Wis. 53203.

"A Practical System for Managing by Objectives," Mar. 31 (Detroit), Apr. 1 (Cleveland), Apr. 2 (Cincinnati), Apr. 3 (Chicago). Designed to teach supervisory people how to plan, implement, and review their own work and the performance of their employees in terms of results; how to motivate themselves and their subordinates to improve day-to-day operations; how to help them develop and apply their creative abilities. $65. Industrial Education Institute, 221 Columbus Ave., Boston, Mass.

"Management for Engineers," Apr. 14-18, Berkeley. Finance, marketing, production, industrial relations, managerial accounting, data processing, personnel management, and related topics. $275.

"The High Technology Firm in International Operations," Apr. 21-25, Berkeley. Product adaptation, marketing programs, pricing techniques, relations with host governments and joint venture partners, training and working with technical personnel abroad, compensation and personnel policies for U.S. managers overseas. $275.

For further details on the above two courses, write to Continuing Education in Engineering, University of California Extension, Berkeley, Calif. 94720.

"Advanced Technology Seminars," Apr. 14-18, Phoenix. Integrated circuit management (Apr. 14), LSI technology (Apr. 15), computer-aided design (Apr. 16), IC reliability (Apr. 17), IC product comparisons (Apr. 18). $175 per seminar; $750 for all five. ICE Corp., 4900 E. Indian School Rd., Phoenix, Ariz. 85018.

"Incentive Contracting," April. 15-17 (Boston), Apr. 22-24 (Los Angeles), Apr. 29-May 1 (Washington), May 6-8 (St. Louis). Background of incentive contracting, cost only incentives, multiple incentives, trade-off matrix, counter proposal analysis, change orders, subcontracting. NSIA members and government personnel, $225; nonmembers, $250.

"Contract Terminations," Apr. 28-30 (Washington), May 5-7 (Palo Alto), May 12-14 (Chicago), May 19-21 (Dallas), May 26-28 (Boston). Roles and responsibilities upon receipt of termination, managing the settlement effort, processing settlement proposals, management of subcontractor termination claims. NSIA members and government personnel, $225; nonmembers, $250.

For added information on the above two courses contact the National Defense Education Institute, 11 Arlington St., Boston, Mass. 02116.

"Project Management Seminar," Apr. 28-30 (Boston), May 26-28 (Washington), June 23-25 (San Francisco). Why project management; the project manager; the nature of electronic engineering projects; project management organization; project definition; network systems (PERT/CPM); project management functions and tools; work authorization; resource management; multi-project management; project management systems; time, cost, and performance evaluation; applications and problems; outlook for the future; case studies. Co-sponsored by The Electronic Engineer and Booz, Allen and Hamilton Inc. John E. Hickey, Jr., Seminar Coordinator, The Electronic Engineer Magazine, 56th and Chestnut Streets, Philadelphia, Pa.

"Vibration and Shock Testing," May 5-9, Torrance, Calif. Types of vibration tests, dynamic motion, measurement and analysis of vibration, calibration of transducers and systems for vibration measurement, shock calibration for shock measurement, vibration exciters, power supplies for electromagnetic shakers, controls for electromagnetic shaker systems, conducting sinusoidal vibration tests, typical test laboratory difficulties and solutions, random vibration, etc. $200. Tustin Institute of Technology, Drawer Q, Santa Barbara, Calif. 93102.

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Centralab engineers have achieved a new degree of temperature stability in semiconductor type, low voltage ceramic disc capacitors with their development of temperature-stable Ultra-Kaps. The 16 and 25 volt units can hold a maximum capacitance change of ±4.7%; 50 volt units as little as ±7.5%.

Ultra-Kaps also exhibit other superior performance characteristics, such as low impedance; high capacitance density; and operation to temperatures as high as 150°C, as low as –55°C. In 50v ratings average dissipation factor is as low as 1.5%; leakage resistance of 1000 megohms, min.

the stable ones

Ultra-Kaps are ideal for use in transistor circuits because they are operable to a frequency of 1 MHz. And they're still low cost units that replace more expensive mylar and "Hi-K" ceramic capacitors. On quantity orders, they're priced as low as 2½ cents each with delivery as short as 4 to 5 weeks. We can send you samples immediately for your evaluation.

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	16 volt		25 volt		50 volt	
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.290	.02	5.0	.015	65.0	.01	1000
.390	.033	3.0	.022	45.0	.015	1000
.405	.05	2.0	.033	30.0	—	—
.485	—	—	—	—	.022	1000
.515	.068	1.5	.05	20.0	.033	1000
.590	0.1	1.0	.068	15.0	.047	1000
.690	0.15	0.65	0.1	10.0	.05	1000
.760	—	—	—	—	.068	1000
.820	0.2	0.5	0.15	6.5	—	—
.920	0.3	0.33	0.2	5.0	0.1	1000

*Thickness: .156 inches maximum
Lead spacing: Discs less than .500″ diameter, nominal lead spacing is .250″
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A Happening in Fun City

IEEE 1969

The key to "unlocking the future in electrical/electronics engineering" is to attend the tutorial seminars.

From March 24 to March 27, visitors and natives alike will follow the yellow brick road in New York to the IEEE Show and Convention in the hopes of unlocking the future in electrical/electronics engineering. As in previous years, the action will be taking place at the New York Hilton (for the convention) and the New York Coliseum (for the show). There will be more to hear at the convention, less to see at the show.

Something old—something new

The convention this year will feature invited (not solicited) papers exclusively, so you can expect more general treatments with less description of specialized hardware. There are also three courses being given this year. Since we of **The Electronic Engineer** attended the two offered last year, and we note with satisfaction that the IEEE is repeating the one course that was successful and has dropped the one that wasn't, we suggest you not miss the following:

• The course in the **fundamentals of integrated circuits** is being given an encore. We attended it last year (together with 200 other people) and found it clear, up to date, and reasonably deep. It will stress the basics underlying IC technology and will discuss the incorporation of integrated circuits in electronic equipment. Dr. Fred Lindholm, Professor of Electrical Engineering at the University of Florida, is the course director. Make it your business to register in advance for this seminar. Ballroom of the New York Hilton from 8:30-10 A.M. each morning, Monday through Thursday.

• If you are interested in **writing and/or speaking effectively on engineering subjects,** check out the course being given by Mr. Joseph D. Chapline. This workshop will help you gain the skill of self expression and will give you tips for preparing proposals, reports, and articles. Rhinelander Galley South, 8:30-10 A.M., Monday through Thursday.

• A tutorial lecture for those interested in the **fundamentals of reliability engineering** is being given by Dr. Martin L. Shooman, an excellent instructor from Polytechnic Institute of Brooklyn, who has written various books on the subject. West Ballroom from 8:30 to 10 A.M., Monday through Thursday.

There will also be two two-day short courses (9 A.M. to 5 P.M. on Thursday and Friday). One of the courses is "Computer Programming for EEs" and the other is "Problem Solving for EEs Using Time Shared Computers".

Special tours have been planned as part of the "new look" of the IEEE Show. These include a medical electronics tour, which will cover new electronic laboratory instrumentation in an urban medical environment (March 24, 1 P.M.); a tour of a Bedford-Stuyvesent Neighborhood Manpower Center where a computer, run by the residents of the community, is being used to match people and jobs (March 25, 9 A.M.); a visit to a sewerage treatment plant where the most massive water pollution control program in the world will be viewed (March 25, 1 P.M.) and an electronic traffic control system tour at Queens Plaza which will demonstrate the use of a computer in operating an experimental traffic control system (March 26, 9 A.M.) If you want to attend these tours, stand in line on Sunday as soon as you register. They are limited to 20 or 25 people each.

The theme for the Highlight Session on Tuesday evening, March 25 (at the Hilton) is "Electronically Expanding the Citizen's World", a panel where leaders representing industry and society will exchange views on how they think electronics will expand the human experience. We hope this one is an exception, but these panels usually limit themselves to exposing interface problems, and fail to challenge the audience to find solutions. Mr. James D. O'Connell, Special Assistant to President Nixon, will moderate.

Potpourri

Four special microwave sessions are planned for March 25 and 26 in Microwave Hall in the Coliseum. Tuesday's session, titled "Computers Can Help Solve the Microwave Problems", will be held from 10:30 A.M.-1 P.M.

1969 IEEE INTERNATIONAL CONVENTION SESSION CHART

NEW YORK HILTON HOTEL	MONDAY MARCH 24		TUESDAY MARCH 25		WEDNESDAY MARCH 26		THURSDAY MARCH 27		FRIDAY MARCH 28
	10:00 A.M. 12:30 P.M.	2:00-4:30 P.M.	10:00 A.M.- 12:30 P.M.	2:00-4:30 P.M.	10:00 A.M.- 12:30 P.M.	2:00-4:30 P.M.	10:00 A.M.- 12:30 P.M.	2:00-4:30 P.M.	
Trianon Ballroom (A)	SESSION 1A Automation for Health	SESSION 2A The Role of the Citizen Engineer in Technological Decision Making	SESSION 3A System Technologies in Politics and Economics	SESSION 4A Where is the Electrical Engineering Profession Headed?	SESSION 5A Electrical Printing and Future Communication—1984	SESSION 6A LSI in Use	SESSION 7A Manufacturing Technology for Microelectronics	SESSION 8A The Electronic Package . . . . What, Why, How Much?	
Mercury Ballroom (B)	SESSION 1B Self Organization and Learning Systems . . . . Review and Outlook	SESSION 2B Structuring tomorrow's Computer Systems	SESSION 3B Today's Choice of Digital Computers—What's the Difference?	SESSION 4B What Edge Does Formal Engineering Management Training Offer?	SESSION 5B The Tale is Told on the Bottom Line . . . Elements of Corporate Financial Success	SESSION 6B Compuer Peripherals	SESSION 7B Communications and the Computer	SESSION 8B Graphics and Computer-Aided Design	
Sutton Ballroom North (C)	SESSION 1C Integrated Microwave Circuits	SESSION 2C Surface Waves—The Acoustic Signal Processing Technique of the Future	SESSION 3C The Laser Comes of Age—I	SESSION 4C The Laser Comes of Age—II	SESSION 5C Recent Advances in Laser and Holographic Optical Systems	SESSION 6C Increased Power Reliability for Industrial Systems	SESSION 7C Electric Power Systems of the Future: New Sources, Uses and Techniques	SESSION 8C New Lines of Power Transmission	
Sutton Ballroom South (D)		SESSION 2D Sensory Aids for the Handicapped	SESSION 3D Visualization of Biological Tissue	SESSION 4D Industrial Semiconductor Devices					
Nassau Suite (E)	SESSION 1E Radio Astronomy —Science and Engineering	SESSION 2E 20 years of Information Theory	SESSION 3E Modern Technology for Signal Handling	SESSION 4E Computer Languages for Process Control	SESSION 5E Trends in Instrument-Computer Systems	SESSION 6E Engineering for Oceanography	SESSION 7E The Interdisciplinary Nature of Reliable Design	SESSION 8E An International Language for Electronics?	
Murray Hill Suite (F)	SESSION 1F Rail Transportation Systems	SESSION 2F Living and Working in Space	SESSION 3F Static Converters —World Wide	SESSION 4F Broadcasting Tomorrow	SESSION 5F Expanding Systems Applications Using Satellites	SESSION 6F Communications Systems—Management and Control	SESSION 7F Filters for the Nonspecialist		9:00 A.M.-Noon Special Session Insulating Materials and Electronic Systems Team Up for the Future
Gramercy Suite (G)	SESSION 1G Acoustical and Optical Interactions	SESSION 2G Materials for Spanning the Infrared to the Microwave Gap	SESSION 3G Thin films or Thick?	SESSION 4G Air Traffic in the 1980's: Order, Chaos or Catastrophe?	SESSION 5G Semiconductor Memory	SESSION 6G Classes in Electronics . . . New Frontiers and New Uses	SESSION 7G Radiation Damage and Hardened Device Development	SESSION 8G Evolutionary Advancements in Audio	
		SESSION 2P 8:00 P.M. Hayden Planetarium Manned Lunar Exploration in the 1970's		Highlight Session 8:00-10:30 P.M. Grand Ballroom Electronically Expanding the Citizen's World			Two-Day Course 9:00 A.M.- 5:00 P.M. Regent Room-Sutton Ballrooms Computer Programming for Electrical Engineers and Problem Solving for Electrical Engineers Using Time-Shared Computers		Two-Day Course 9:00 A.M.- 5:00 P.M. Regent Room-Sutton Ballrooms Computer Programming for Electrical Engineers and Problem Solving for Electrical Engineers Using Time-Shared Computers
Sutton Ballroom South	8:30-10:00 A.M. Workshop: How to Write a Technical Paper		8:30-10:00 A.M. Workshop: How to Write a Technical Paper						
West Ballroom	8:30-10:00 A.M. Tutorial Seminar Fundamentals of Reliability Engineering		8:30-10:00 A.M. Tutoral Seminar Fundamentals of Reliabiiity Engineering		8:30-10:00 A.M. Tutorial Seminar Fundamentals of Reliability Engineering		8:30-10:00 A.M. Tutoral Seminar Fundamentals of Reliability Engineering		
Rhinelander Gallery South	8:30-10:00 A.M. Tutorial Seminar Effective Engineering Writing and Speech		8:30-10:00 A.M. Tutorial Seminar Effective Engineering Writing and Speech		8:30-10:00 A.M. Tutorial Seminar Effective Engineering Writing ard Speech		8:30-10:00 A.M. Tutorial Seminar Effective Engineering Writing and Speech		
East Ballroom	8:30-10:00 A.M. Tutorial Seminar Fundamentals of Integrated Circuits		8:30-10:00 A.M. Tutorial Seminar Fundamentals of Integrated Circuits		8:30-10:00 A.M. Tutorial Seminar Fundamentals of Integrated Circuits		8:30-10:00 A.M. Tutorial Seminar Fundamentals of Integrated Circuits		
NEW YORK COLISEUM South America Room Continuous Film Theatre—10:30 A.M.—6:00 P.M.—Monday through Thursday									
Microwave Hall (1st Mezzanine) Special Microwave Presentations			SESSION A 10:30 A.M.-1:00 Computers can Help Solve Your Microwave Problems	SESSION B 2:30-5:00 P.M. Microwave Reflectometry	SESSION C 10:30 A.M.-1:00 Low Noise Receivers	SESSION D 2:30-5:00 P.M. High Power Microwave Tubes			

These sessions recommended by Electronic Engineer editors.

IEEE 1969 (concluded)

The afternoon discussion from 2:30-5 P.M. deals with "Microwave Reflectometry". "Low Noise Receivers" is the subject for the Wednesday morning meeting (10:30 A.M.) and the session's finale includes a talk on "High Power Microwave Tubes".

There will be a special session on Friday, March 28, titled "Insulating Materials and Electronic Systems Team Up for the Future" (from 9 A.M. to noon in the Murray Hill Suite of the Hilton). The session's organizer is Charles Harper of Westinghouse Electric Corp.

Registration

Registration will take place at either the New York Hilton or the New York Coliseum. For those "checking in" at the Hilton, the hours are from 2-8 P.M. on Sunday, March 23, and from 9 A.M.-5 P.M. daily during the Convention. (Tuesday the registration period will be extended to 8 P.M.) At the Coliseum you can register from 9 A.M.-8 P.M., March 24-27. The registration fee is $3 for IEEE members and affiliates and $6 for non-members.

Fees for the three tutorial seminars are $85 for members and $100 for non-members. The cost for short courses is $75 for members and $90 for non-members.

And back at the show

If you attend the show, you'll see about 25% fewer companies exhibiting than you saw last year. Many component manufacturers have shunned the show during the past four years —feeling that few people go to the IEEE Show to select components— and several instrument makers have followed their example this year. The decrease in exhibitors can also be attributed to absorptions of smaller companies by their "big daddies".

With the absence of some of the larger companies, there is more room for companies to "show their wares". See our products section for those products being introduced for the first time at the show.

The exhibition at the Coliseum will be open from 10 A.M. to 8 P.M. during "show time". Despite the falling off of exhibitors, all four floors will be utilized. The first floor has been set aside for production equipment and service organizations (publishers and consultants). The second floor is restricted to systems and instruments. The third and fourth floors will be devoted to components with microwave components included in the third-floor exhibits.

We set out to build the best dual-gate MOSFET available...

It's called the MFE3007.

This newest addition to the growing Motorola family of dual-gate types combines FET advantages with dual-gate capabilities resulting in characteristics of low cross-modulation, more efficient AGC action and lower feedback capacitance. It's the finest dual-gate MOSFET available. RF circuit designers will find many applications waiting for the MFE3007 such as AGC amplifiers, frequency converters, TV/FM tuners and color demodulators. Cascode applications are facilitated by the series arrangement of the two channels, each with a separate and independent control gate, thereby maintaining separation of RF signal and AGC voltage.

Consider how these specifications would mean more to *your* application:

- Power Gain (G_{ps}) — 18 dB (min), 24 dB (typ) @ 200 MHz
- Noise Figure (NF) — 4 dB (max) @ 200 MHz
- Forward Transconductance (y_{fs}) — 10,000 μmhos to 18,000 μmhos
- Input Capacitance (C_{iss}) — 5.5 pF (max)
- Output Capacitance (C_{oss}) — 3.5 pF (max)
- Reverse Transfer Capacitance (C_{rss}) — 0.02 pF (typ)

And that's not all. The MFE3007 is fabricated using the Motorola-developed silicon nitride passivation process. This process yields higher gate-to-source breakdown voltages (35 volts) and assures long-term stability under both high temperature and reverse biasing conditions.

Top performance specifications, versatility, long term stability. All offered at a mere 99¢ (in quantities of 1,000-up). Upgrade your RF circuit performance by evaluating the MFE3007 today. Your local Motorola distributor has units waiting. And while you are checking take a look at these other Motorola dual-gate MOSFETs:

Device	G_{ps} (min)	NF (max)	C_{rss}	y_{fs} (μmhos)	Price (1000-up)
MFE 3006	20 dB @ 100 MHz	4.5 dB @ 100 MHz	0.02 pF (typ)	8,000 to 18,000	90¢
3N140	16 dB @ 200 MHz	4.5 dB @ 200 MHz	0.03 pF (max)	6,000 to 18,000	98¢

Evaluation will prove that Motorola offers more in dual-gate MOSFETs.

—where the priceless ingredient is care!

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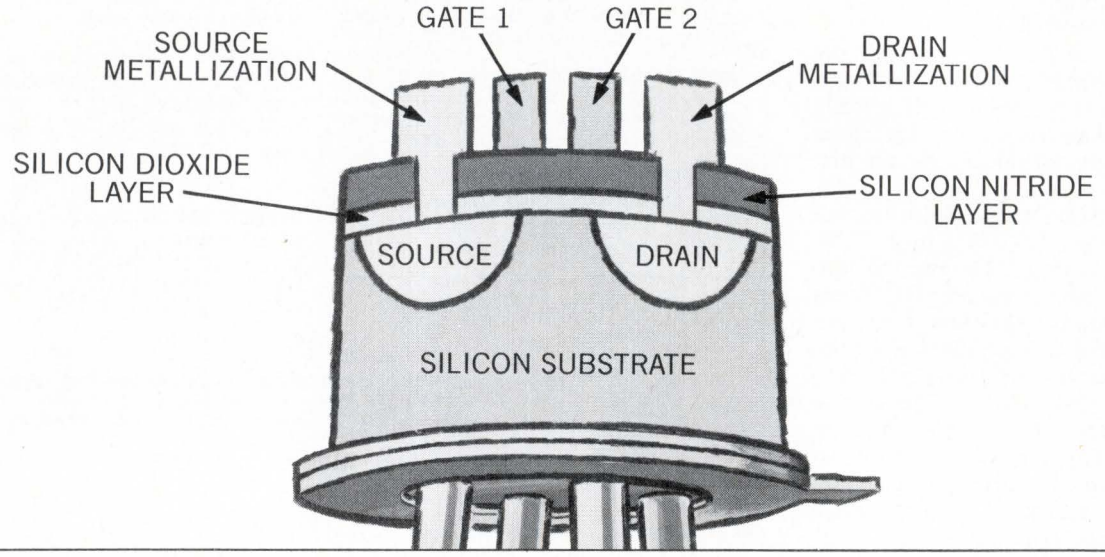


IC regulator removes restrictions

This linear IC challenges discrete, hybrid, and modular voltage regulators. Unlike IC predecessors, it accommodates high and negative voltages, high currents, and provides easily-adjusted controls without the need for many external components.

By J. Darryl Lieux and **Robert D. Ricks**
Fairchild Semiconductor, Mountain View, Calif.

The trouble with many monolithic voltage regulators is inflexibility. They can carry a user only so far, because their arrangements restrict their application, and there is a general lack of sufficient internal circuitry.

Thus, when a system calls for high voltage (a few hundred volts), negative polarity inputs, a floating source, or a high current-driving capability, the design engineer finds himself severely limited. If he uses a typical monolithic regulator in these not-so-common system situations, he is virtually compelled to buttress the circuit with a host of external components. The result often is a hodge-podge of parts that negates the value of using an IC in the first place. Worse yet, the network will meet but one case; a slightly different application will often call for a complete redesign.

Now, a new monolithic, the μA723, removes these restrictions. Full of elements arranged for maximum design flexibility, it meets the voltage regulator needs of a majority of systems. In many cases, only a rearrangement of external resistors is needed to make the circuit "fit" a new application.

The IC can handle levels ranging from a few volts to kilovolts, and functions with both positive and negative power supplies. It can control milliamperes through amperes. Its accuracy is precise to within a tenth percent of a volt. You can tie it to your system ground or float it above a reference, and operate it either in series or in shunt. It has high ripple rejection, an adjustable output, and can run as a constant-current source.

Some performance parameters

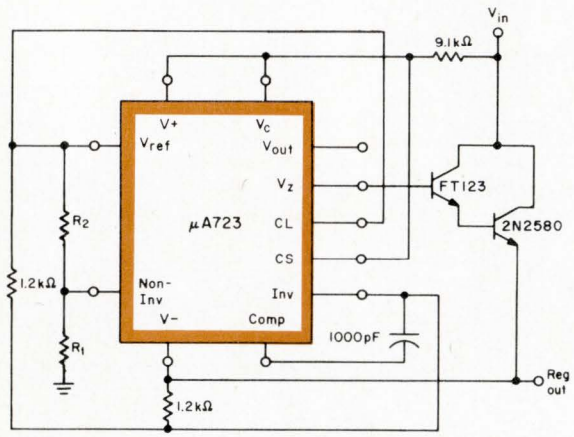
Line reg.: 0.01%
Load reg.: 0.02%
Ripple reg.: 74 dB
Output voltage temp. coeff.: 0.002%/°C
Reference voltage (nom.): 7.15 V
Standby current drain: 2.5 mA
Output voltage: 2-37 V
Output current: 0-150 mA
Output noise voltage: 20 μV rms
Stability (long term): 0.1%/1000 h
Input voltage (nom.): 9.5 V min.; 40 V max.
Max. power dissipation: 800 mW
Power derating: 6.8 mW/°C above 25°C

Matching the mix

Besides the normal IC element complement — npn transistors, diodes, resistors—the regulator has a variety of less-common elements, such as zener diodes, junction field-effect transistors, pinch resistors, and pnp transistors. The result is a grouping of stages that compensate for one another thermally and give you electrical advantages such as high gain, ease of frequency compensation, level-translation, and so forth.

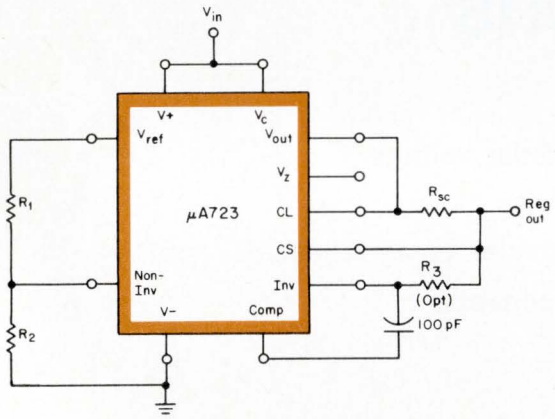
The main parts of the chip are the voltage reference section, the error amplifier, the current sources, and the output stages (see the panel on p. 56).

Basic voltage regulator applications



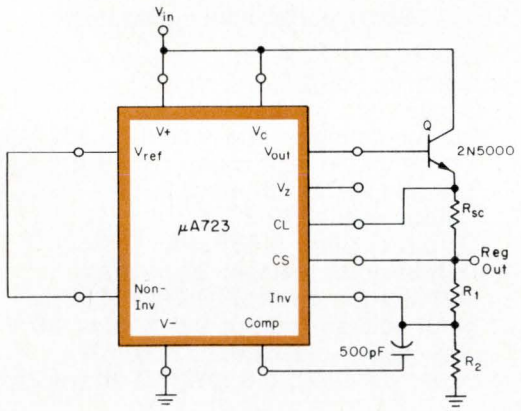
High-voltage floater. Base-emitter junction of current-limit transistor is zenered and added to V_{ref} to form a pre-stabilized +14V supply. This eliminates need for extra floating supply.

Typical performance		Design guidelines	
Reg. output voltage	100 V	V_{out} range	20 V min.
Line reg. ($\Delta V_{in} = 20$ V)	15 mV	V_{in} range	130–180 V
Load reg. ($\Delta I_L = 100$ mA)	20 mV	I_{ref} (output)	5 mA
		$V_{out} = 3.5\ (R_2 + R_1)/R_1$	



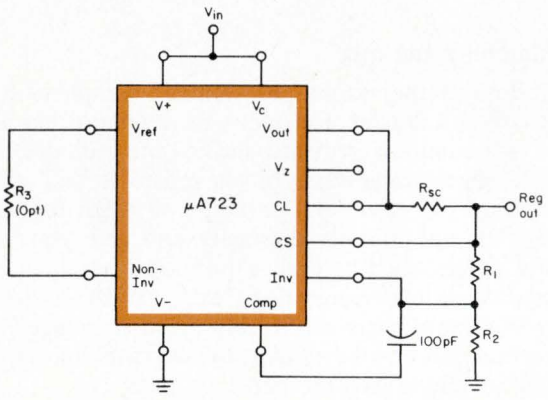
Standard, low-voltage regulator is self contained. Resistor divider connection at V_{ref} obviates need for output attenuation feed to inverting input of comparison amplifier.

Typical performance		Design guidelines	
Reg. output voltage	5 V	V_{out} range	2-7 V
Line reg. (ΔV_{in}=3 V)	0.5 mV	V_{in} range	9.5-40 V
Load reg. (ΔI_L=50 mA)	1.5 mV	V_{out}=[$R_1/(R_1+R_2)$] x 7 V; R_3=$R_1R_2/(R_1+R_2)$ for min. drift	



High-current regulator. External npn pass transistor boosts power capabilities, accommodates ampere outputs.

Typical performance		Design guidelines	
Reg. output voltage	15 V	V_{out} range	7-37 V
Line reg. (ΔV_{in}=3 V)	1.5 mV	V_{in} range	9.5-40 V
Load reg. (ΔI_L=1 A)	15 mV	I_{max} (output of Q)	2 A
		V_{out}=[$(R_1+R_2)/R_2$] x 7 V	

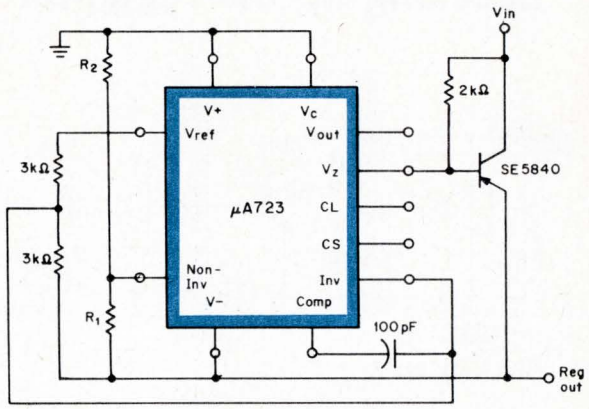


Medium-current regulator configuration for higher output voltages. Resistor attenuator regulates levels above internal reference voltage. Feedback capacitor in frequency compensation network uses breakpoint provided by R_1.

Typical performance		Design guidelines	
Reg. output voltage	15 V	V_{out} range	7-37 V
Line reg. (ΔV_{in}=3 V)	1.5 mV	V_{in} range	9.5-40 V
Load reg. (ΔI_L=50 mA)	4.5 mV	V_{out}=[(R_1+R_2/R_2)] x 7 V; R_3=$R_1R_2/(R_1+R_2)$ for min. drift	

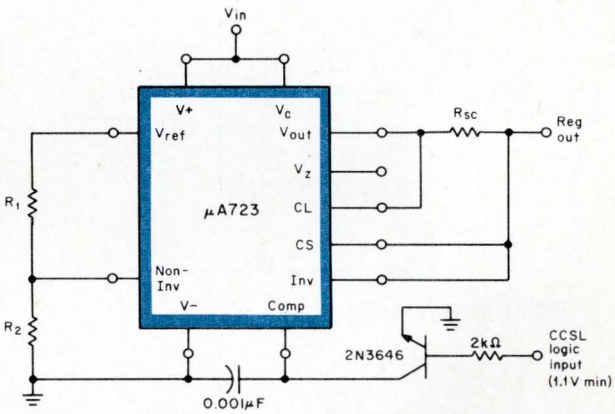
Negative voltage regulator accepts minus-input power supply. Breakdown of the pnp series pass elements limits the input voltage.

Typical performance		Design guidelines	
Reg. output voltage	−15 V	V_{out} range	−15 V min.
Line reg. ($\Delta V_{in} = 3V$)	1.0 mV	V_{in} range	−20 V min.
Load reg. ($\Delta I_L = 100$ mA)	2.0 mV	I_{out} max	1 A
		$V_{out} = 3.5\ (R_2 + R_1)/R_1$	



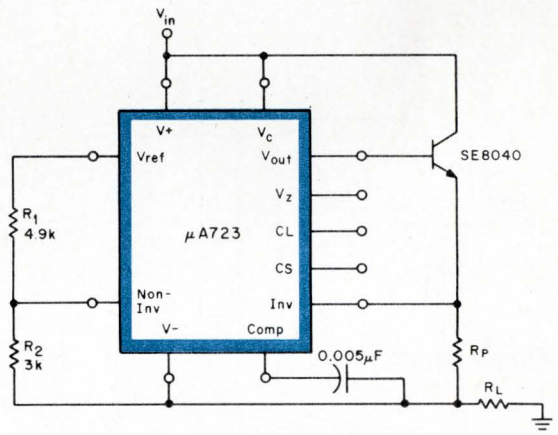
Remote-shutdown regulator. Complementary current-sinking logic from external digital elements lets regulator be turned OFF remotely. If you do not need current limiting, ground the CL pin and drive the CS input with 1 mA. This lets you use the internal series-pass device for shutdown.

Typical performance		Design guidelines	
Reg. output volt.	5 V	V_{out} range	2—7 V
Line reg. ($\Delta V_{in} = 3$ V)	0.5 mV	V_{in} range	9.5—40 V
Load reg. ($\Delta I_L = 50$ mA)	1.5 mV	$V_{out} = [R_1/(R_1 + R_2)]$ x 7 V	



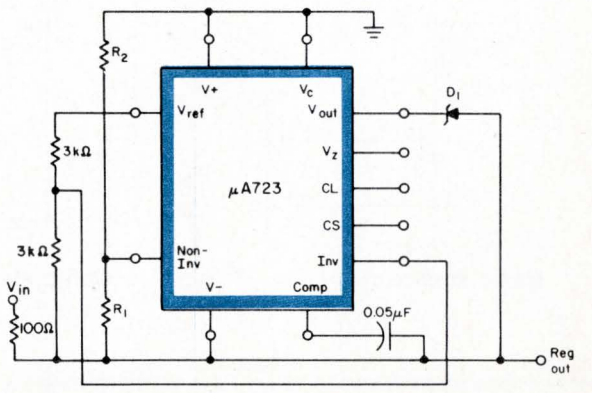
Current regulator. Voltage regulator is constant-current source via programming resistor R_p and floating connection.

Typical performance		Design guidelines	
Reg. output current	30 mA	I_{out} range	10 mA min.
Line reg. ($\Delta V_{in} = 5$ V)	0.3 mA	V_{in} (min)	9.5 V
Load reg. ($\Delta R_L = 200\ \Omega$)	0.2 mA	$I_{out} = 3/R_p$ (in ohms)	
		V_{in} (min) $= 9.5$ V $+ R_L I_{out}$	

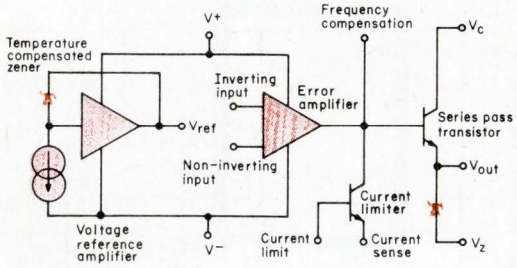


Negative shunt regulator. Negative and positive shunt-regulators supplement series-mode operation. D_1 can be the internal zener (V_Z pin, 20 mA limit) or the base-emitter junction of the internal CL transistor (5 mA limit). High-current loads (to 150 mA) need an external element (such as a conventional zener of three forward-biased diodes).

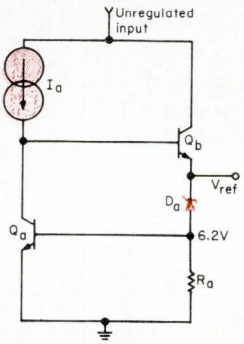
Typical performance		Design guidelines	
Reg. output voltage	−15 V	V_{out} range	−9.5 V min.
Line reg. ($\Delta V_{in} = 3$ V)	2 mV	V_{in} (min)	−10 V
Load reg. ($\Delta I_L = 50$ mA)	10 mV	$V_{out} = 3.5(R_2 + R_1)/R_1$	



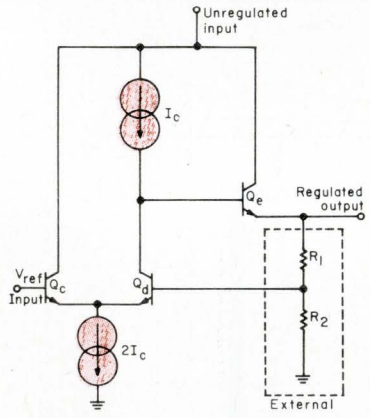
Breaking up the regulator



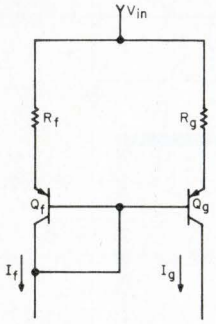
Block by block



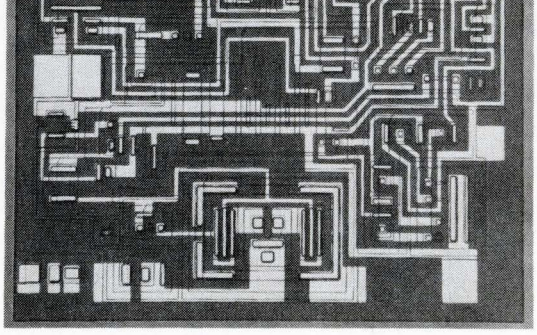
Point of reference



Simple error

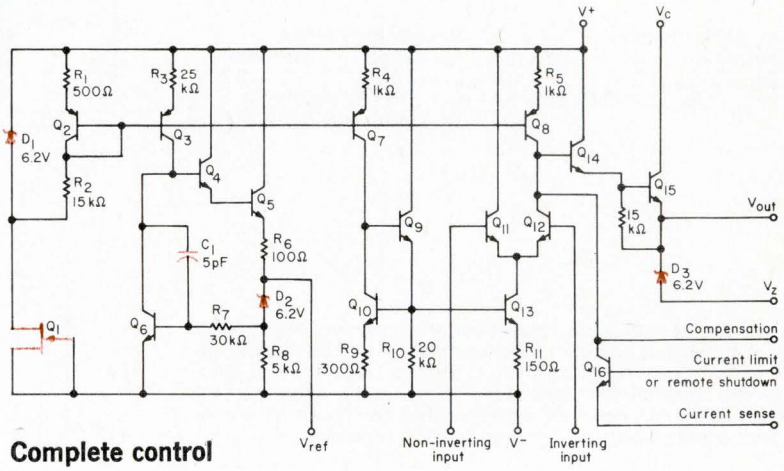


Basic source



Pinning down the chip

Regulator's versatility is traceable to high chip content, which reduces the external component count. The block diagram defines major portions of the monolithic, and its terminals to the outside world. In the simplified voltage reference section schematic, transistor Q_a matches and offsets temperature drift of the zener element. The simplified error amplifier portion has constant-current sources in a differential configuration; external resistors R_1 and R_2 set the output voltage. A high output impedance current source (shown simplified) gives high line rejection and keeps gain high. The regulator's complete schematic shows a diversity of elements: npn and pnp transistors, FETs, zeners, and an MOS capacitor. An 11-pin chip, it measures 53 by 60 mils.



Complete control

The basic voltage reference section uses a zener diode, D_a, which has a breakdown voltage of 6.2 V (typ.) at 100 μA and a temperature coefficient of 2.1 mV/°C. Resistor R_a biases D_a to its operating current. The collector current of Q_a can be varied to match the temperature coefficient of D_a, and current source I_a may be set to provide a net temperature coefficient of zero. Variations in I_a change only the V_{BE} of Q_a and not the breakdown voltage of D_a. Thus, variations in the value of V_{ref} are low. Transistor Q_b supplies the current of D_a, R_a, and any external loads.

In the simplified error amplifier section, transistors Q_c and Q_d form a differential pair driven by current source $2I_c$. The voltage on the V_{ref} input is equal to the voltage at the junction of R_1 and R_2, so the regulated output voltage is:

$$E_o = \frac{(R_2 + R_1)}{R_2} V_{ref}$$

Transistor Q_e is a buffer — it unloads Q_d. The gain from the base of Q_d to the output is very large because of the pnp current source in the collector of Q_d. So this single stage provides adequate voltage gain for the error amplifier function. Because there is only one stage, compensation is simple.

The whole bag

In the complete schematic, Q_1, Q_2, D_1, R_1 and R_2 make up the biasing network for the pnp current sources Q_3, Q_7, and Q_8. Transistor Q_1 is an n-channel FET. Since the current it draws is independent of power supply variations, line regulation is greatly improved. This also minimizes power dissipation because the current drawn does not increase appreciably at large supply voltages. Diode D_1 regulates the bias network voltage, and provides a well-regulated voltage at the base of Q_2 with respect to V+.

The current sources, Q_3, Q_7, and Q_8, must have a very high output impedance to provide high-line rejection and to increase the gain of the error amplifier. With a high-Z bias network (see simplified schematic), a change in V_{BE} has only a small effect on the voltage across R_2. The collector current is constant with changes in collector-to-emitter voltage, giving a very high output impedance.

For a low output impedance in the voltage reference loop, a Darlington pair (Q_4 and Q_5) and a resistor (R_6) are combined. Capacitor C_1, an MOS device, eliminates the need for any external compensation of this loop.

Transistors Q_7, Q_8, Q_9, Q_{10}, and Q_{13} are the current sources I_c and $2I_c$ shown in the simplified error amplifier schematic. Q_7 and Q_8 supply about 200 μA, which doubles to 400 μA in Q_{13}, because R_9 is twice R_{11}. Transistor Q_9 keeps Q_{10} out of saturation. A Darlington pair, Q_{14} and Q_{15} — represented by Q_e in the simplified error amplifier—unloads the collector of Q_{12}. The power pass-transistor, Q_{15}, is actually a multiple device with individual emitter resistors. They prevent current-hogging and secondary breakdown, and enlarge the safe operating area.

Resistors R_1 and R_2 divide the reference output, V_{ref}, to the desired output voltage value, and supply the non-inverting input of the error amplifier, which is a voltage-follower. Capacitor C_1 rolls off the error amplifier's response, and eliminates the need for external compensation. The Darlington pair, Q_4 and Q_5, together with R_6, provide a low-impedance output for the voltage reference loop.

A feature of the voltage regulator is that it can operate under floating conditions. This is possible because both input terminals of the error amplifier are brought out for connection externally. This also lets the IC have large positive and negative voltage outputs. An input voltage beyond the absolute maximum rating of the voltage regulator may be regulated down as low as 5 V.

When used without external pass transistors, the μA723's frequency stability is assured by a C_1 value of 100 pF. With external pass transistors, you should increase C_1 to about 500 pF. If you want a minimum component count, use a 1000-pF capacitor from the compensation pin to ground, instead of the 100 pF from the compensation pin to the inverting input. And if there is a large amount of input power supply lead inductance present, you should place a 0.47 μF ceramic bypass across the two power supply leads.

For optimum temperature tracking, you should add a resistor equal to the parallel combination of R_1 and R_2 between the V_{ref} and non-inverting terminals. This resistor should also be added if you use a bypass capacitor between the non-inverting input and ground. Such a capacitor reduces noise and ripple, since the output impedance of the V_{ref} terminal is only 1 Ω.

In high power applications, you may have to heat sink the μA723. Be sure that the device doesn't exceed a junction temperature of 150°C in the TO-5 package, or 125°C in the dual-in-line package.

Control options and applications

These built-in interconnection options give the IC its versatility:

- Two addressable error amplifier inputs—inverting and noninverting—can accommodate high voltage and negative supplies.
- An internal power transistor collector is made available externally.
- An internally generated reference voltage is buffered and brought out.
- An offsetting zener diode cuts down on external parts.

The panels on pages 54 and 55 show some applications of the 723 regulator. The performance figures cited are those obtained at room temperature independent of one another (e.g., the line regulation figure is achieved under constant load, and the load regulation figure under constant line conditions).

In each of the regulator circuits shown here, the sum of R_1 and R_2 should be 1.5 kΩ or higher to avoid loading errors. The value of the current-limiting resistor, R_{sc}, is $0.7/I_{Lim}$. (I_{Lim} is the short-circuit current.)

INFORMATION RETRIEVAL

Integrated circuits, Semiconductors, Circuit design, Power supplies

NEW PRODUCT NO. 71

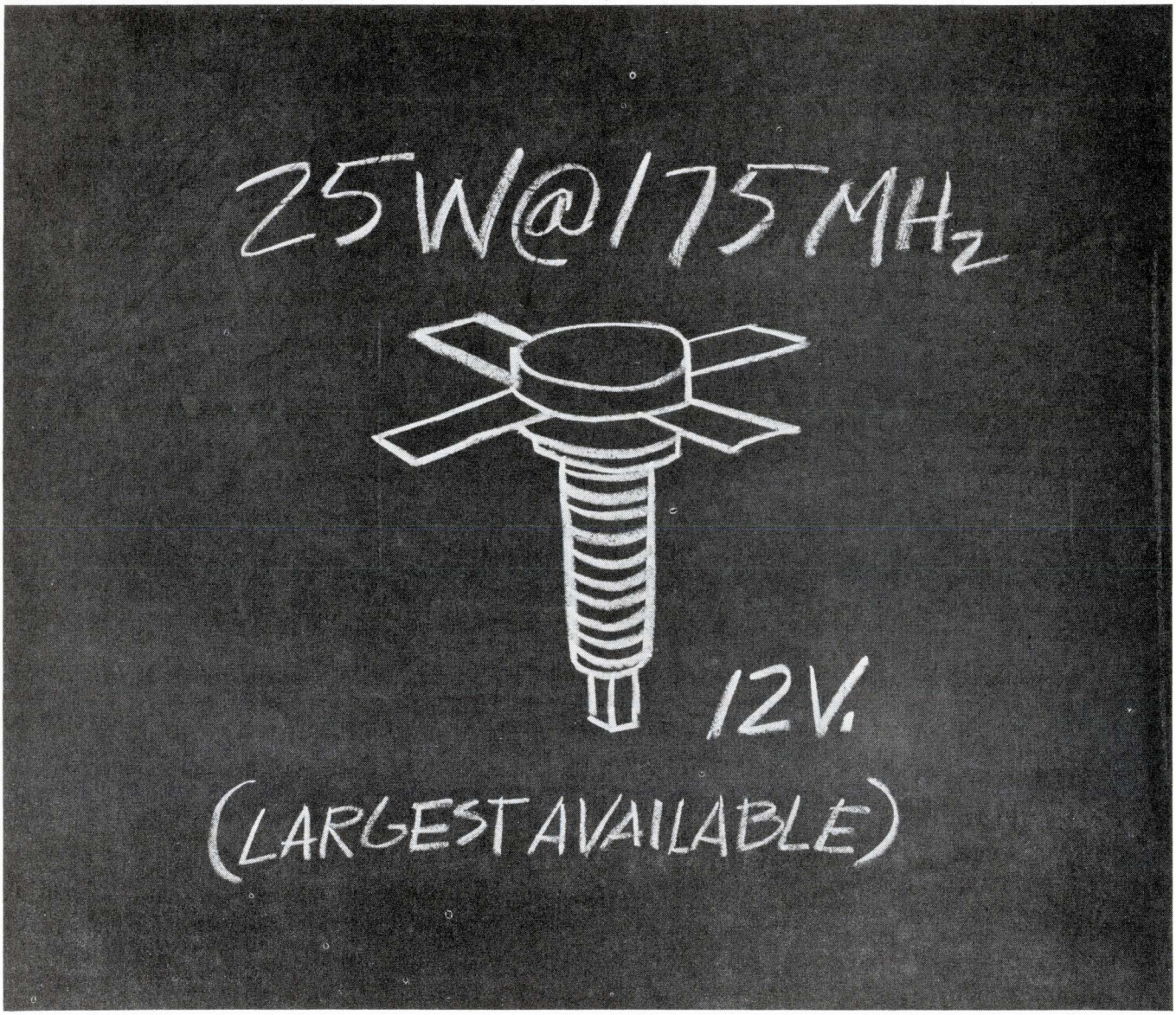
MSA 8506 RF POWER TRANSISTOR

The MSA 8506 is Fairchild's first new discrete device for 1969. It provides a combination of power output, frequency and price that can't be matched by any competitive transistor.

The new RF device features 25W output at 175MHz. It's resistor-stabilized and comes in the largest strip line package on the market. (Package size contributes to improved power dissipation.)

The MSA 8506 is designed for final power amplifier applications in communications systems such as AM and FM radio; Mobile, marine radio, and portable radios.

Typical specifications for the 12V device include LV_{ceo} of 18, BV_{ces} of 36 and 25W P_{out}. It's radiation hardened and will operate over the entire temperature range from —55°C to +125°C. Write for complete specs. Your Fairchild distributor has this device in stock now. Prices are $36.00 each for 1 to 99, $29.00 each for 100 to 999.



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Protecting circuits from over and under voltages

Circuits that detect voltage changes caused by line variations or circuit failures have become increasingly important due to the number of transistor and integrated circuits being used. Protect your design with these circuits.

By Richard Klein, Acme Electric Corp., Cuba, N. Y.

Voltage regulators are growing in popularity for supplies that deliver power to transistorized and integrated circuitry. But when these regulators fail, they can cause over- or under-voltage—which can play havoc with a design. Excess voltage can easily damage transistors and low-thermal-capacity resistors; low voltage can make bias supplies inadequate and cause load malfunctions (e.g., relays drop out or computer memory is lost).

Series regulators can cause over- or under-voltage; e.g., if the series element shorts, the unregulated source voltage will be applied across the load, making the load voltage increase; if full control drive to the series element is lost it can absorb too much voltage, resulting in under-voltage at the load.

Shunt regulators can also create similar problems. If the series impedance shorts, it will cause an over-voltage; if the shunt element shorts, it will cause an under-voltage.

Even **special-design regulators** can cause unplanned increases or decreases in the voltage across the load, regardless of how sophisticated the design. In fact, it's a rare regulator circuit which will not cause either under- or over-voltage when some malfunction occurs.

Because regulators have this problem, circuits which protect the load from over- or under-voltage are more necessary than ever. The degree of protection needed depends upon the load tolerance to voltage and power stress. It ranges from no extra protection, to over-voltage, and shut-down schemes. The following circuits vary in component count, and complexity. The simplest that will do the job is the best choice.

Over-Voltage

An over-voltage circuit measures the output voltage, compares it with a reference, develops a signal when limits are exceeded, and triggers an indicator or shut-down device.

An alarm may suffice when long-term over voltages can be tolerated. For moderate thermal time constants, circuit breakers or fuses may be activated to protect circuit and load. To protect against voltage breakdown or short thermal time constants, crowbar or other voltage-limiting circuits may be used to limit the actual voltage rise.

Figure 1 shows a simple arrangement in which a zener-diode voltage operates the circuit and also controls the unijunction transistor firing. Resistor R will receive current pulses when the UJT emitter is above the firing level. These pulses can be used for alarm or control purposes. By using an isolated zener supply and a pulse transformer in place of R, you can completely isolate the circuit and place it anywhere in the supply circuitry.

You can adjust the base 2 resistor to compensate for temperature changes in the zener and the UJT. Select the value of R so that leakage current through the B1-B2 resistance of the UJT will not develop excess voltage across R during the quiescent mode. Resistance of the voltage divider feeding the UJT emitter should be enough to limit the emitter current to less than valley-current level; otherwise, only one pulse will be developed across R.

The capacitor provides stored energy to be dumped into R when there is an over voltage. It adds a small time delay but the overall circuit can operate very rapidly—typically 200 μs. This circuit is suitable for applications where sensing accuracy of 2 or 3% is ade-

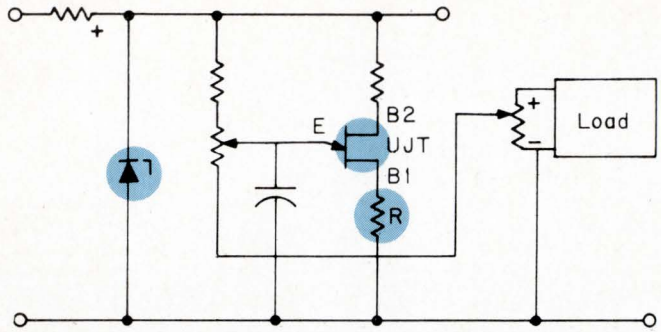

Fig. 1: Over-voltage circuit. In this circuit the zener-diode voltage is both a voltage source that operates the circuit and a reference voltage that controls the UJT firing. The UJT is in a standby non-oscillating state. Abnormal increases in output voltage raise the emitter above the standoff point, firing the UJT and sending a pulse of current into resistor R. These pulses can, in turn, be used to fire a small SCR to operate a relay, light a lamp, or trigger a large crowbar SCR to short the power supply.

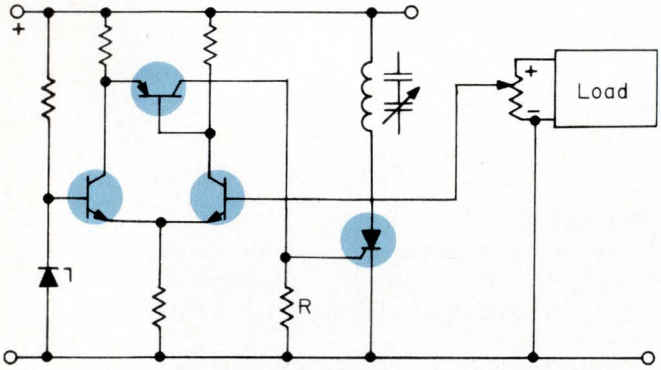

Fig. 2: This over-voltage circuit is more accurate than the one shown in Fig. 1. Here a differential amplifier operates as a level detector. When the sensed output voltage exceeds the level of the reference zener, Q1 and Q2 switch, turning on amplifier Q3 which furnishes a gate signal to an SCR, or driver power to a relay. Interchanging the base connection of Q1 and Q2 changes this circuit into an under-voltage detector.

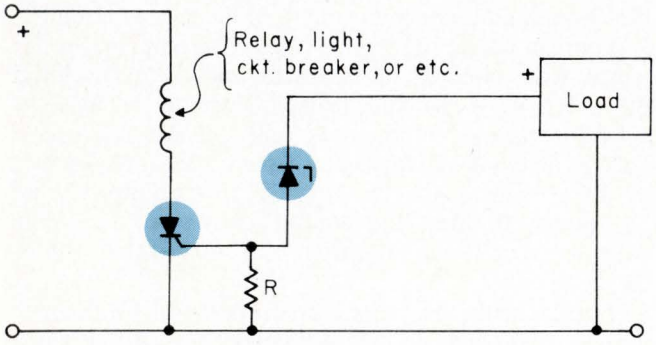

Fig. 3: This simple over-voltage circuit uses the zener voltage plus the SCR gate-cathode voltage as a standoff. When sensed output exceeds that sum, zener current flows into the SCR gate to fire the SCR.

quate, and where voltages to be sensed are higher than 3 V. Below 3 V, accuracy drops rapidly.

Where a higher accuracy over-voltage detection is needed, try the circuit of Fig. 2. It is not only more accurate, but its dc output can be used in many ways. If it gates an SCR crowbar switch, total circuit operating time is only about 5 μs.

The circuit in Fig. 3 offers simplicity where trip-point accuracy is not critical. Accuracy of the setting will vary with temperature changes which will cause the SCR gate voltage and the zener voltage to change. Overall trip-point accuracy is in the 15-20% range. The circuit works with voltage inputs of 4 V or more. We use this circuit with good results in custom power supplies which energize blocks of integrated circuitry in office copying machines, automatic process control equipment, and computer graphic devices.

Under-Voltage Circuits

Slight changes in circuit connections can change an over-voltage circuit into an under-voltage circuit. Figure 4, for example, is the under-voltage equivalent of Fig. 1. In one case, over-voltage *pushes* the emitter up, causing the UJT to fire. In the other case, under-voltage *pulls* the emitter up, with the same result.

Interchanging the base connection of Q1 and Q2 in Fig. 2 changes circuit into under-voltage detector.

The circuit of Fig. 3 is not as easily transformed, but Fig. 5 shows an under-voltage circuit which works on the same general principle.

If you need protection against both under-voltage and over-voltage, you can use these "matched pairs" of circuits in combination. For cases where extensive protection with minimum components is needed, you may have to couple several circuits to a single detector.

Turn-on and turn-off transients

Transients fall into two categories — those in the power and load circuit, and those in the control circuit. Both must be considered when designing voltage-detection circuits. The control circuit time constants are involved in bringing up the regulator circuits. The filter circuits in the bias supplies determine at what rate or after how much delay the reference voltages will be turned on. And, of course, these same time constants are present when the control circuit is turned off.

When over-voltage detection is used, the over-voltage reference must rise faster than the voltage being measured, to avoid tripping during turn-on. However, if the rate difference is large, the over-voltage may trip during turn-off.

When under-voltage sensing is used with over-voltage sensing, it is difficult to select the proper time constants to prevent tripping. In this situation you can use electronic or relay disabling to connect the trip circuits after bias and load voltages are present and to remove them before bias and load voltages are shut down. Usually, disabling only the under-voltage trip is enough.

A convenient method of coordinating time constants is to use a separate reference for the voltage regulator and the over-voltage circuit. The control reference can have a long time constant on turn-on, causing the output voltage to rise slowly. In this way, time is provided to bring up and stabilize the over-voltage reference. With this method the control reference time constant doesn't appear in the control circuit response time.

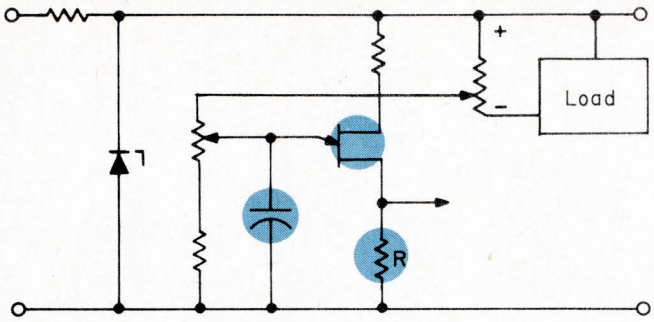

Fig. 4: Under-voltage circuit. This circuit is similar to that of Fig. 1, but opposite in the sense that decreases in load voltage raise the UJT emitter, sending a current pulse from C into R.

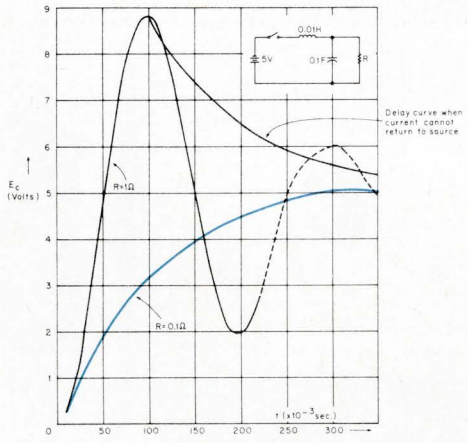

Fig. 6: The type of filter used will help determine whether or not there will be an over-voltage or overshoot at turn-on or during load step changes. With this circuit it's apparent that an overshoot could occur when voltage is applied. The actual transient for one set of circuit values is plotted. When a 0.1-Ω resistor is the load, the circuit is heavily damped and there is no significant overshoot. With a 1-Ω resistance as the load the circuit is under-damped, resulting in a 76% overshoot at turn-on. Series resistance which has been ignored here will help to reduce the overshoot.

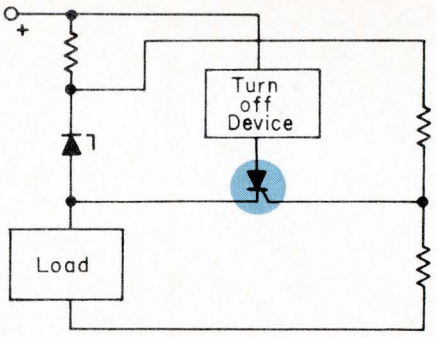

Fig. 5: This under-voltage circuit works on the same general principle as the circuit shown in Fig. 3. It operates as a bridge consisting of a zener, an output voltage, and two resistors. Decreases in load voltage make the gate positive with respect to the cathode, causing the SCR to turn on.

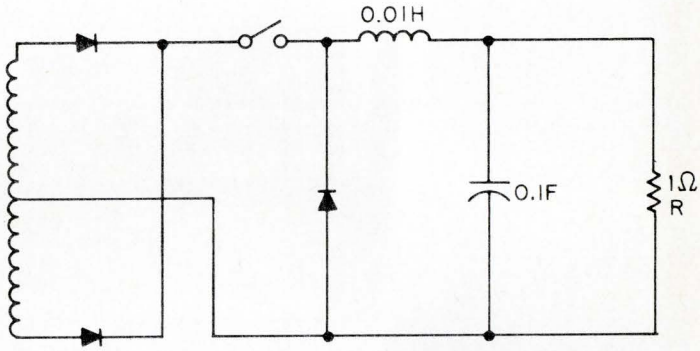

Fig. 7: A typical rectifier LC filter with resistive load. When the switch is closed, resonant charging will overcharge C, which will then discharge to normal level into load R. Since the diodes present reversal of the resonant portion of the current, there will be no undershoot at turn on.

Another method with the same advantage involves putting a long time constant on the bias voltage from which the detecting circuit transistors (if any) operate. Sometimes a nonlinear time constant can be used on the over-voltage reference. This can be done by charging a capacitor rapidly through a diode and discharging it slowly on turn-off through a resistor.

In practice, the nature of the load circuit along with the regulator response time and filter type will determine whether or not there will be an over-voltage or overshoot at turn-on or during load step changes. With a filter circuit such as that in Fig. 6, an overshoot could occur when the voltage is applied. Figure 6 also contains a plot of the actual transient for one set of circuit values, arbitrarily chosen. The same circuit, when lightly loaded (1-Ω resistance), is under-damped, resulting in 76% overshoot.

The solution is to apply the dc voltage to the filter network at some finite rate—in this case a rate slower than the natural frequency of the filter. The filter frequency is about equal to

$$\frac{1}{2\pi\sqrt{LC}} = \frac{0.159}{\sqrt{0.01 \times 0.1}} = \frac{0.159}{0.0333} = 4.8 \text{ Hz}$$

The period of the transient is

$$P = \frac{1}{f} = \frac{1}{4.8} = 0.208 \text{ s},$$

a value which is verified by the plot of Fig. 6.

If the voltage were applied at a rate of 5 V in 100 ms, the over shoot would be much less. To obtain this rate, simply use a capacitor across the voltage-regulator reference.

Figure 7 shows a more realistic circuit that will alter the characteristic of the transient. The diodes in the rectifier circuit do not let current flow back into the source, so the over-charge on the capacitor must decay into the load resistor with a time constant of RC. This waveform is also shown in Fig. 6.

The circuits shown here are typical of proven methods for sensing a voltage change and initiating a voltage correction. You can use these same circuits to sense variations of current, temperature, or any other parameter which can be represented by a dc voltage.

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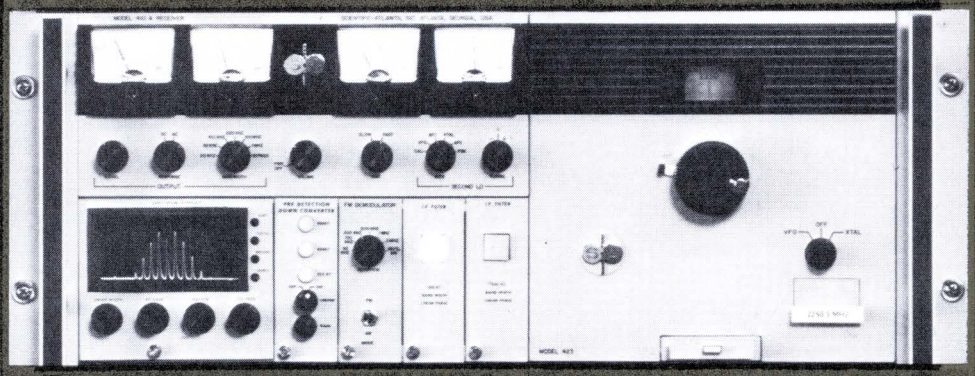

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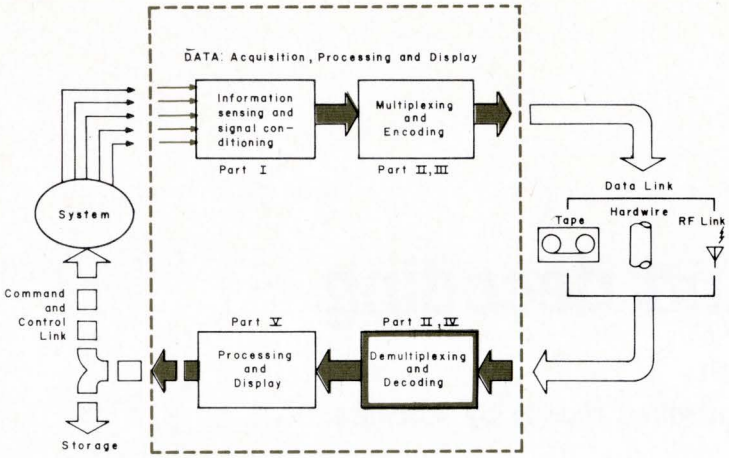
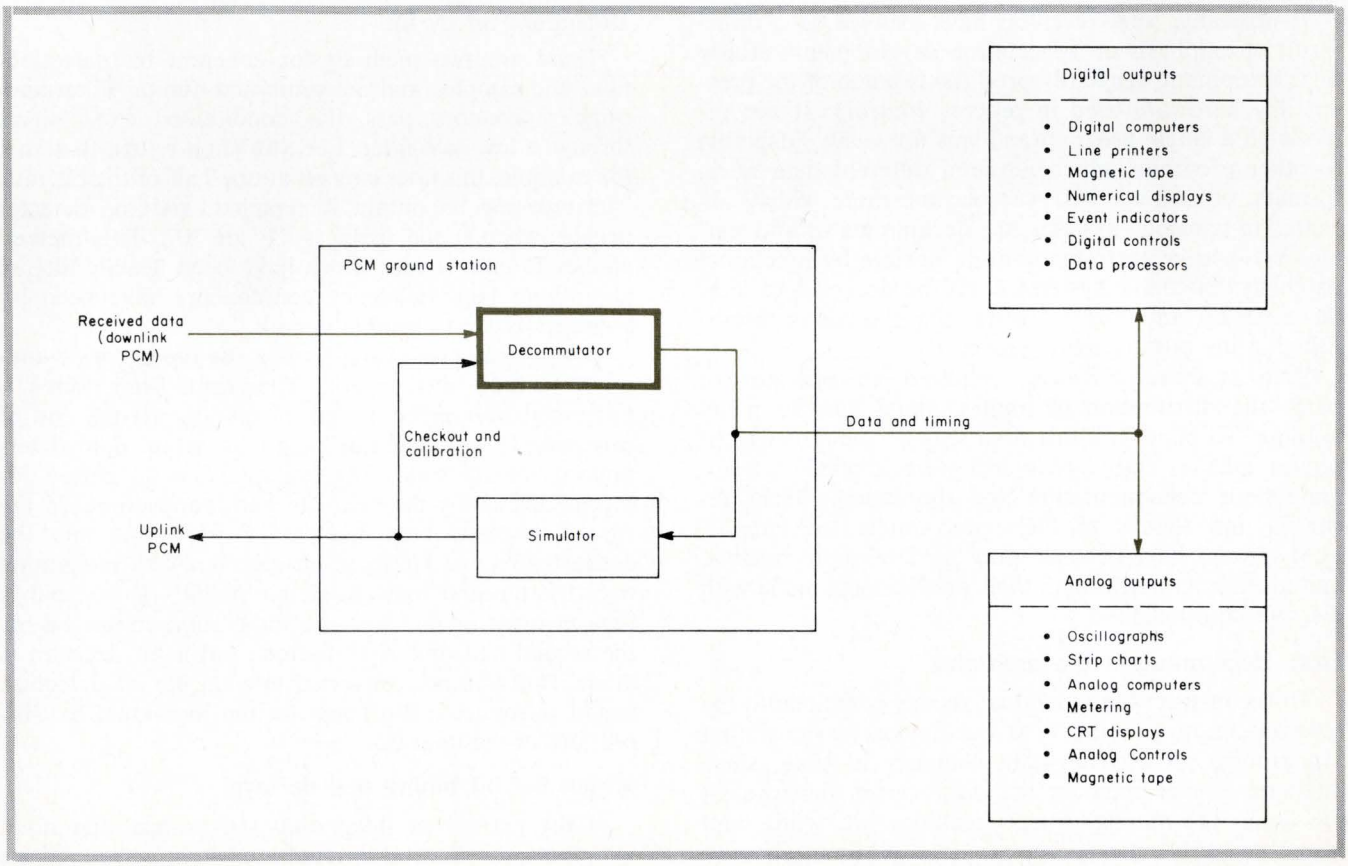


Data:
acquisition, processing, and display

We started this course by getting data, then turning it into information. Last month, the article "Time-division multiplexing" explained how to use sampling and analog-to-digital conversion to interleave data from many sources into a serial, pulse-coded stream of bits. This month, we learn how to process (mostly with software) this bit-stream to re-establish the data integrity while maintaining accuracy.

Whether the information is transmitted in TDM or in FDM, the receiver's job is the same: to demultiplex and decode the signals, and to route them to their digital or analog outputs. In PCM, the most-often-employed form of time-division multiplexing, data demultiplexing and decoding is called decommutation. A PCM receiver may have one or more decommutators, plus a simulator for calibration and checkout. Both the decommutation and simulation are under computer control or, at least, under control of a stored program.



Telemetry course—Part IV

Time-division demultiplexing and decoding

In PCM, a decommutator performs both demultiplexing and decoding. It is controlled mostly by software.

By George J. Slusarchyk, Radiation, Inc.
a subsidiary of Harris Intertype Corp., Melbourne, Fla.

The receiver in a **Time-division multiplexing** data system performs the same function as the receiver in a **Frequency-division multiplexing** system—it separates the signals contained in the received data stream. This separation consists of synchronizing the data at each commutation level, and distributing or routing the individual channels of data to selected output devices automatically as an on-line function. In pulse-code modulation—the most popular form of TDM, a receiver consists of one or more PCM decommutators (which demultiplex and decode the signal), as well as a PCM simulator that checks out and calibrates the receiver. In today's systems, it is often a computer program that controls these functions.

Historically, TDM receivers have evolved as a direct result of emphasis on spaceborne developments. Early PCM equipment was hard-wired (as is much of the present day hardware used in process control). It accommodated a single program and was not easily adaptable to other programs which required different data rates, formats, or outputs. As PCM became more widely accepted in telemetry systems, the decommutator and simulator functions were made more flexible by functional patching. Patchable systems could be designed to handle virtually any format within the limitations established in the IRIG telemetry standards.

Such systems, however, required an operator to patch the distribution of multi-channel data to many outputs. To cope with this requirement, computer techniques such as *stored programs* were applied to automate both decommutation and simulation. More recently, and thanks to high-speed integrated circuits, PCM systems have become more flexible, more reliable, and more economical than their predecessors made with discrete components.

First, decommutate the multiplex

To reconstruct the individual signals contained in the received multiplex, the PCM decommutator must first synchronize all arriving data channels in time, since any time-displacement of the data stream destroys all the data. The timing process includes bit, word, and frame and subframe (group) synchronization.

Second, synchronize the bits

PCM data receivers must re-establish bit timing to detect the data properly. The data comes in usually as a serial PCM bit stream which can be either relatively clean, or corrupted by noise. Since very few PCM links can afford the bandwidth required for a separate timing channel, the timing is inherent in the data stream, and must be accurately extracted even if noise is present.

The detection of an individual bit should be independent of the effects of adjacent bits. Also, the process should be "matched" to any external perturbations such as noise, bit jitter, baseline variations, and amplitude changes. A local clock is needed, its phase slaved to the input signal. These three functions—detection, matching, and clocking—are performed by the bit synchronizer (also called PCM signal conditioner).

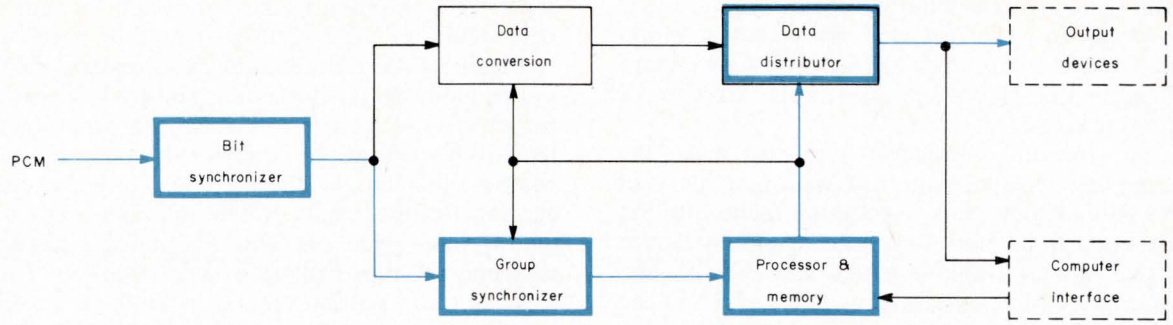
Detection: bit by bit

There are two methods for coherent bit detection: filter-and-sample, and integrate-and-dump. Filter-and-sample detectors pass the conditioned PCM signal through a low-pass filter. For NRZ (non-return-to-zero), for example, this filter cuts off at one-half of the bit rate. The resulting bit output is sampled, and the detector decides whether the signal is "1" or "0". This method applies to PCM signals which have been heavily filtered and whose high frequency components have been attenuated by the transmission path.

For relatively wideband signals, use the integrate-and-dump method bit detection. The signal (and noise) is integrated over precisely one bit period. At the end of this period, the integrator output is sampled to determine its binary state. For example, the bit period for NRZ is defined by the phase-locked loop output. In the case of bi-phase PCM, the data (with noise) must be converted to NRZ (prior to bit detection) by integrating over the the first half of the bit period. The signal is then inverted or rectified, the integration continued for the second half of the bit period, and a bit decision is made. Had you not converted to NRZ, the bit detection would introduce a 3-dB loss on the individual half-bit portions of the total bit.

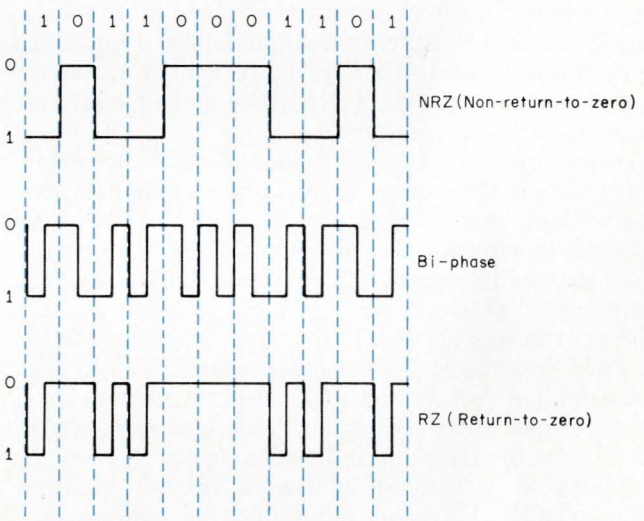
Watch the bit timing and dc level

If the periods of integration lag or lead the input waveform, the detector output for each bit period reflects



Stored-program decommutator. The **bit synchronizer** reconstructs the bit timing of the incoming data stream. It also detects the bits to "clean-up" the pulses, issuing noise-free serial data for further processing. The **group synchronizer** correlates the sync pattern at the different commutation levels, thereby forcing the stored-program instruction sequence to track the incoming data. (The sync pattern was inserted into the data stream by the encoding electronics—see Part III of this course). A **processor/memory** contains core storage for the programmed instructions. The **data distributor** rearranges the serial data into parallel words available to the appropriate output units. These units are updated with parallel data only when their respective addresses appear in the stored-program instructions. The decommutator can be interfaced with a variety of output devices including a digital computer (for on-line data processing). Computer can convert the decommutator program into a language familiar to the data user.

PCM data waveforms. The **non-return-to-zero** (NRZ) waveform uses the bandwidth efficiently, since the entire bit period contains signal information. Timing information is indicated by signal transitions of binary ones and zeros, or zero-crossings of the waveform's average value. The lack of near-dc response in the signal path will cause shifts in the signal's baseline for period of few zero crossings or low transition density. If this baseline-shifting is not compensated, it will seriously affect synchronization and regeneration of bits. **Bi-phase** waveform compensates for the lack of dc response at the expense of increasing the total bandwidth required. A zero-crossing is assured for each bit period, and the effect of transition density upon the average signal value is minimized. The entire bit period contains signal information. **Return-to-Zero** (RZ) waveform transition density depends upon the quantity of binary 'ones' transmitted. This method of signal coding wastes 50% of its bandwidth—because one-half of its bit period does not contain signal information—resulting in a theoretical 3-dB loss in bit detection performance compared to NRZ and bi-phase, which are more efficient.



the effects of adjacent bits (intersymbol cross-talk). In practice, bit decision errors occur because the bit synchronizer cannot track the input signal precisely. When choosing system hadware, pay special attention to clock and VCO (voltage-controlled oscillator) stability.

Asymmetrical codes such as NRZ and RZ are more susceptible to both dc offset and noise (and will have a greater number of errors in bit decision) than the symmetrical bi-phase bit detection. Whatever the coding, though, bit-synchronizers have a considerable amount of circuitry for restoring dc and rectifying the bi-phase code.

The prime contributor to bit errors in detection is additive input noise (introduced by the transmission link). Since noise is random, you cannot accurately predict its instantaneous effects upon pulse integration over a specific bit period. Instead, use the statistical effect of noise upon bit detection over an adequate time, depicted in Fig. 1.

Commercial synchronizers available today can be tuned over a bit-rate spectrum ranging from near-dc for deep-space instrumentation probes) to 1.2 megabits-per-second (in ground-based wideband information systems). The units can be tuned locally, or remotely from a stored-program decommutator or computer. Some provide continuous tuning, while others let you select several plug-in bit-rate tuning units. Universal bit synchronizers can handle all PCM code types over an input signal range exceeding 20 dB; some can acquire and maintain synchronization down to a signal-to-noise ratio of zero dB or better.

Synchronization: where does a frame start?

The next step in decommutation is to locate the start of a sequence of serial data words that comprise a frame of information. A data frame corresponds to a scan of

the PCM source multiplexer, and its beginning is usually identified by a unique bit pattern of sync code (see Part III of this course). The receiving equipment must examine the PCM bit stream to see if the sync code pattern can be identified or correlated, even in the presence of substantial bit detection errors.

When implementing a system, you must make the data spacing between sync patterns (frame length) small enough to minimize the time to acquire synchronization (or to reacquire it, in case of sync loss); i.e., maximize the time that data is available to the user. Conversely, the frame length should be large enough to maximize the bandwidth devoted to data. Considering these tradeoffs, a PCM format should allow 3-5% of its total data bandwidth for frame synchronization.

The sync pattern must be long enough for a parallel correlator to identify where the data frame starts. The sync code must have good cyclic autocorrelation to assure pattern recognition at precisely the proper bit time and it must have poor correlation at non-sync bit times to minimize false pattern recognition. Patterns of all ones, all zeros, or repetitive ones and zeros do not meet these requirements since adjacent data bits could cause false sync. Random data can also appear as a correct sync pattern, but will eventually be rejected as its binary value changes. The pattern must maintain its correlation properties even when degraded by individual bit errors due to transmission noise. References 1 and 3 list several codes that satisfy these criteria.

To acquire frame synchronization, a parallel correlator or pattern recognizer looks at the serial PCM bit stream "broadside." The pattern recognizer output (proportional to sync correlation) is examined as its serial data input shifts within each bit. At the same time, the recognizer scans the serial PCM input to locate an acceptable frame sync which tentatively identifies where the PCM data frame starts. An adjustable threshold can be established such that correlation peaks greater than the threshold mean acceptable synchronization, while those below the threshold indicate no sync.

Thanks to high-speed integrated circuits, modern digital parallel correlators can follow the pattern correlation for each successive bit period. The highest output the correlator attains during the scan of one entire frame (in search mode) corresponds to the maximum likelihood that the true sync pattern has been located. The lowest value corresponds to negative correlation, which can indicate that either the complement of the desired sync pattern has been located, or that the input data is inverted and should be corrected.

Since group synchronization is so important to getting the right data, the correlator reevaluates the pattern exactly one frame after it finds correlation. For this "check" mode, the bit error tolerance may be relaxed from that allowed in search mode. If the check fails, the sync is false. The synchronizer, therefore, returns to search mode to scan for a more acceptable sync location. Several consecutive successful sync patterns and checks may be needed before achieving the lock mode.

Once in synchronism, it locks

Most correlators tolerate more bit errors (in the sync pattern) in the lock mode than in the search mode, and do not return to search unless several consecutive patterns fail to meet the relaxed criteria. The reason for this greater tolerance in the lock mode is to maintain data synchronization in the presence of temporary data degradation as might occur with random noise bursts.

Parallel pattern correlation is necessary only in the search mode; serial correlation (bit-by-bit) can be used for check and lock modes since the synchronizer has tentatively defined the individual synch bit positions when it shifts into the check mode. The serial correlator accumulates the results of sync bit comparisons during one or more sync timeslots to establish an adequate sampling prior to making a sync decision. Thus, this correlator can be time-shared in both check and lock modes, but separate bit-correlation accumulators are required.

How to synchronize the subframes

A subframe sync pattern generally occupies one or more subchannels in a subframe, as shown in the PCM format diagram. Since the frame synchronizer has already identified the prime frame timeslots containing subframe-related data and sync, you can use a serial correlator to synchronize the subframe by examining only those bits occurring in the timeslot(s) dedicated to subcommutated information. The correlator searches the subframe sequentially bit by bit, for each subchannel, until it locates an acceptable pattern. The sync strategy for check and lock is similar to that used for frame sync, but the subframe sync correlation requirements differ. Since parallel correlation is not necessary, the subframe sync pattern can be any fixed bit sequence, including all zeros or all ones.

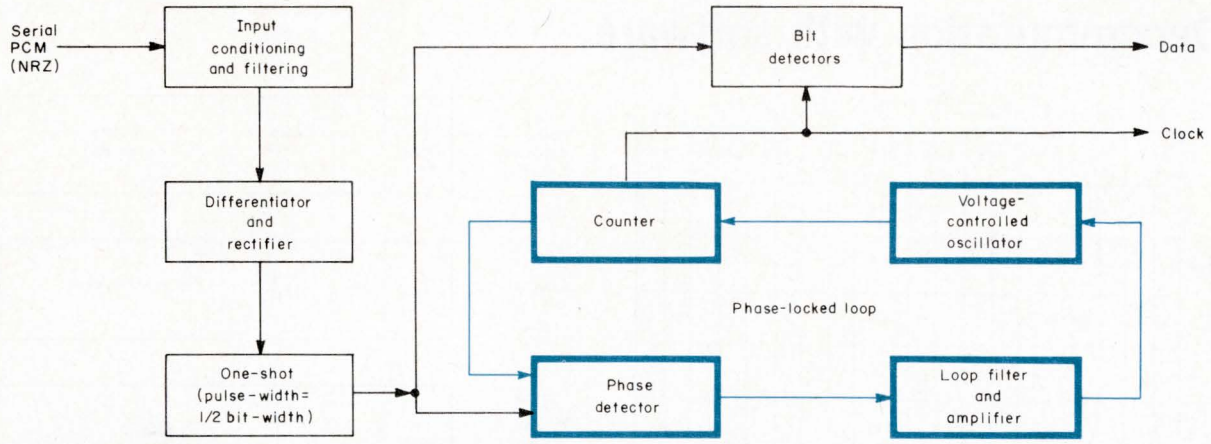
Another way to identify the start of a subframe is to invert the frame sync pattern to indicate subframe sync. Since the complementary pattern exhibits the same correlation properties as the true pattern, subframe sync recognition also signifies the presence of a prime frame sync pattern. Therefore, a reversal of the sync pattern (such as will occur during decommutation of data issued by a reverse-playback tape transport) preserves the pattern's correlation function.

A subframe can also be synchronized by using an ID (identification) sync pattern. This is a variable pattern that corresponds to the actual frame count in a subframe sequence. The advantage of ID synchronization is that it can achieve sync anywhere in the subframe, not only at the recycle of the subframe. This advantage, however, comes at the expense of bandwidth available for data, since the ID subframe sync takes an entire prime frame timeslot for each subchannel. Although ID sync requires exact pattern coincidence and precludes allowance for bit errors, noise immunity can be enhanced by successfully checking more than one subframe for proper ID sequence before advancing to lock mode. Similarly, the failure of several successive checks can be programmed to return to "search."

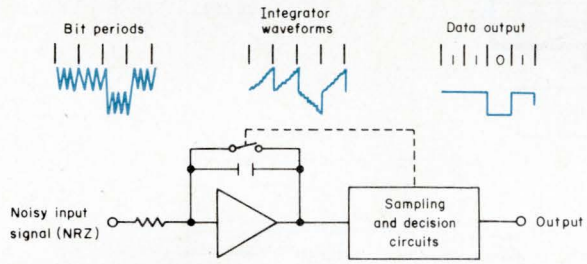
Decommutation—under computer control

The processor/memory controls all decommutator operations with a set of instructions resident in its core memory. For most applications, a memory capacity of 4,000 words suffices. Instruction fields of 24 to 36 bits, together with 1-μs full-cycle times, provide data decommutation rates consistent with megabit input rates.

The processor uses the format setup instruction to begin all necessary functions in the decommutator dur-



Bit synchronizer. To establish bit timing, the PCM input signal is conditioned and filtered to compensate for variations in amplitude, baseline offset and bandwidth. Passing the signal through a nonlinear element (such as a zero-slicer and /or rectifier) develops a frequency component at bit rate. The phase of this component is compared with the phase of pulses from the voltage-controlled oscillator (VCO). The error output drives the VCO to maintain lock with the input signal. Appropriate loop compensation (filtering and amplification) permits the loop to acquire phase-lock, allows optimum signal tracking under adverse conditions, and maintains phase-lock even in the event of temporary loss of data. Acquisiton and tracking ranges of ±10% of the nominal bit rates are typical.



Integrate-and-dump method for coherent bit detection. The signal (with noise) is integrated over exactly one bit period. The logic circuits sample the signal at the end of the integration period to determine its binary state. If the integration period is not in phase with bit period, there will be crosstalk between adjacent bits.

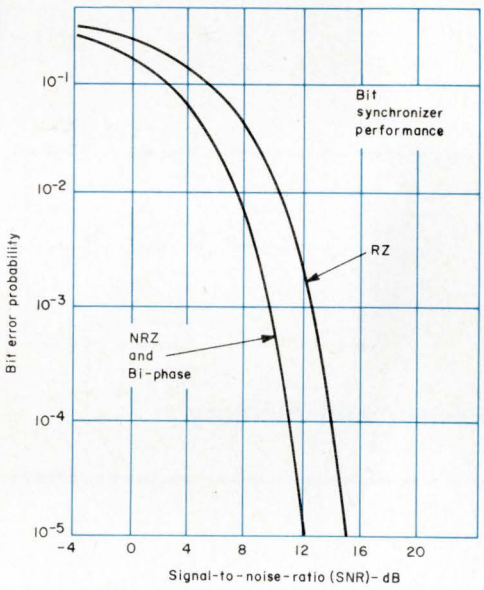


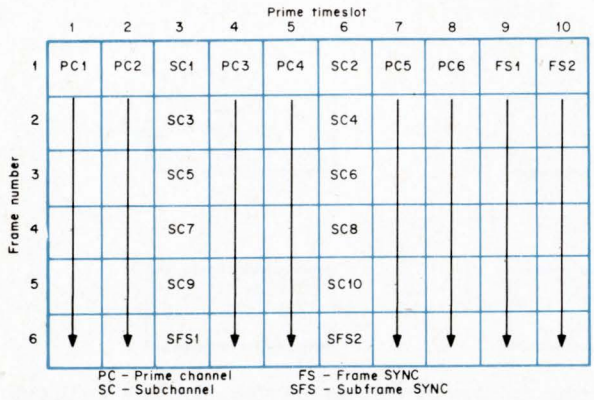
Fig. 1. Statistical probability of bit error as a functio of the ratio between peak signal and rms noise (with the noise bandwidth referenced to one-half the bit rate). Because of secondary signal perturbations such as ac offset, bit jitter and transition density, the actual performance of a bit synchronizer falls within 1 dB of the theoretical over its bit-rate spectrum.

ing its pre-acquisition mode; i.e., prior to data input and distribution. Setup instructions can program the bit synchronizer, establish group sync parameters, and generally configure the decommutator for a particular PCM data mission. The sync instruction identifies which synchronizer to enable, the expected bit content of a partial sync pattern or syllable, and the length of the syllable. The data distribution instruction specifies the length of the input data word together with the address of its destination (e.g., display register or digital-to-analog ocnverter). A single-input PCM word can be distributed to more than one device by including multiple addresses in the same instruction, or by giving it multiple addresses in the memory while the data word is present.

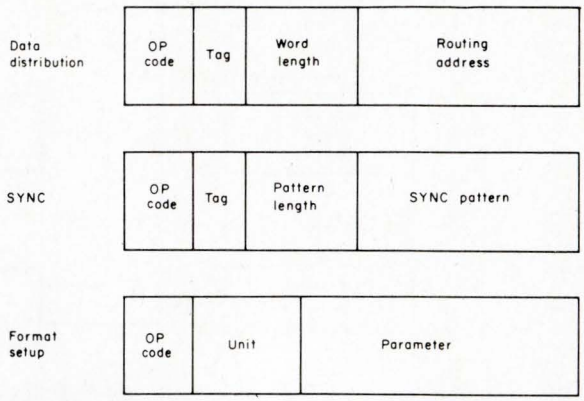
When the instructions specify the word length, an input PCM word can be conveniently organized into artificial partial words or syllables. Such variable-word-length programming lets the decommutator truncate information, making it compatible with output devices. For example, reducing the syllable size to a single bit allows routing of an on/off event to a single output register or display.

The instructions to decommutate an input frame are sequentially executed. The program starts with the initial data distribution instruction, progresses through each of the data channel routing commands, and ends with a sync-testing instruction which is tagged to recycle and repeat the loop's sequence for the next input frame.

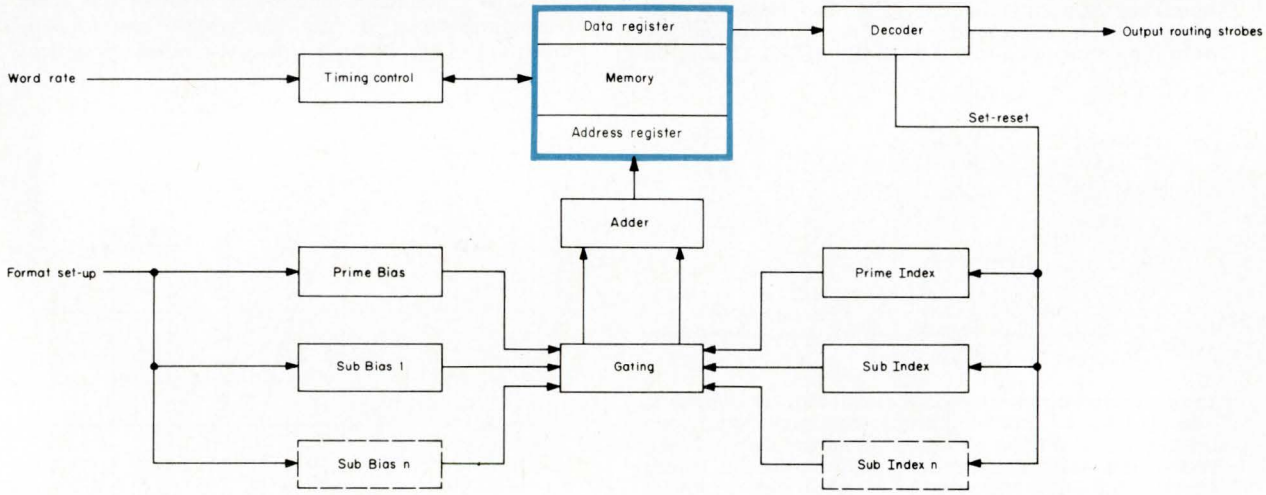
Decommutation with software



PCM format (matrix diagram)



Instruction fields

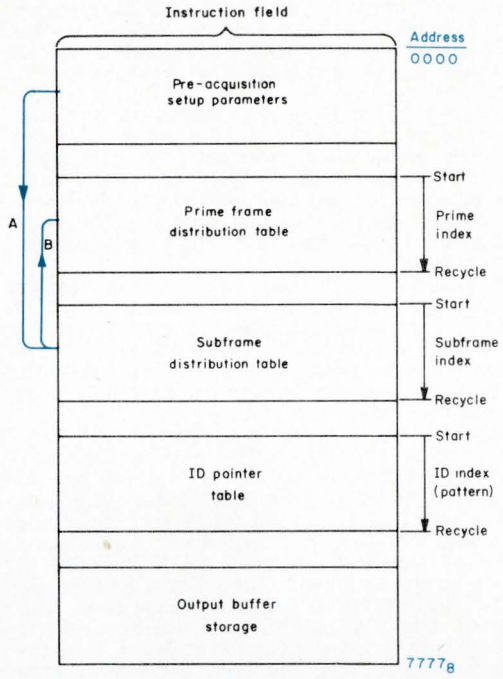


Processor and memory

The efficient use of memory in handling subcommutated data is very dependent on efficient programming. For example two memory accesses were needed to locate a subchannel distribution instruction in decommutating the prime frame shown on page 69. The time consumed by the second access can limit the rate of PCM data throughout, especially if the distribution rate of PCM real-time bits is high. Locating a subcommutated distribution instruction can be reduced to a single memory access if the previous instruction (prime channel, for example) contains a pointer or tag which indicates that a particular subframe index register will immediately address its subframe table when the next word (subchannel) arrives. This method requires a separate register to store the index bias address (subframe table start-address), and a separate index function for each independent subcommutated data sequency (including sub-subcommutation). A typical stored-program decommutator with four to six index registers will give you considerable programming flexibility.

Distribution instructions for ID-referenced data channels can also be organized into tables similar to those of recycled subframes. However, the prime reason for an ID sync pattern is to synchronize the ID-referenced data with its respective distribution instruction immediately, not only when recycle occurs.

To synchronize immediately, an address (pointer) table indirectly locates the instruction related to the current ID-referenced data word. The ID sync pattern serves as an index for an address (pointer) table to locate the appropriate indirect address (path A, in the example of page 69) which, in turn, points to the proper memory location in the distribution instruction table (path B). The pointer table is entered only for initial synchronization between the current ID data word and its respective routing instruction. Once sync has been acquired, program execution is confined to the prime and subframe (ID-referenced) tables.



Decom memory map

	PROGRAM ADDRESS	OPERATION	OPERAND
Prime Table	PRIME-START	ROUTE	PC1 data
		ROUTE	PC2 data
		JUMP	SUB-START as sub-indexed.
		ROUTE	PC3 data
		ROUTE	PC4 data
		JUMP	SUB-START as sub-indexed.
		ROUTE	PC5 data
		ROUTE	PC6 data
	PRIME-RECYCLE	SYNC	FS1 syllable
		SYNC	FS2 syllable, reset prime index.
Sub Table	SUB-START	ROUTE	SC1 data, return to prime.
		ROUTE	SC2 data, return to prime.
		ROUTE	SC10 data, return to prime.
	SUB-RECYCLE	SYNC	SFS1 syllable, return to prime.
		SYNC	SFS2 syllable, return to prime, reset sub-index.

Decommutator program

Decommutation of a prime frame. Consider the subcommutated information contained in a prime frame timeslot (shown here in simplified format). If direct addressing were used exclusively, the core memory would require a prime frame block of storage for each subchannel. This can be avoided by using a block of memory for prime frame instructions, then indexing to locate the subchannel instructions. In this example, we use two blocks of memory (or tables of instructions), one for prime channels and another for subchannels. The **memory map** and the simplified block diagram of the **processor/memory** (including the index function) correspond to this **decommutation program.** As the processing goes through the prime frame table of instructions, it finds an instruction which indicates that the current input word is associated with a subframe. This instruction contains a bias address which is the first memory location of the subframe table. The subchannel's distribution instruction is located at the bias address as modified by the contents of the subframe index register. The index register is incremented after the subchannel instruction is executed. One frame later, processor enters subframe table again to locate the distribution instruction for next subchannel. Even though a prime frame typically contains more than one sub-channel associated with same subcommutator, indexing technique remains the same; index register is bumped for each subchannel, then recycled at end of its subframe loop.

Distribution of data—analog and digital

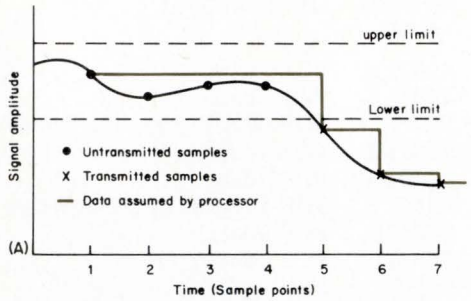
A serial-to-parallel converter organizes into words the noise-free data issued by the bit synchronizer. In this context, a word is defined by the word-length field contained in its accessed instruction. Thus, an output word can vary from a single bit up to the maximum bit capacity afforded by the field of the data-processor. But clock pulses increment a bit-per-word counter, which recycles at the count corresponding to the programmed word-length and issues a word-rate output. Simultaneously, the serial-to-parallel converter accumulates PCM data in a serial register until a word-rate pulse transfers the data broadside into a holding register. For the duration of the next word, this parallel data word will be buffered and distributed by a data bus to all output devices.

From the processor's viewpoint, every connected output device appears to the parallel data bus as some form of parallel storage register. Under program control, parallel data on the bus is strobed into the uniquely-addressed output device register, and the contents of this register are updated again whenever its routing code appears in an instruction.

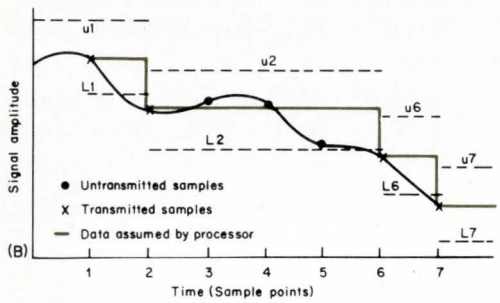
To handle other output devices, it may be necessary to accumulate several non-adjacent syllables in a single register composed of several individual syllable registers, each connected to the parallel data bus, and each updated upon the arrival of its respective data. This multi-syllable assembly continues until the final syllable has been loaded. Then the full parallel output from all syllable registers is available to the output device.

To reconstruct the original analog signals, the decommutator frequently has a bank of D-A converters. Each converter is effectively an addressable register updated from the parallel data bus. The analog outputs can drive analog meters, stripchart recorders, CRT displays, X-Y plotters, oscillographic records and so forth. Analog computer inputs or selected channels may be

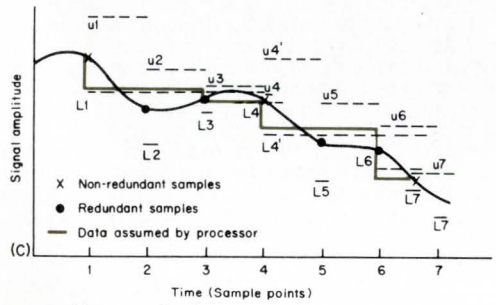
Data compression



Fixed limits



Floating aperture



Extended step

The overwhelming flow of data generated by modern sensors is strangling transmission media and choking up the processing electronics of data acquisition systems. If you're willing to live with tolerances on data accuracy—the pressure can be reduced.

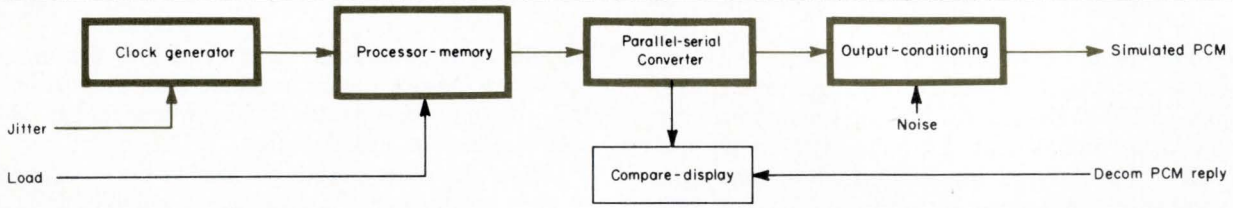
Eliminate redundant data, and the information transfer rate of your system (not to be confused with bit transfer rate) can be increased, simplifying the data processing. A data compressor (general purpose or special digital computer) built into your system between the encoding electronics (A/D converters) and transmission electronics can do this. The computer lets you utilize the bandwidth better, and lowers acquisition and processing costs.

A simple computer algorithm that prevents the transmission of unnecessary data uses a **fixed upper and lower limit** (A). If the data is within this band at the sample time, no information flows; if the sample point is outside this band, its value is sent on to the processor. When the processor does not receive data, it simply takes the middle value between upper and lower limit. It's simple, but it works.

A more sophisticated algorithm uses a fixed-height (in magnitude) **aperture,** but the aperture **floats** (B). In essence, it predicts future samples. The sampler sends the first sample (1) to the processor, and at the same time it establishes the location of the tolerance band (U1 to L1). Since the second sample falls outside this band, it is also sent, and the tolerance band drops to U2—L2. The next three samples (3, 4 and 5) fall between U2 and L2, so the sampler sends no new data; it assumed the value to be the same as the last sample sent. The aperture moves again at both sample times 6 and 7. A refined version of this algorithm varies the aperture height with the magnitude of the sample to keep the data uncertainty at a fixed percentage of the data.

Extended-step redundancy reduction (C) is also predictive and uses a floating aperture, but differs in several ways from the preceding technique. First, the tolerance range **varies.** Second, a sample is considered redundant if its tolerance range **overlaps** that of the preceding sample. And third, when a non-redundant sample occurs, the mid-point of the tolerance corridor is transmitted as the **preceding** sample. Besides eliminating redundant data, this procedure provides a noise averaging effect that eliminates small amplitude noise on the signal.

Applying the Extended Step method to the signal of example B, the first sample establishes the same tolerance range. This tolerance stays for sample 2, which is redundant because the upper limit U2 falls between U1 and L1. U2 is more restrictive than U1, however, so the new tolerance range is L1 to U2. Using this new range about sample 3, we find that sample 3 is redundant and again we pick the most restrictive tolerance range (U3 to L1). With this latest aperture height, U4 and L4 fall outside the range of L1 to U3, so the midpoint between U3 and L1 is sent as the value of sample 3. The processor also uses this value for all preceding redundant samples. The process starts again with the original tolerance limits on sample 4. The colored line indicates the data acquired by the processor at the receiver, which is more accurate than in B.



Stored-program PCM simulator. Its basic timing source is the programmable **clock generator,** which spans the entire PCM bit rate spectrum. With a VCO as the basic clock, the bit-rate output can be externally modulated to simulate timebase variations. This output generates word-rate timing, and is also used for subsequent parallel-to-serial conversion. The word-rate output, issued by the bit-per-word counter, is used to access the simulator's **memory.** This memory has storage capacity, cycle time, and instruction fields similar to those of the decom memory but, instead of the decom's distribution field, it has a simulated data word (or syllable). The access of each simulator instruction extracts the data or sync word, and converts it from parallel to serial to create a continuous PCM bit stream. The instruction's word-length field controls the recycling of the bit-per-word counter and the **parallel-to-serial converter.** As in the decom, the simulator usually has a set of index registers for programming efficiency, especially for complex formats. An elementary interrupt system can be included to permit rapid selection or changeover of several formats stored in memory.

The simulated serial data is logically re-shaped to provide codes such as NRZ, RZ, and bi-phase. The resultant bit stream can be filtered, and **conditioned** with varying amounts of dc offset, baseline modulation, and noise. Adjustment of the composite PCM output amplitude, and selected blanking of periods of data simulate data dropout. Overall, the simulator can precisely control the degradation of its PCM output to evaluate decommutator performance.

recorded on tape for subsequent analysis. In this manner, a user gets only the data he needs, and many users can be served simultaneously.

For devices requiring digital data, the program routes individual bits to selected indicators or sends them to perform on/off control functions. Raw binary data, converted to BCD, drive decimal displays and also produce hard copy on strip and line printers. Digital information can also be stored on paper and magnetic tape. Sometimes, a portion of the decommutator's core memory serves as a storage buffer that matches the input data rate to the transfer rate required by output units such as unbuffered line printers, computer-compatible magnetic tape transports, and common-carrier data terminals.

How to enter the data into the computer

When you interface a general-purpose digital computer with a decommutator, the key goal is to optimize the interface for maximum data throughput. The simplest method is to present the output of the decommutator's serial-to-parallel converter to the computer's input. This is acceptable if the computer program can afford the cycle-time needed to service each data entry at the decommutator's word rate.

Another method routes only data of interest to the computer input, under control of the decommutator's stored program. This method slaves the computer's input port and associated programming to the decom's output data rate. To circumvent this situation, data can be held in temporary storage (buffered) for transfer at the convenience of the computer. A block of the decom's core memory serves as a storage buffer, and its program flags those words that must be loaded into the buffer. When ready, the computer unloads the buffer into its own input channel at its own rate.

The buffer transfer rate can be increased if the decom has direct access to the computer's core storage. In this case, each core location in the decom's buffer contains the currently-stored data value together with the computer memory address to which it will transfer that value. When ready to refresh its memory, the computer assigns input/output control to the decom program. The decom sequentially unloads its buffer locations and directs the accessed data values into the specified computer memory locations. Loading of data arriving during the transfer process is sequentially interlaced with the unload operation.

Another way to optimize the transfer of information from decom to computer involves the use of data redundancy removal techniques. Many PCM acquisition systems accommodate the peak bandwidth required by their transducers which is much larger than the average bandwidth needed to transmit the information. Reference 5 discusses how to implement algorithms that remove the redundancy.

PCM simulation

PCM simulation equipment for checkout and calibration can be a simple fixed-format word generator, a patchable PCM simulator, or a versatile stored-program simulator. Each of these performs the inverse function of decommutation; selected digital data (simulated data and sync), multiplexed into pre-programmed time-slots, form a cyclic output format of varying complexity. Basically, a simulator accesses simulated data words from core storage at a selected clock rate, serializes the data words, and conditions the serial output with predictable perturbations which can occur in a transmission link.

Programming

The decommutator and simulator derive their data handling flexibility from the fact that they are stored-program devices, as is their cousin, the digital computer. Brute-force machine language programming may suffice for simple PCM formats, but as the format complexity increases, a general-purpose computer is absolutely necessary to simplify the programming task. The computer's compiler translates user-oriented instructions into machine-related programs. Although most TDM decom's and simulators can be programmed via punched paper tape, in some facilities they are connected directly to the computer. This connection permits rapid program loading and, if a full duplex connection exists, the decom and simulator memories can be dumped into the computer for verification.

The greatest advantage that stored-program decommutation and decoding offer is the ability to rapidly change format structure. Although the basic PCM format may not generally change during operation, the distribution of data parameters to output devices usually varies and may be dependent upon real-time events occurring during data acquisition. Stored-program equipment takes care of this situation by loading multiple programs into the decom equipment, each program using the same basic format but different distribution arrangements. These individual programs can be dialed manually during a mission, or can be phased in automatically as a result of a particular data response detected by the decom or computer.

NEXT MONTH:

Decommutation has converted the data bit-stream into separate channels of information, but that's not the end of the process. So far, it was electronics. To use the information available, an engineer steps in to examine the data. And, since "a picture is worth a thousand words", the last part of this series will be "Displays—Technology and Techniques."

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2. Perkins, F. A., "The effect of bit and group synchronization on the reception of PCM/FM telemetry signals," *National Telemetry Conference Proceedings,* June 1964.

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EE DRAWER

Components feel the SQUEEZE of ICs

There is no denying that components are being squeezed by integrated circuits. But, instead of giving up, component people are making better products at lower prices and have created a new breed of components for ICs.

By David H. Surgan,
Eastern Editor

There is no question that you are using more and more integrated circuits all the time, but are you using less discrete passive components? Chances are you are not using less discretes, only different ones.

To find out, The Electronic Engineer asked the manufacturers of discrete components: "What are you doing about the increasing use of integrated circuits?" Most manufacturers have taken the approach that "if you can't beat 'em, join 'em." They have improved their products; modified existing ones; and created new ones. Let's look at some of the things that various manufacturers are doing to maintain their business. We will start with resistors.

Resistors stay on top

Many variable resistors today use cermet as a resistance element with the binder in cermet being glass. As you know, glass is a hard, abrasive material that can wear out wipers, leading eventually to a catastrophic failure of the variable resistor. Also, surface roughness generates noise when the wiper arm is rotated.

Two companies have come up with a solution for rough surface problems. First, CTS, in its cermet pots, uses a carbon button wiper instead of a metal wiper. With initial use, the carbon wears slightly and acts then as a lubricant over the cermet material. The amount of carbon deposited is so small that it does not affect the resistance of the pot. Amphenol has a different attack. It puts a thin-film coating (in the order of Angstroms) of platinum over the resistance element in its small trimmers. This reduces wear on a metal wiper.

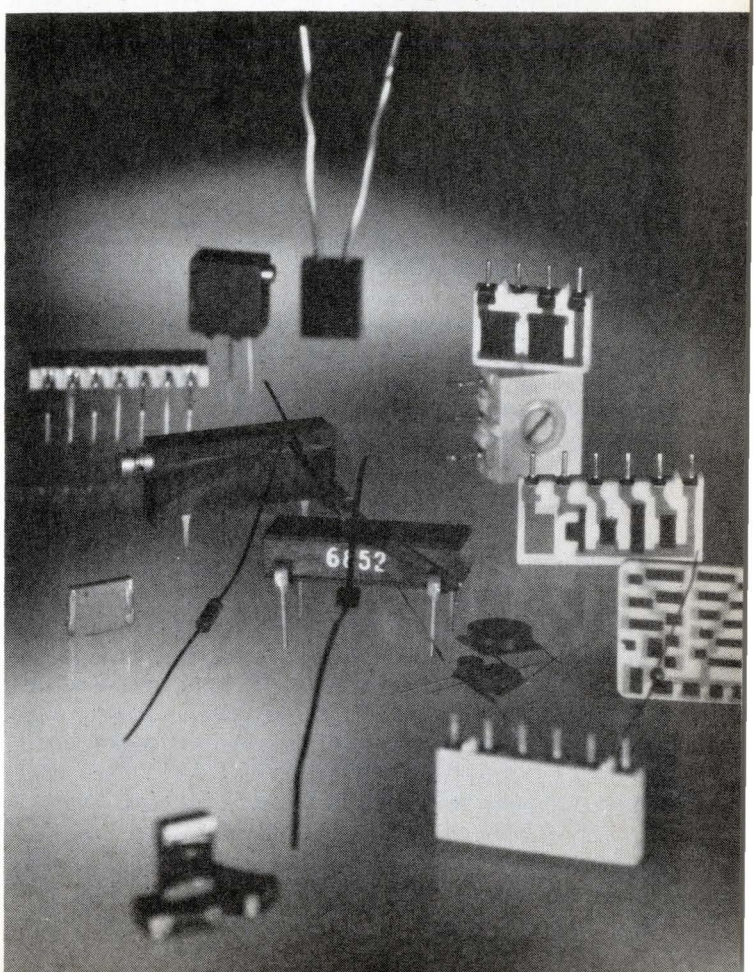
In the fixed resistor areas, manufacturers are supplying tighter tolerances and better temperature coefficients in their products. Along with physical improvements in existing lines, the manufacturers have been able to, in many cases, lower prices on these items to enhance their use and stay competitive.

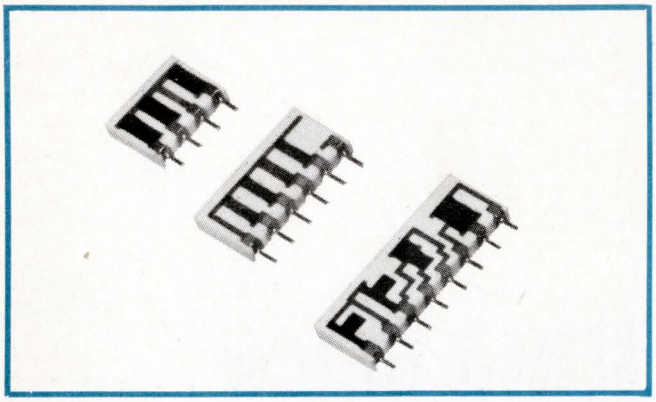
Product modifications

Most trimmer manufacturers have modified their products to fit on standard printed circuit grids for better mounting on PC boards. Several companies have made the leads on multiple resistor packages so they will lock into the board and stay there until they are soldered.

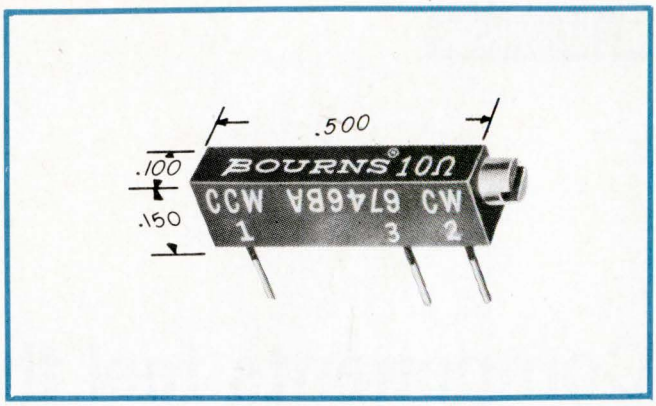
Square or rectangular resistor packages now have

New components come in many smaller sizes and configurations today to match our ever changing requirements.





Resistor networks, such as these by CTS are being made by various manufacturers to meet the needs of integrated circuits. This type of packaging is only one of many types, such as flat pack and dual in-line, that are available.



Trimmer resistors are available from many manufacturers in all kinds of shapes and sizes to suit your needs. The need for trimmers has been growing with the IC market.

small molded standoffs on their bottom so that the board can be cleaned after soldering, thus eliminating possible contamination. Many discrete resistors once made with only axial leads are now being produced with radial leads to make printed circuit board insertion possible without requiring prior bending operations.

Some new products created

Primarily because of integrated circuits, resistor manufacturers have taken two avenues—to make their products smaller and to make complete resistor networks in packages that are compatible with ICs. These compatible packages may be rectangular in shape, or take the form of flat packs or dual in-lines. In many cases, when you look at a 14-pin dual in-line package, you cannot always be sure whether it is an integrated circuit or a resistor network. Sometimes the package can even be a hybrid IC made by a resistor manufacturer.

Many manufacturers, because they already have the materials knowhow, take the next step beyond discretes —depositing resistor networks with thin or thick film techniques. These are sold as complete packaged units, having just straight resistor networks, or as specialized ladder networks. For instance, both Allen-Bradley and Nytronics make resistor ladder networks with thin film techniques, while CTS, Bell & Howell, and Centralab do similar work with thick film methods.

CTS supplies a resistor network to an automobile manufacturer where the resistance element, rather than being potted, is on a plug-in substrate, with the resistive element having a passivation layer over it. The automobile manufacturer places this network into a circuit and adjusts the circuit by trimming the resistors with air abrasion equipment. This eliminates the need for a trimmer, thus cutting the cost of the overall package. We suspect you'll be seeing more of this type of circuit "tuning" in the future.

One cute way that manufacturers "join 'em" in the integrated circuit market is by making very small resistors for repairing integrated circuits. Companies such as CTS, Allen-Bradley, Corning, Mepco, and IRC make very small chip resistors and/or miniature packaged resistors. When a resistor element within an IC is defective or is the wrong value, one of these can be used. Attachment is by die or wire bonding. Platinum-gold, gold, silver, or tinned terminations on the ends of the chip resistors permit attachment by reflow soldering. The chip resistors and "pill" shaped resistors are also ideal for hybrid ICs and terminating strip line in microwave circuits.

Many manufacturers such as IRC, CTS, Bourns, Amphenol, to name a few, make extremely small variable trimmers. With the growth of integrated circuits, there is a large need by designers for trimmers. These little trimmers are size and mounting compatible with ICs. They come in many case sizes and shapes to meet almost any need.

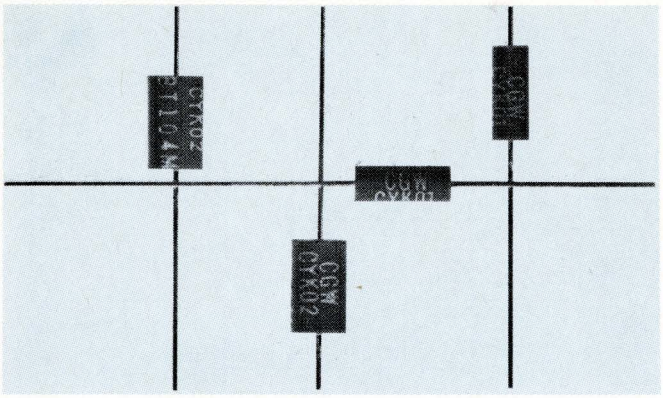
With the shifting technology, companies such as Vishay have emerged with products to suit new needs. Precision resistors are available with tolerances to 0.005%, having a TC as low as 0 $\pm$1 ppm/°C. They also supply precision "fixed" resistors that the user can adjust to his exact resistance need. Adjustment is made by using a scriber and a resistance bridge. Applying its precision techniques to networks, Vishay can supply binary ladders for handling up to 15 bits.

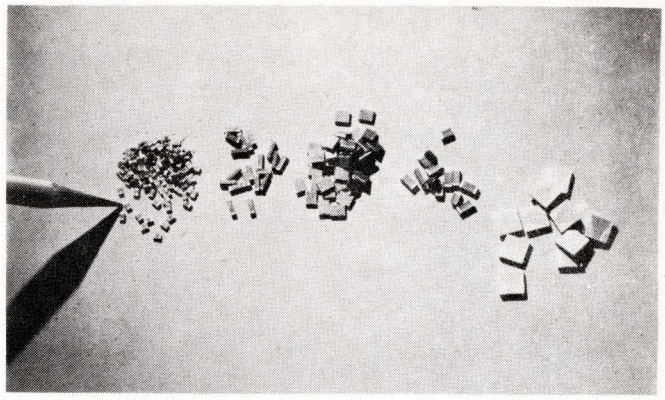
Some of the resistor manufacturers we spoke to feel that eventually carbon composition fixed resistor use will dwindle. One reason for this is that new materials and technology will permit other types of resistors, such as films, to be available at a very low cost. And at this lower cost they will have better temperature coefficients along with tighter resistance tolerances.

It is interesting to note that the wirewound resistance manufacturers such as Ohmite and RCL don't believe that the advent of the integrated circuit can materially affect them. On Ohmite's case, the smallest wirewound resistors are 3 W, and the company feels that when you need power dissipation, you need power dissipation, regardless of whether a resistor is used with an integrated circuit or with any other type of circuit design.

Capacitors for microelectronics, the chips are very much up

The two types of capacitor chips that are most successful in microelectronics are the two with the highest volumetric efficiency: tantalum and ceramic. Ceramics are a logical choice, because they are easy to handle with assembly methods used for printed circuits and for hybrid circuits. But tantalum chips, although they have





Small Capacitors that are compatible with integrated circuits, both hybrid and monolithic, are being supplied by many manufacturers. As typical examples, photo above shows packaged glass capacitors by Corning, while this photo shows chip capacitors made by Vitramon for hybrid integrated circuits.

more microfarads (volts per centimeter), are more delicate to handle and harder to fabricate with suitable terminations.

	Highest capacitance—voltage product available	Dimensions
Ta Chip	100 μF—10 V (polar)	0.475 x 0.375 x 0.150
Ceramic chip	0.1 μF—100 V	0.230 x 0.230 x 0.065

Ceramic capacitors

This field has grown so rapidly that many manufacturers are now asking for an EIA standard for ceramic chips. Such a standard is needed not only to make size more uniform (and reduce the types of capacitors in stock), but primarily to standardize the form and methods of termination.

For example, most manufacturers are providing their chips with terminals that can be attached by reflow soldering. Since the capacitors are made of ceramics, the classical material for termination has been one of Dupont's platinum compositions. If you consider that a high value ceramic capacitor consists of up to 80 individual layers connected in parallel, such a capacitor may have up to $2.00 worth of platinum. Recently, Dupont developed a suitable silver-palladium composition as a substitute for platinum, which can reduce the cost of termination by ten times.

Tantalum chips

Every time you buy an integrated circuit voltage regulator, the chances are you need a tantalum capacitor to filter out the voltage you are regulating. Recognizing this fact of circuit life, both Sprague, Kemet div. of Union Carbide and Tansitor Electronics offer encapsulated capacitors as either chips or disks, in a form compatible with integrated circuits.

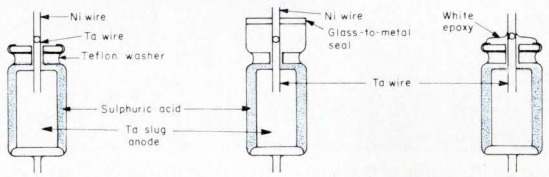
So far, there are no "leadless" tantalum chips (comparable with ceramic chips that have metallized terminals). Manufacturers furnish Ta chips with leads or with a Kovar or nickel tab. However, Kemet welds a nickel crossbar to the chip anode—to permit reflow-soldering—and most manufacturers are experimenting to make chips with metallized terminals.

Variable capacitors

Since ceramic chips are popular for microelectronic

Wanted:
A hermetic seal for wet tantalums

Since miniature capacitors would require the highest volumetric efficiency, and since the capacitor with the highest volumetric efficiency is the "wet tantalum capacitor," this capacitor should be a natural choice for miniaturization. It isn't, because it's wet. The electrolyte is sulphuric acid,

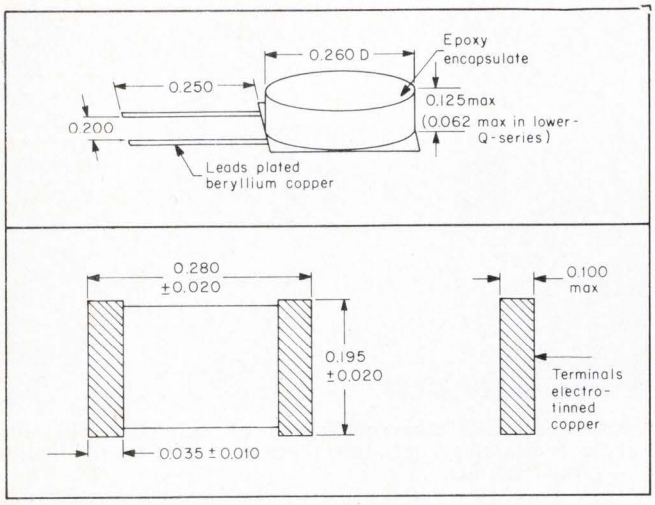


and no matter how well it is sealed, sooner or later it leaks because there is no hermetic seal that can be attached to a tantalum wire.

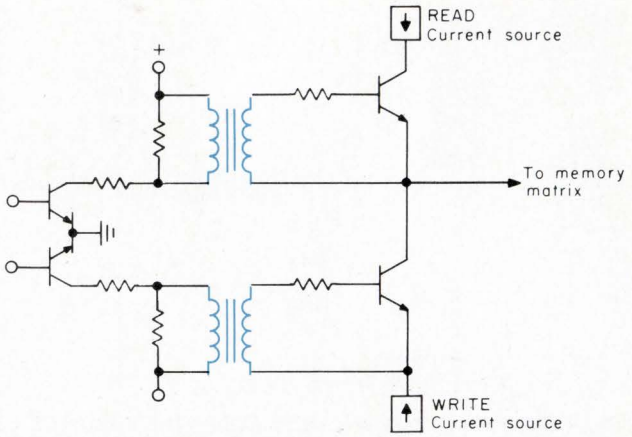
Look at the sketch of a simple wet tantalum capacitor. The tantalum riser wire that emerges from the anode "slug" is not attacked by the sulphuric acid, but it is not possible to make a hermetic seal on it. The best seals use several ingenious combinations of Teflon washers and silicon elastomers, but they are not perfect seals.

Sprague Electric uses a double seal, the top one hermetic, to solve the problem. This is the best type of wet capacitor in the market, but it still has the problem that, when the lower seal leaks, the sulphuric acid attacks the nickel wire and the capacitor fails catastrophically. A compromise approach used by the Capacitor Division of NCI is to seal the top of the Teflon seal with epoxy. The idea is to hold the silver can in place and keep the crimped Teflon washer as tight as possible. In addition, the white epoxy acts as a detector for a leak, because it changes color in the presence of sulphuric acid.

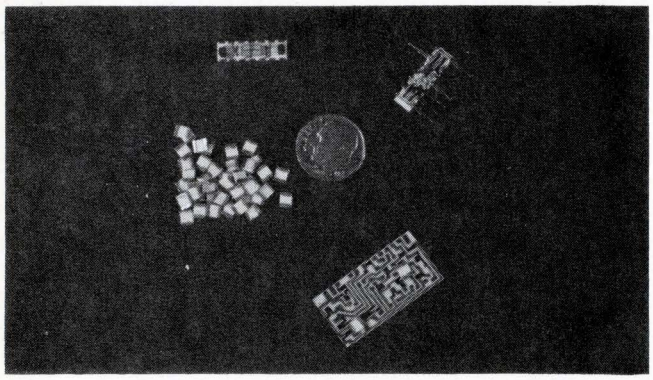
No matter how ingenious these methods are, the wet tantalum capacitor is not used for microelectronics. The device that is being used is the "solid slug" which has a lower CV product per unit volume than the wet capacitor, but does not leak because the electrolyte is solid.



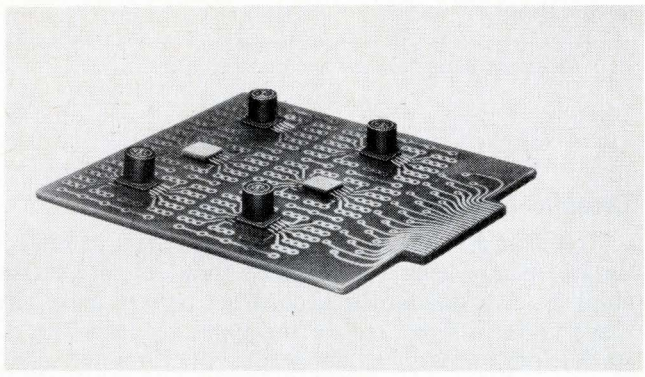
Competitors. Delevan inductor (top) is basically a coil on a tab with leads. Nytronics device is formed of two ferrite halves bonded together into a chip. Delevan also has a series of 0.065-inch high inductors with Qs of 35-45.



Floating switches select a drive line in a memory matrix, allowing either the read or write current to flow, each in its own direction. They "float" when the (read or write) pulse rises, because the inductive kick it produces in the drive lines must be isolated from the selection matrix. Pulse Engineering Inc., Santa Clara, Calif., puts four pulse transformers in a module designed for floating switches.



Miniature rf coils are made by Cambion for hybrid circuitry. Upper right and left are self lead types, center left of photo shows leadless inductors (chip), while bottom right has chips bonded to a substrate.



Larger inductors are being modified and improved for use with integrated circuits. These inductors are designed for flat mounting on pc boards with ICs.

circuits, you would expect that a ceramic trimmer should be popular whenever you have to vary the capacitance. It is. But the range of variation is necessarily limited. Since the best dielectric is air, E. F. Johnson Co. has introduced a special, 12-plate capacitor that fits in a standard whole pattern of the printed circuit board.

Inductors

You have probably heard before that we are all trying to "design out" inductors, since those are the components that cannot be integrated. Since they need a coil, they must be bulky, until the time when someone discovers a suitable magnetic substrate on which we could deposit a thin-film coil.

Designed out? Don't you believe it. Coils are used today more than ever, particularly with integrated circuits. You see, the easiest way to get a sizeable output signal from a very small integrated circuit is by boosting its output with a step-up transformer.

Manufacturers of miniature coils, such as Piconics, Nytronics, and Delevan, and of miniature transformers such as Pulse Engineering, Inc. and the UTC division of TRW, have been forced to develop inductive components that have form factors dictated by integrated circuits. But while the price of an integrated circuit goes down as the chip size becomes smaller, the price of coils goes up with miniaturization, since the coil still has to be wound, and winding a fine thread of #50 wire is far more difficult than winding #30 wire.

Nytronics, Inc., Berkeley Heights, N.J., has just announced a family of chip inductors that cram as much as 1000 μH into a fully shielded, terminated 0.280 by 0.195 by 0.100 in. chip. At present the only package configuration with this degree of miniaturization is the Micro i series of inductors offered by Delevan Electronics, E. Aurora, N. Y.

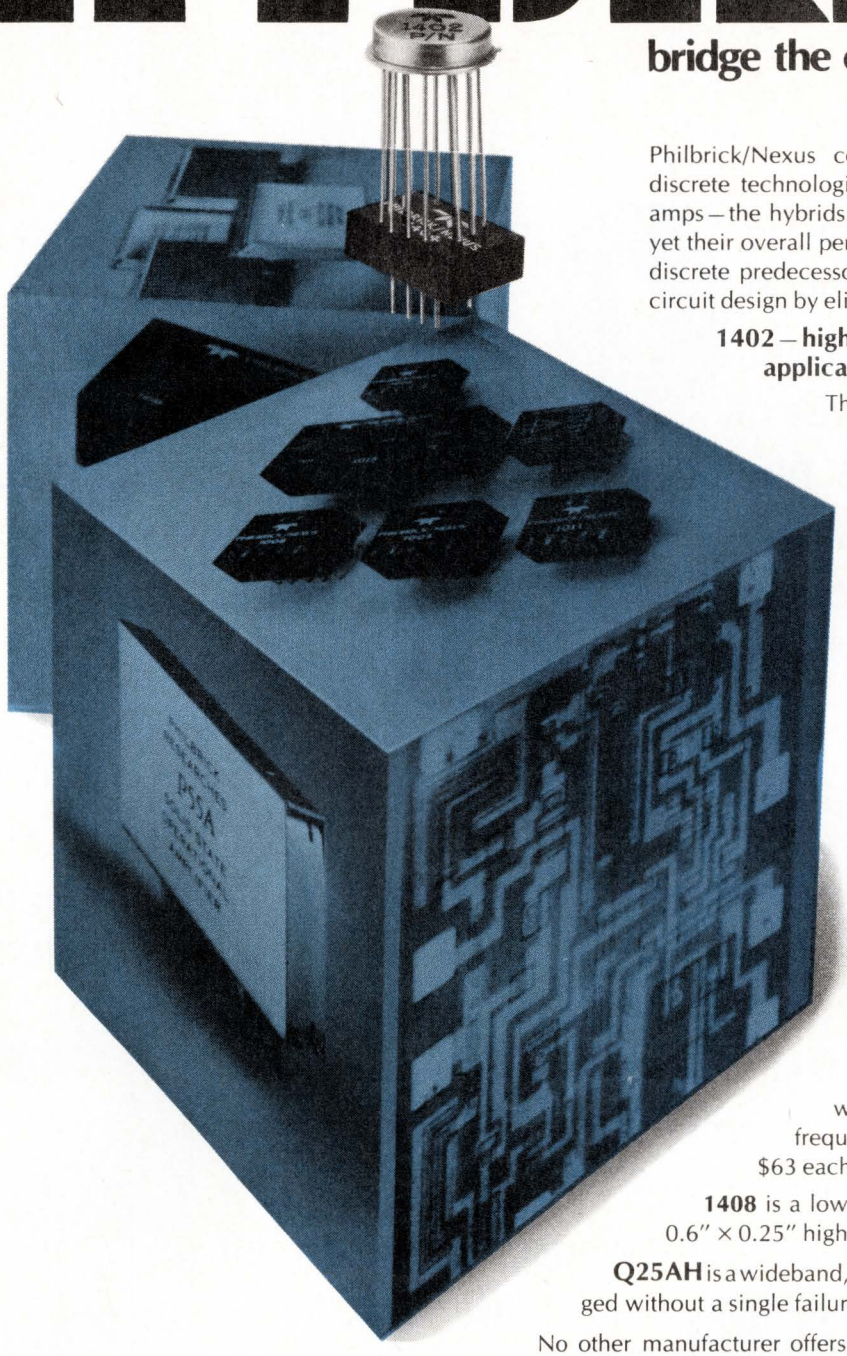
Nytronics' inductors are formed of two ferrite half-cores which serve as the core, the magnetic shielding and the package. The coil is dropped in the half-cores, which are bonded together, and terminations are made via "wrap-around" bands of electro-tinned, oxygen-free copper. Leads can thus be attached to the ends or to the face of the chip. The device is amenable to any termination. Nytronics will deliver it with solder bumps, leads, or other configurations.

Pricing of the new devices is attractive. Nytronics forecasts about a $2 unit cost. The Delevan devices are also priced at about $2 each in quantities of 100.

INFORMATION RETRIEVAL
Components, Materials

HYBRIDS

bridge the op amp generation gap



Philbrick/Nexus combines the best of monolithic and discrete technologies to create the now generation of op amps—the hybrids. They're micro-miniature and low cost, yet their overall performance is equal to or better than their discrete predecessors. And, built-in stabilization simplifies circuit design by eliminating external components.

1402—high performance FET for battery applications

The 1402 features a quiescent current drain of only *500 μA* with a power supply voltage range of ±4V to ±24V, full output frequency of 80 KHz and output capability of ±14V at ±5mA with ±15V power supply. TO-8 case; 0.5" diameter, 0.14" high. Price: $75 each in 1-9 quantity.

Other hybrids offering interesting performance characteristics:

1404 offers the lowest power drain (50μA) of any general purpose hybrid on the market. ±2.5 to ±15 volt operation. Produces 1 mA output. Size: 0.75" × 0.45" × 0.20" high. Price: $58 each in 1-9 quantity.

1406 is a small (TO-8 case) fast general purpose op amp. Price: $36 each in 1-9 quantity.

1407 is a low cost high performance FET which features a gain band width product of 30 MHz. Full output frequency is 100 KHz. TO-8 case. Price: $63 each in 1-9 quantity.

1408 is a low cost differential FET input. Size: 0.6" × 0.6" × 0.25" high. Price: $30 each in 1-9 quantity.

Q25AH is a wideband, high reliability FET. 1,000,000 hours logged without a single failure. TO-8 case. $180 each in 1-9 quantity.

No other manufacturer offers as wide a variety. Ability to innovate, design and manufacture will continue to provide a greater variety of hybrids from Philbrick/Nexus than you'll get from any other single source.

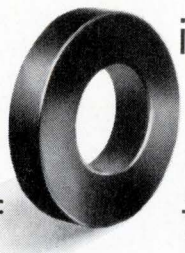
For complete specifications and technical assistance, contact your Philbrick/Nexus field-engineering representative or write, Philbrick/Nexus Research, 67 Allied Drive at Route 128, Dedham, Mass. 02026.

VISIT US AT THE IEEE BOOTHS 2A32, 2A34 and 2A36.

PHILBRICK/NEXUS RESEARCH

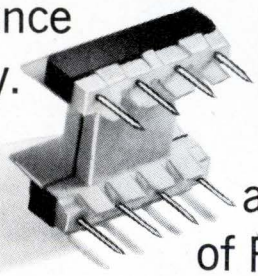
A TELEDYNE COMPANY

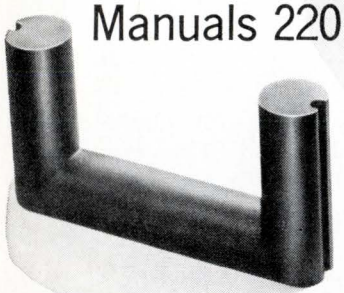
How to save money and avoid headaches in transformer and inductor design.

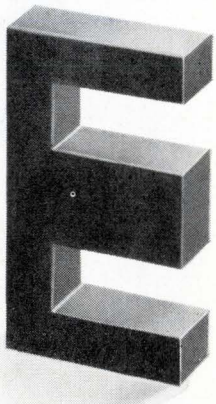


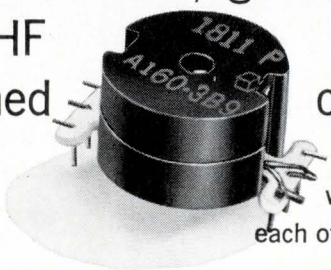
STEP 1. Mental attitude is important. Don't think you have to use laminated metal cores just because Steinmetz did. He didn't know about ferrite cores. **STEP 2.** Reflect on the advantages of ferrite cores:

self-shielding for complete packaging freedom... easy to wind and assemble, miserly of space... wide range of standard sizes, shapes and magnetic characteristics ...two-way economy —lower direct costs of manufacturing your product and indirect savings in tight tolerance control, which often "unburdens" associated circuitry. **STEP 3.** Update your knowledge of ferrite cores and their advantages. Read our Design Manuals 220 and 330. They cover the application of Ferroxcube ferrite cores to the design of optimum inductors and transformers. **STEP 4.** With Ferroxcube cores and accessories, a pad and a slide rule, go ahead and design all manner of pulse, HF and power transformers, filters and tuned circuits.









If you don't have Bulletins 220 and 330 (Step 3), write for them today. They'll help you breeze through each of the other stages. **FERROXCUBE**

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EE LAB

A quick guide to environmental specifications

With the following tables you can easily and quickly find the environmental requirements of a military specification. You can also compare various requirements at a glance.

By Rudolf Wernick, Project Officer
Dept. of National Defence, Ottawa, Ontario, Canada

Trying to keep track of the various environmental requirements of military specifications can be a nightmare, particularly when you are working on several different types of equipment simultaneously.

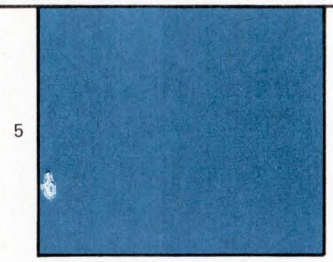
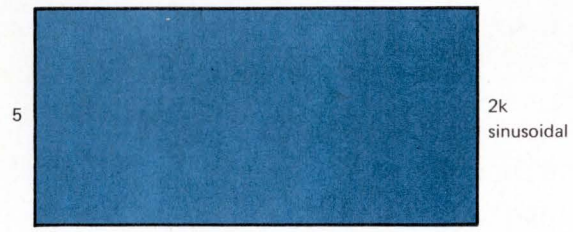
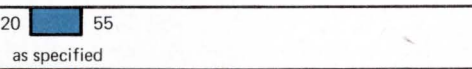
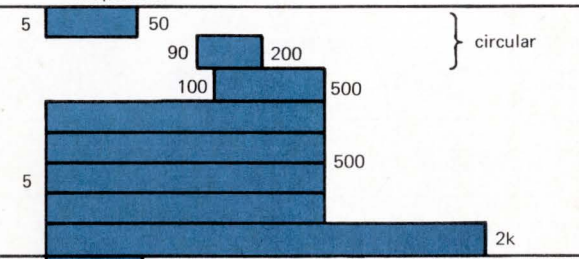
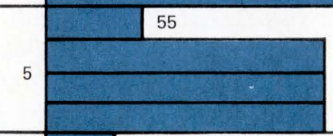
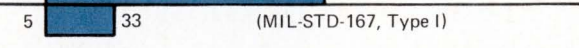
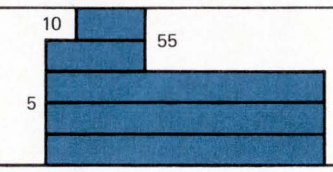
Because I had this problem, I tabulated the important data from the common specifications and grouped the information together. This made my life much easier, and hopefully it will do the same for you.

The tables are grouped according to the various types of tests—altitude, temperature, temperature/altitude, vibration, shock, and humidity. Along with quickly spotting a specific requirement for a specification, you can compare various specs for similar tests.

If complete details are needed then, of course, you should consult the applicable document. The tables even make this easier by giving you the specific paragraph in the specification that has the information you want.

LIST OF SPECIFICATIONS		
MIL-STD-810 B	15 JUN 67	Environmental Test Methods (Equipment)
STANAG 3518 2 Draft	28 MAY 68	NATO: Environmental Test Methods for Aircraft Equipment and Associated Ground Equipment
MIL-E-4158 C (USAF)	5 JUL 62	Electronic Equipment Ground; General Requirements for
MIL-E-5272 C (ASG)	13 APR 59	Environmental Testing, Aeronautical and Associated Equipment; General Specification for
MIL-E-5400 J	7 DEC 66	Electronic Equipment, Aircraft; General Specification for
MIL-T-5422 E (ASG)	13 APR 59	Testing, Environmental, Aircraft, Electronic Equipment
MIL-E-16400 F (NAVY)	24 FEB 66	Electronic Equipment, Naval Ship and Shore; General Specification for
MIL-T-21200 G	21 FEB 67	Test Equipment for use with Electronic and Fire General Specification for Control Systems;
MIL-STD-202 C	12 SEP 63	Test Methods for Electronic and Electrical Component Parts

VIBRATION

Specification	Method/Para.	Curve/Detail	G	5 10 50 90 200 500 1k 2k 3k Hz
MIL-STD-810 B	514-1,5,6	V	1.3	
		A,B	2	
		Y	2.5	
		W	4	
		AA,AB,AQ,C,M	5	
		D,Z	10	
		E	15	
		F	20	
	514-2,3	.36"	G	
		K	2	
		J	5	
		H	10	
		G	15	
		L	20	
		.06"	G	
		N	2	
		P	5	
		Q	10	
		R	15	
		S	20	
		T	30	
		U	50	
	514-4	G	G	
		AE 5.3	AK 20.7	
		AF 7.4	AL 23.9	
		AG 9.3	AM 29.3	
		AH 11.9	AN 37.8	
		AJ 16.9	AP 46.3	
STANAG 3518	15k		21.5	
MIL-E-4158 C	3.2.12 3.2.28.2			
MIL-E-5272 C	4.7	Proc. IV,V		
		VIII	15	
		VII	10	
Proc. VI discont.		XII B	2	
Proc. I,IX,X,XI use XII		III, XIII	2	
		XII A	10	
		II	20	
		XIV	20	
MIL-E-5400 J MIL-T-5422 E	3.1.35 3.2.21.5 4.2	Parts	.06"	
		Curve II	2	
		III	5	
		I,IV	10	
MIL-E-16400 F	3.11.8.1 4.5.14			
MIL-T-21200 G	3.1.35 3.2.16.4	Parts	.06"	
		Class 2,3	.06"	
		Class I-II	2	
		I-III	5	
		I-I,IV	10	

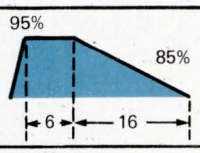
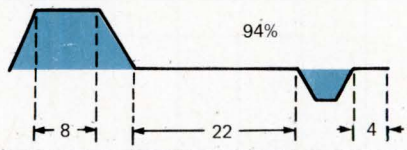
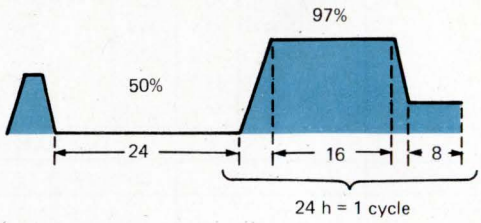
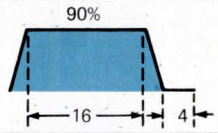
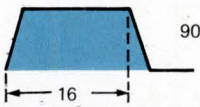
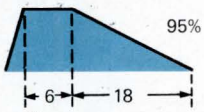
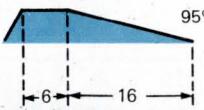
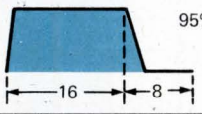
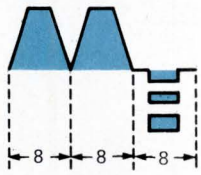
VIBRATION

Specification	Method	Condition		G	5 10 50 90 200 500 1k 2k 3k Hz
MIL-STD-202	201A			.06"	10 — 55
	204A		A	10	500
			C	10	sinusoidal
			B	15	10 — 2k
			D	20	
	214	Let.	I	II	
		A	5.2	5.9	
		B	7.3	8.3	
		C	9.0	10.2	
		D	11.6	13.2	
		E	16.4	18.7	
		F	20	22.8	50 — 2k random
		G	23.1	26.4	
		H	28.4	32.3	
		J	36.6	41.7	
		K	44.8	51.1	

TEMPERATURE

Specification	Meth./Para.	Detail	-80 -40 0 40 80 120 160 200 300 400 500°C
MIL-STD-810 B	501 Hi	Proc. I	71
		II	68
	502 Lo	Proc. I	as spec.
	503 Shock	Proc. I	-54 — 71
STANAG 3518	15b Hi	f	55
		e	70
		d	85
		c	100
		b	125
		a	155
	15c Lo	d	-10
		c	-40
		b	-54
		a	-62
	15o Shock		-54 — 71
MIL-E-4158 C	3.2.28.1.1	Indoor	0 — 52
		Out, Moder.	-40 — 52
		Out, Cold	-54 — 71
		Out, Desert	
MIL-E-5272 C	4.1 Hi	Proc. I=II	71
	4.2 Lo	Proc. I	-54
		II	-62
	4.3 Shock	Proc. II=I	-40 — 85
MIL-E-5400 J MIL-T-5422 E	1.2 3.1.1	Class 1, 1A	-54 — 55
		2	-54 — 71
		3	-54 — 95
		4	-54 — 125
MIL-E-16400 F	1.3 3.8.1 4.5.8	Class 4	0 — 50
		3	-40 — 50
		2	-28 — 65
		1	-54 — 65
MIL-T-21200 C	none, see Temp/Alt.		
MIL-STD-202	102 A	Cond. B	-55 — 65
		A,D	-55 — 85
		C	-65 — 125
	107 B	A	-55 — 85
		B	125
		F	150
		C	-65 — 200
		D	350
		E	500

HUMIDITY

Specification	Meth./Para.	Details	°C	0 12 24 36 48 hours	No. Cyc.	Total Hours
MIL-STD-810 B	507	Proc. I	71° 28°		10	240
		Proc. II	65° 30° 20°		5	240
		Proc. III		as in Proc. II plus 480 h at 30°C		720
		Proc. IV	60° 45° 30° 25°		5	144
		Proc. V	40.5° 21°		20	480
STANAG 3518	15e		60° 25°		5	120
MIL-E-4158 C	3.2.28.1		37.8°	100%		—
MIL-E-5272 C	4.4	Proc. II, I	71° 28°		10	240
		Proc. III	49°	95%		360
MIL-E-5400 J	3.2.21.4			100%		—
MIL-T-5422 E	4.4		50° 40°		10	240
MIL-E-16400 F	4.5.9		60° 30°		5	120
MIL-T-21200 C	3.2.16.2			100%		—
MIL-STD-202	103 B Steady State		40°	90%	B 96 A 240 C 504 D 1344	
	106 B		65° 25° -10°		10	240

SHOCK

Specification	Met/Para	Details	Handling	Design	Crash	Hi Impact	Pulse	Notes
MIL-STD-810 B	516	Pr. II V VI	Drop Bench Rail Imp.					
		Air Ground Air Ground — I		15g 11ms 40g 18ms 20g 11ms 40g 18ms			half-s. half-s. sawt. sawt.	
		Air Ground Air Ground — III			30g 11ms 75g 11ms 40g 11ms 75g 11ms		half-s. half-s. sawt. sawt.	
		Air Ground Air Ground — IV				100g 6ms 100g 6ms 100g 6ms 100g 11ms	half-s. half-s. sawt. sawt.	
STANAG 3518	15j	3a 3b		as spec.	as spec.			
MIL-E-4158 C	3.2.28.2	as specified						
MIL-E-5272 C	4.15	Pr. II=V I=IV III		15g 11ms	30g 11ms 50g 8.5	as spec.	half-s.	MIL-S-4456 JAN-S-44 MIL-S-901
MIL-E-5400-J MIL-T-5422 E	3.2.21.6 4.3	}		15g 11ms	30g 11ms			
MIL-E-16400 E	3.11.8.1 4.5.14.1	}				1,3,5 ft. 400 lb.		MIL-S-901, Gr.A
MIL-T-21200 G	3.2.16.5 4.3.2.1		Transient Drop	15g 11ms	30g 11ms			

SHOCK

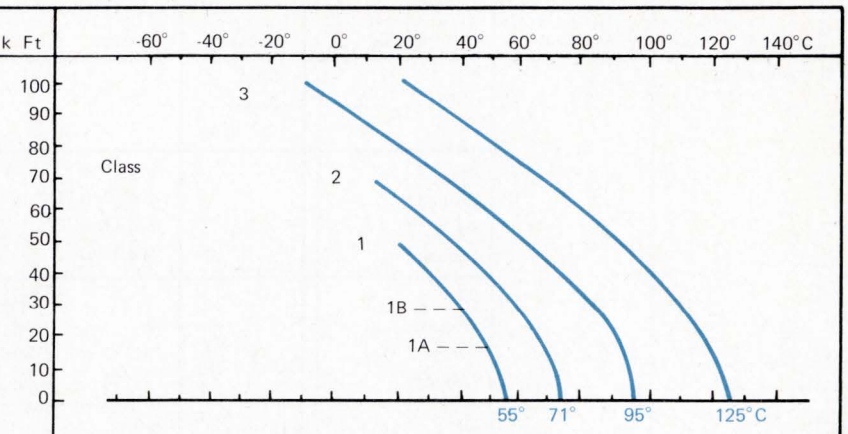
Specification	Method	Condition	Handling	Design	Hi Impact	Pulse	Notes
MIL-STD-202	203 A		Drop				
	202 B ≤4 lbs	as specified					
	205 C ≤300 lbs	A B C		15g 11 ms 30g 11 ms 50g 11 ms			
	213	preferred — A B C D E F G H I		50g 11ms 75g 6ms 100g 6ms 500g 1ms 1000g .5ms 1500g .5ms 50g 10ms 75g 6ms 100g 6ms		half-s. half-s. half-s. half-s. half-s. half-s. sawt. sawt. sawt.	} for semiconductor
	207 ≤300 lbs				1, 3, 5 ft 400 lbs		MIL-S-901, Class HI

TEMPERATURE/ALTITUDE

Specification

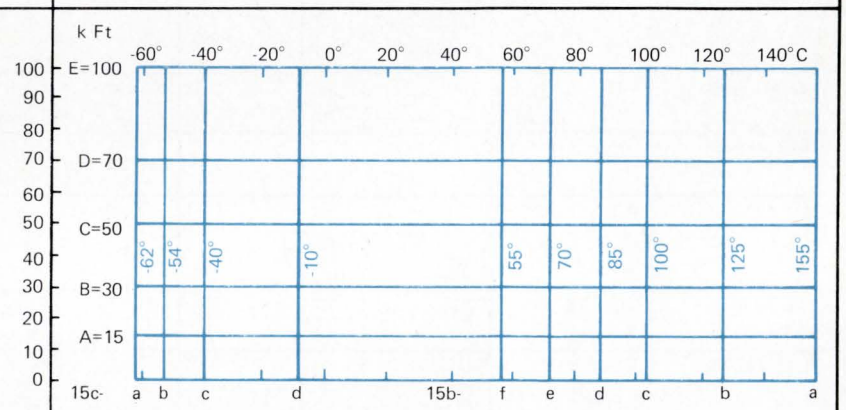
MIL-STD-810 B Meth. 504
Curve A : Cont. Oper.

Figure	Class	0 Ft	Alt.	Temp.
504-1	1B	55°C	15k	49°C
-1	1A	55°	30	40°
-1	1	55°	50	19°
-2	2	71°	70	11°
-3	3	95°	100	- 9°
-4	4	125°	100	23°



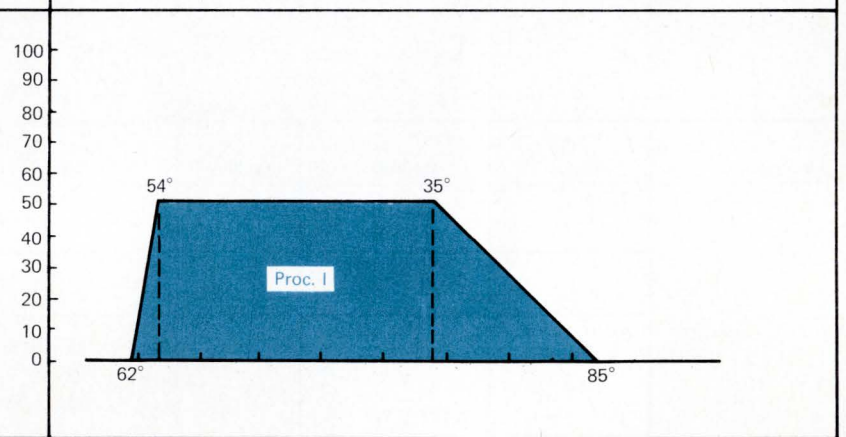
STANAG 3518 15 1.2a

Specify Altitude with a temperature of 15b and 15c.



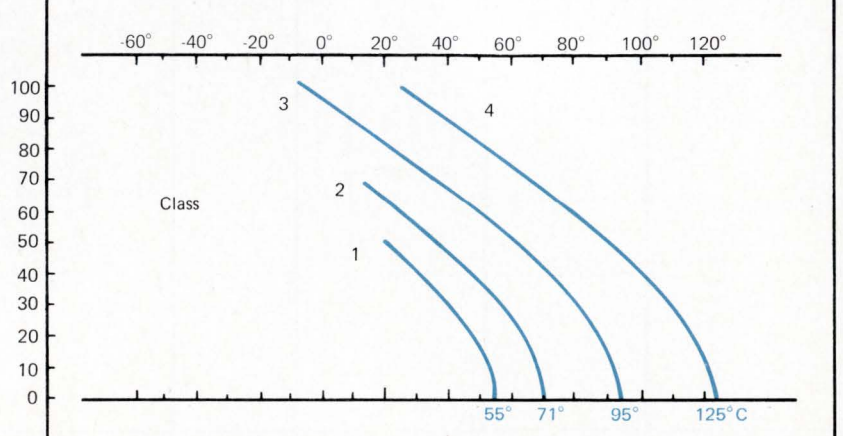
MIL-E-5272 C 4.14

Proc.	0 Ft	50 k Ft
I	-62° to 85°C	-54° to 35°C
II	as specified	



MIL-E-5400 J 3.2.21.3 Fig. 4
Curve A: Cont. oper.

Class	0 Ft	Alt.	Temp.
1	55°C	50k	20°C
2	71°	70k	10°
3	95°	100k	-9°
4	125°	100k	23°



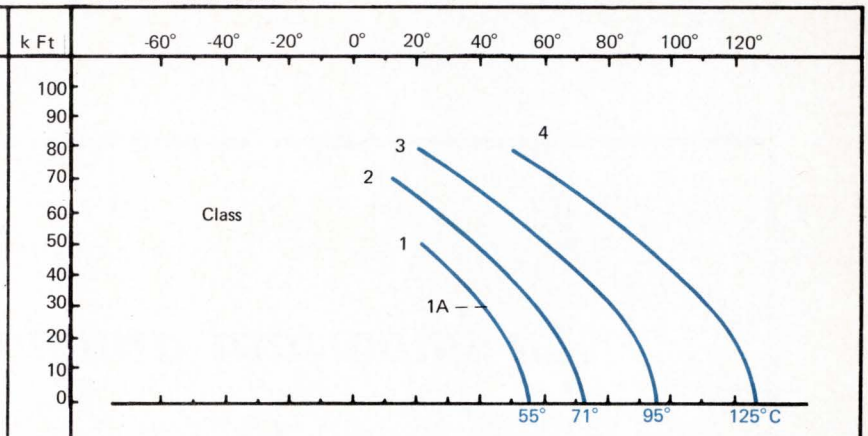
TEMPERATURE/ALTITUDE

Specification

MIL-T-5422 E 4.1 Fig. 1

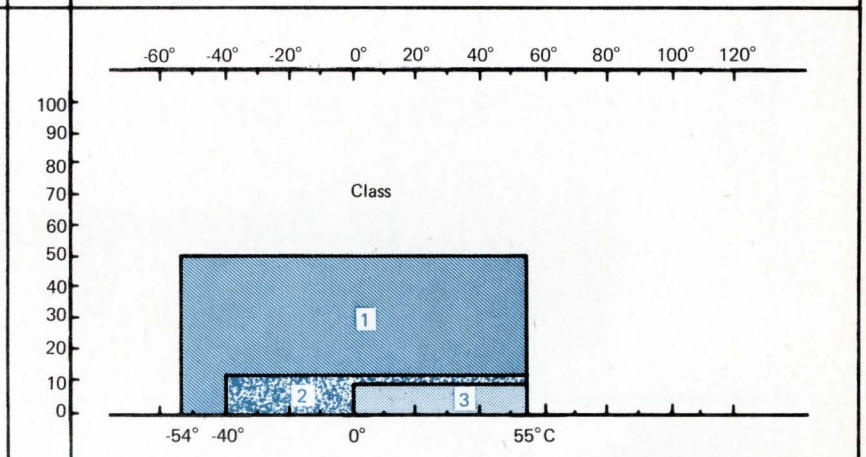
Curve A: Cont. oper.

Class	0 Ft	Alt.	Temp.
1A	55°C	30k	40°C
1	55°	50k	20°
2	71°	70k	11°
3	95°	80k	20°
4	125°	80k	50°

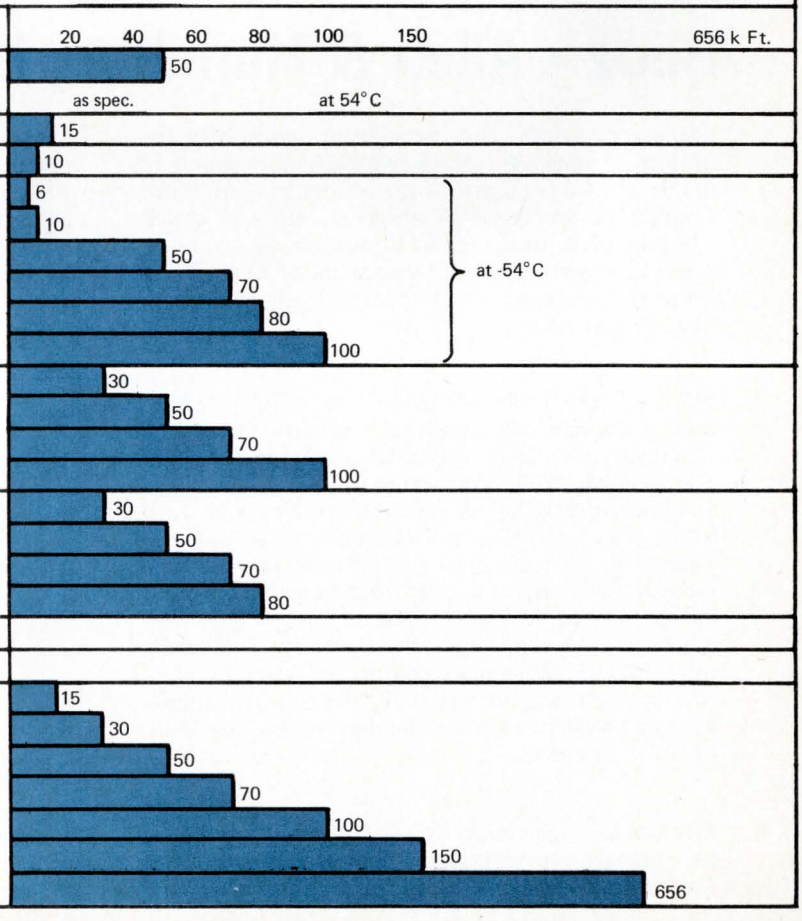


MIL-T-21200 G 3.2.16.1

Class	Altitude	Temperature
3	0 to 10k	0° to 55°C
2	0 to 10k	-40° to 55°
1	0 to 50k	-54° to 55°



ALTITUDE



An important announcement

to the engineer

who is on the way up

in his company

Under the direction of

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Because of a wide and enthusiastic response to the Project Management Series which has appeared in the pages of this magazine, the editors have arranged a series of professionally directed seminars which will take place in key cities throughout the country. These Seminars on the "Management of Engineering Projects" are open to all qualified engineers who wish to participate.

The purpose of the Seminars is to develop within each participant an improved capability to manage effectively both large and small electronic projects. The Seminars will provide the practical knowledge to those responsible for electronic projects to do a better job of planning and executing those projects. There will be particular emphasis on the methods used to reach an objective while remaining within the prescribed product specifications, budget and schedule. The tested methods used in the Seminars will help the individual electronic engineer or manager increase his personal skills, sharpen his capability and broaden his understanding of Project Management problems.

Electronics engineering projects require the use of new management concepts which are often difficult for the traditionally-oriented manager to understand and accept. Because they cut across many functional (specialist) and organizational lines, these projects do not fit comfortably within the lines of authority in the traditional organizational structure. Even more important, these projects are scheduled to achieve *certain specified results at a particular point in time.*

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EE

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Two new HP oscillators are teaching the old standard new tricks in performance and value. Both the new HP 204C and HP 209A Oscillators have exceptional spectral purity (< 0.1% −60dB). Both have FET's in the bridge for improved stability—balanced output—sync in/out. All this adds up to greatly improved performance. And, you get this extra value at only a modest increase in price over the old standard.

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High power output, sine or square wave. The 209A generates simultaneous sine and square wave outputs over a frequency range of 4 Hz to 2 MHz. Amplitudes are independently adjustable. Power output for sine wave is double that of 204C—5 Vrms into 600 Ω, 10 Vrms into open circuit. Square wave output is 20 V peak-to-peak. Price HP 209A, $320.

Get full value for your signal-source dollar. Consult your HP Instrumentation Catalog for full specifications and order your oscillator by calling your nearest HP telephone order desk. For additional data, write Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland.

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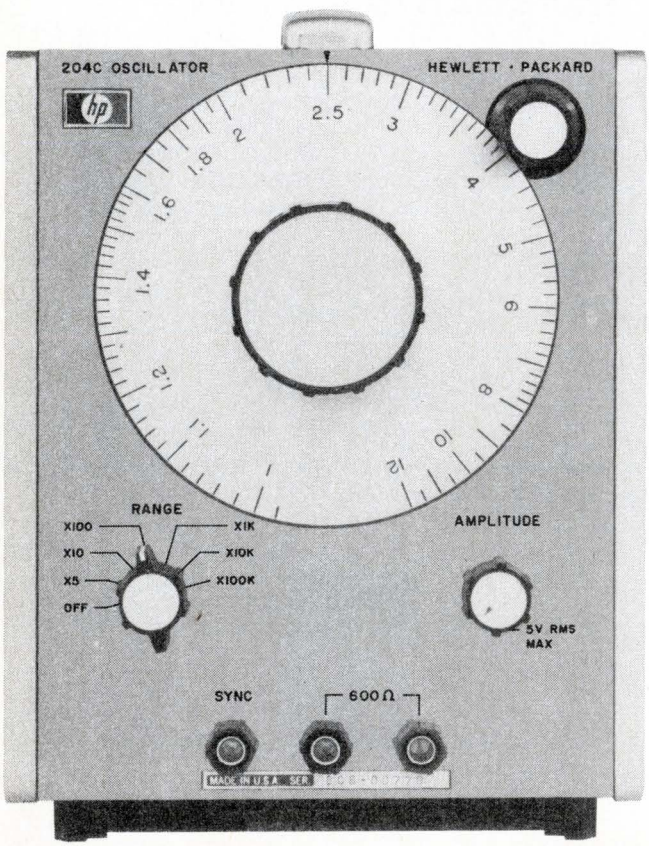
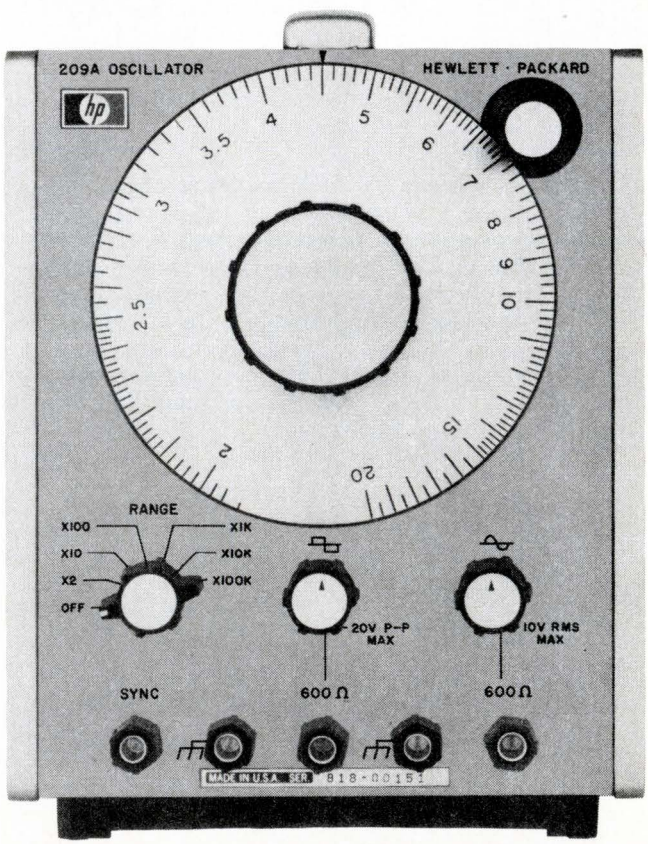
SIGNAL SOURCES





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Here's how you voted

The winning Idea for the October 1968 issue is, "Low cost voltage regulator from one IC."

Les Toth, our prize-winning author, is a Project Engineer at the San Diego, California division of COHU Electronics, Inc. Mr. Toth selected the Triplett Model 600 TVO multitester as his prize.

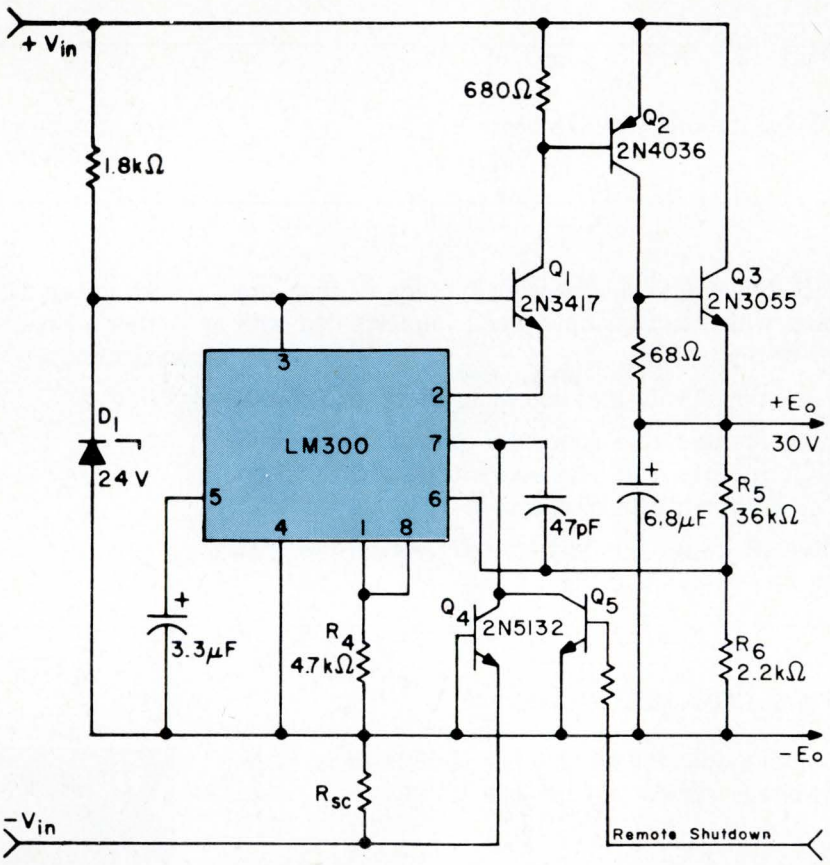
910 Voltage regulator has extended range, remote shutdown

Walter C. Jung
MTI, Cockeysville, Md.

A good, economical voltage regulator, National Semiconductor's LM300, is even more attractive in the circuit shown here. Besides upping the output voltage beyond the IC's specified limit, the circuit adds external short-circuit protection and remote shutdown capability.

Resistors R_5 and R_6 sense the output voltage. Although the values shown are for 30-V operation (the spec sheet max. is 20 V), there is no inherent limit if you choose suitably rated transistors. To accommodate the larger input voltages, you must add a preregulator (D_1) and a level-shifter (Q_1) to the basic regulator.

For high-voltage applications, R_5 can be at least ten times R_6. Thus, you can set $R_6 = 2.2$ kΩ—the optimum resistance for the LM300 at the pin 6 feedback terminal. Because there is 1.8 V at this point, $I = 1.8\ V/2.2$ kΩ, or 0.82 mA For a 30-V output, then, R_5 is simply $(E_o - 1.8)/I$, or $28.2\ V/0.82$ mA = 34.4 kΩ (use 36 kΩ, the nearest 5% value).



The isolation of pins 1 and 8 from the output terminal negates the LM300's internal short-circuit protection. But adding Q_4—a low cost epoxy transistor—gives you very good external short-circuit protection. When the load current flow through R_{sc} is large enough, Q_4 saturates and clamps pin 7 (the compensation terminal). This clamping action switches the regulator into a current mode, which protects the IC. ($R_{sc} = {}^{\prime}V_{be4}/I_{sc}$.)

Similarly, you can collector-OR additional transistors with Q_4 to shut the regulator down with a dc signal. Q_5 is a single-transistor example of this technique.

Input (line) regulation is better than 0.002%/V at 1-A load current. Load regulation is better than 0.05%, again at a 1-A load. The temperature performance is the same as the original IC specs, since the reference voltage source is untouched. R_4 supplies the minimum chip current, 3 mA.

Anyone can think small.

Frankly, we had something bigger in mind.

Model 1290 DPM will be on display at IEEE Booths 2C-39—50. Watch us plug it in and play your favorite numbers.

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.

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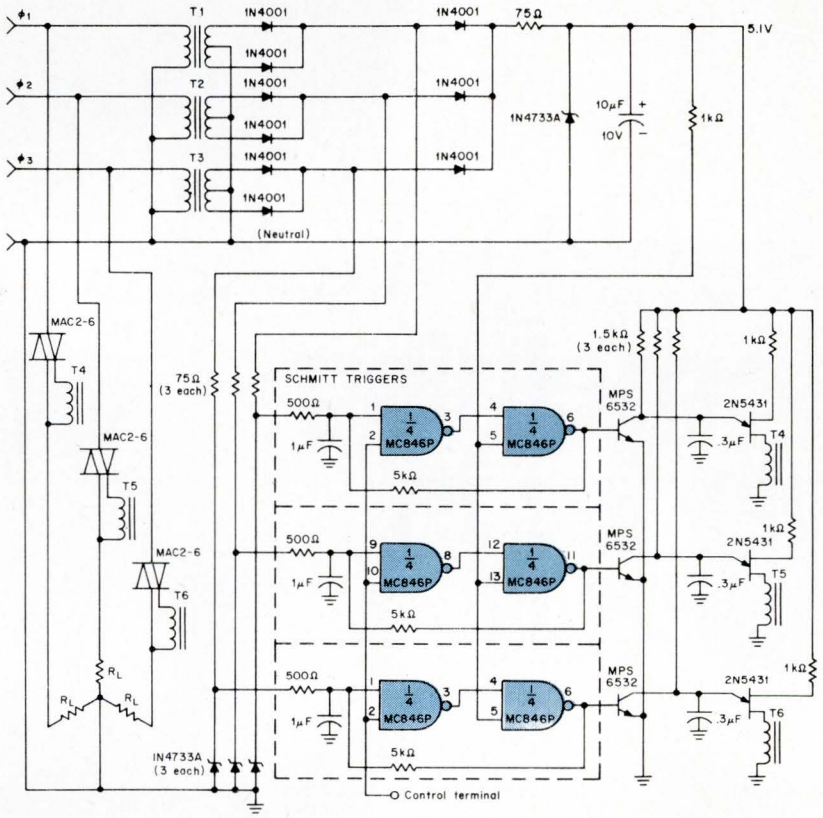
911 Zero-point switching eliminates EMI

Robert A. Phillips
Motorola Semiconductor, Phoenix, Ariz.

Solid-state circuits in high-power ac controllers let you use zero-point switching, which is not practical with relay-type controllers. A zero-point switch turns a circuit on only when the voltage on the input line is zero, at the start of a cycle. This eliminates switching transients, a prime source of EMI.

High-power systems often have three-phase line inputs. The circuit on your right gives you zero-point switching of such voltages, and, in addition, you can control it with any logic system compatible with DTL or TTL gates.

The input lines connect to the load through control triacs. Transformers T_1, T_2, and T_3, with their rectifiers, form a three-phase full-wave bridge. This rectified ac output is a 5.1-V collector supply for the logic circuitry. It also puts 5 V on the inputs of the Schmitt triggers, except when the line voltage crosses near zero in each phase.



Two Motorola MC846P NAND gates in each phase are wired as a Schmitt trigger. When the line voltage crosses near zero and the voltage at the input to each gate falls below the logic 1 level, the output of the second gate follows the input to the first. As the output of the second gate falls to the logic 0 level, the MPS6532 transistor loses base drive and turns off. As it goes off, its collector voltage rises to 5 V, and the 0.3-μF capacitor charges.

When the capacitor reaches about 4 V, it fires the unijunction transistor (2N5431). The UJT then applies a series of trigger pulses to the gate of its triac (through T_4, T_5, or T_6). Triggering continues until the input of the Schmitt rises above 1.5 V, turning the MPS6532 on. Thus, a triac has gate drive only when the voltage across that particular triac is zero.

Keep the control terminal of the circuit at a logic 1 level (5 V) until you want circuit turn-on. At that time, drop the terminal's voltage to a logic 0 level. Raising it to 5 V again will then turn each triac off after the immediate half-cycle finishes, disconnecting its load.

MSI HYBRIDS

In 1967 we started taking the circuit design out of system designing by making MSI available off-the-shelf. Since then, we've developed a series of 12 digital MSI building blocks that do the work of a hundred IC's.

Now we've even one-upped ourselves with MSI hybrids. We pack several MSI chips on a single substrate using multi-layer ceramic for the interconnections. You need fewer external connections to your system, so reliability goes up, and fewer packages, so space needs go down. And our MSI hybrids come to you fully assembled, fully tested, so total system costs go down.

We started on our MSI hybrids by doubling up on our reliable 9304, a Dual Full Adder with a carry propagation delay of only 8ns. Shown are three examples of what this does for you. They're all available now from your stocking Fairchild distributor. Write for complete specifications.

New product number **64.**

SH8080 4-BIT ARITH-METIC UNIT

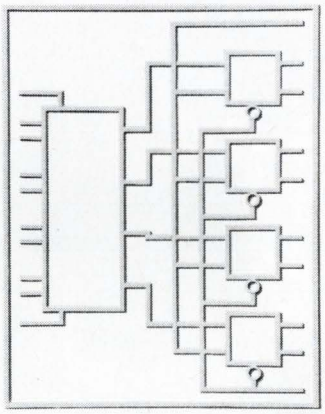
The SH8080 is a 4-bit ripple-carry adder with a built in holding register. Typical carry propagation delay is 32ns and the noise margin is one volt. Several units may be connected in series to handle longer words.

The SH8080 uses two Fairchild 9304 dual full adders and two Fairchild 9020 dual $JK\bar{K}$ flip-flops interconnected on a multi-layer substrate. It is fully compatible with all Fairchild CCSL devices.

The SH8080 is available in a 32-lead flat pack and operates over the full military and industrial temperature ranges. You can get it from your Fairchild distributor today. Write for complete specifications.

To order the SH8080, ask for:

Part Number	Temperature Range	Prices 1-24	25-99	100-999
HBY80801XX	−55°C to +125°C	$120.00	$96.00	$79.25
HBY80809XX	0°C to + 70°C	46.00	35.80	30.80



New product number **65.**

SH2204 BYTE PARITY GENERATOR/ CHECKER

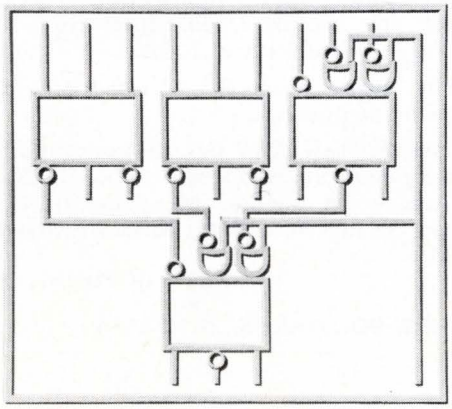
The SH2204 Byte Parity Generator/Checker generates parity for an 8-bit byte or checks parity over 9 bits with a typical delay of only 35ns from input to odd parity. For longer words, just connect additional units in parallel.

The SH2204 uses two Fairchild 9304 dual full adders interconnected on a multi-layer substrate. It is fully compatible with all Fairchild CCSL devices.

The SH2204 is available in a ⅜″ x ⅜″ 14-lead flat pack and operates over the full military and industrial temperature ranges. It's in stock at your Fairchild distributor now. Write for complete specifications.

To order theSH2204, ask for:

Part Number	Temperature Range	Prices 1-24	25-99	100-999
HBK22041XX	−55°C to +125°C	$68.00	$54.00	$48.00
HBK22049XX	0°C to + 70°C	32.00	26.00	22.00



New product number **66.**

SH2205 RIPPLE-CARRY ADDER

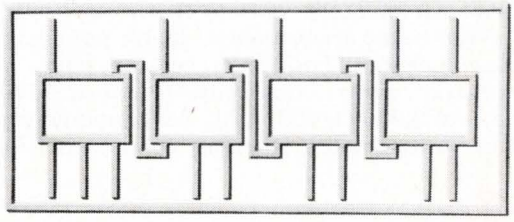
The SH2205 is a ripple-carry parallel addition (or subtraction) function block containing four full adders. Typical carry propagation delay is 8.0ns per bit. The circuits are high speed, high fan-out TTμL with input diode clamping.

The SH2205 uses two Fairchild 9304 dual full adders interconnected on a multi-layer substrate. It is fully compatible with all Fairchild CCSL devices.

The SH2205 comes in a 16-pin ceramic DIP and operates over the full military temperature range. Your Fairchild distributor has it in stock now. Write for complete specifications.

To order the SH2205, ask for:

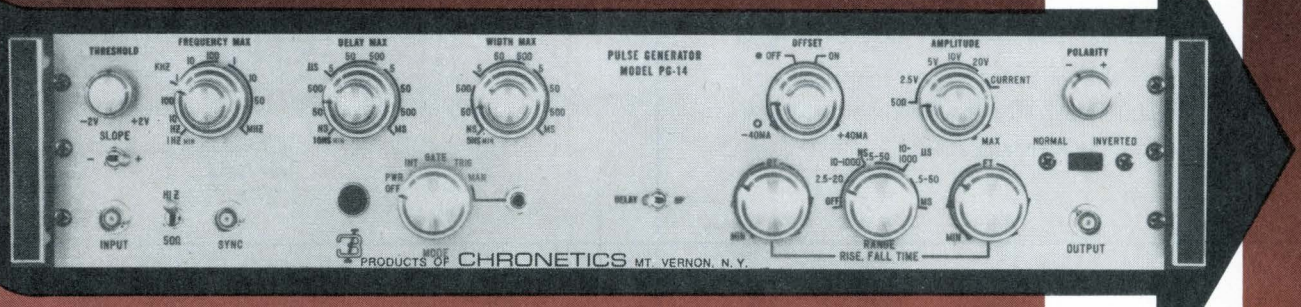
Part Number	Temperature Range	Prices 1-24	25-99	100-999
HBK22051XX	−55°C to +125°C	$63.00	$50.00	$44.00
HBK22059XX	0°C to + 70°C	32.00	26.00	22.00



FAIRCHILD SEMICONDUCTOR

FAIRCHILD SEMICONDUCTOR A Division of Fairchild Camera and Instrument Corporation Mountain View, California 94040, (415) 962-5011 TWX: 910-379-6435

PG-14



Risetime: 2 ns; Amplitude: ±20 volts

If you have some other 50 MHz Pulser maybe you can send it back.

Just about anything you want to do with a pulse generator at rep rates to better than 50 MHz you can do with a PG-14. It's easily the most advanced and highest performing pulser in the 50 MHz group. And it gives you a degree of pulse shape control that lets you do what might otherwise require a multitude of lesser pulsers to do and some things you can't do even with the multitude.

Capital budgets, please note: $1,250.*

Spec Checking? Fine. Spec Check:

Rep Rate: continuously variable 1 Hz to >50 MHz. **Modes:** single pulse; delayed pulse; double pulse; ext. trigger; gating; one-shot. Positive or negative pulses or the complement of either. **Amplitude:** less than ±100 mV (±20 mA) to ±20V (±400 mA), continuously variable. Current or voltage modes. **Risetime:** continuously variable from <2.5 ns to 50 ms with 2 ns fixed position. **Falltime:** <3.5 ns to 50 ms. Rise and fall are independently variable and linear. **Width:** continuously variable from 5 ns to 500 ms. **Delay:** continuously variable from 10 ns to 500 ms. **DC-Offset:** continuously variable from -5V (-100 mA) to +5V (+100 mA). **Duty cycle:** 100%.

Solid state, naturally, and 3-1/2" high (19" wd x 17" d); bench mounting optional.

Want more technical data? Or a demonstration? Write or phone the pulser professionals. CHRONETICS, INC., 500 Nuber Avenue, Mt. Vernon, New York (914) 699-4400. In Europe: 39 Rue Rothschild, Geneva, Switzerland (022) 31 81 80.

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Charts and Nomographs

Chart pinpoints receiver interference problems, M. W. Shores, General Dynamics, "EDN," Vol. 14, No. 2, Jan. 15, 1969, pp. 43-46. A receiving system has potential EMI problems when it must operate adjacent to such other sources as radars or flight-guidance beacons. To reduce the EMI, the system designer can use this "universal interference chart." With it, he can determine the i-f least susceptible to interference from nearby sources, the maximum number of interference-free channels, the preferred channel-spacing, and so forth.

Circuit Design

A new type of frequency multiplier, Harvey L. Morgan, LTV Electrosystems, "EEE," Vol. 17, No. 1, Jan. 1969, pp. 72-74. The tapped delay line, a common component for generating line-discharge pulse, is used here to multiply the frequency of signal. The author claims that such a multiplier is more efficient than those based on the non-linear characteristics of diodes and that it allows multiplication of modulated signals (preserving the modulation). He shows an application for a quadrupler, from 100 kHz to 400 kHz.

Differential-amplifier circuit file, Richard S. Hughes, China Lake Naval Weapons Center, "EDN," Vol. 14, No. 2, Jan. 15, 1969, pp. 37-40. The differential amplifier is a versatile circuit. Proof of this is its use in a great many linear ICs. This article shows six variations of discrete-component diff-amp circuits that include a log amp, a follow-and-hold amp, a gated pulse integrator, and so forth.

Log diodes can simplify design, James Raby & Ronald Embley, Electronic Associates, Inc., "Electronic Design," Vol. 17, No. 2, Jan. 18, 1969, pp. 58-59. Designing analog circuitry to multiply, divide, raise to a power, or take a root? The silicon logarithmic diode is a natural circuit component. Designs are simple and straightforward, as this short article shows.

Network design using operational amplifiers, Joseph Salerno, Bell Telephone Laboratories, "Electro Technology," Vol. 83, No. 2, Feb. 1969, pp. 48-49. You can use operational amplifiers as basic building blocks when designing networks. Here's how.

Synthesizing active filters, Sanjit K. Mitra, Univ. of Calif., "IEEE Spectrum," Vol. 6, No. 1, Jan. 1969, pp. 47-63. Extensive research on the theory and practice of linear active networks has made this area one of the most attractive and promising branches of circuit theory. The author presents a unified, comprehensive survey of achievements in the field of network synthesis for linear, lumped, and finite networks from 1965 through 1968.

***Protecting circuits from over and under voltages,** Richard Klein, Acme Electric, "The Electronic Engineer," Vol. 28, No. 3, March 1969, pp. 59-61. This article describes many under- and over-voltage regulators. From this you can select the regulator that is needed without wasting money or over-regulating your power supply.

Get the facts on one-shot design, Richard S. Hughes, U.S. Naval Weapons Center (China Lake), "Electronic Design," Vol. 17, No. 2, Jan. 18, 1969, pp. 70-74. Building a discrete one-shot can be cheap—if you can meet period and output specs and avoid trial-and-error debugging. This concise design article goes through a simplified procedure and carries out the theory with a design example.

Communications

Signal averagers, George Flynn, Sr. Assoc. Editor, "Electronic Products," Vol. 11, No. 10, Feb. 1969, pp. 36-44. Signal averagers pull repetitive, low-level signals out of noise. But the process need not stop there. For instance, if you tie-in a computer, you can calculate various characteristics of the recovered waveform, such as its variation from the average value, its true rms value, and so forth. The computer accounts for the great differences in price between low- and high-cost averagers. This article briefly discusses the basics of signal averagers, and describes a number of commercially available instruments.

Components

Relays, Sidney C. Silver, Assoc. Editor, "Electronic Products," Vol. 11, No. 10, Feb. 1969, pp. 46-62. Solid-state relays offer a number of advantages over their electromechanical counterparts. But they are still expensive and, for some users, certain problems outweigh the advantages. This article describes the state of the art of solid-state relays of various types (optoelectronic, reed-input/triac-output, and so forth).

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New York, N. Y. 10017

The Electronic Engineer
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56th & Chestnut Streets
Philadelphia, Pa. 19139

EE ABSTRACTS

***Components feel the squeeze of ICs,** David H. Surgan, Eastern Editor, "The Electronic Engineer," Vol. 28, No. 3, March 1969, pp. 73-76. Manufacturers point out that ICs still need capacitors, variable and precision resistors, and inductors. In some cases products have to be modified or new ones created. What these manufacturers are doing is both important and useful to engineers. Products described in this special report range from "outboard" parts to components for hybrids.

Ceramic capacitors for hybrid integrated circuits, Donald W. Hamer, Erie Technological Products, "IEEE Spectrum," Vol. 6, No. 1, Jan. 1969, pp. 79-84. The high-dielectric-constant ceramic chip represents one of the most effective solutions to the problem of obtaining capacitance in the fabrication of hybrid thick-film integrated circuits. The author discusses ceramic chip capacitors in multi-layer, single-layer, and screened-on configurations. He also covers relationships between size, capacitance, and cost for three common ceramic formulations.

Switch low-power loads reliably, E. F. Heiser, Micro Switch, "EDN," Vol. 14, No. 2, Jan. 15, 1969, pp. 48-49. Switching low-voltage, low-current loads may mean contact problems. Here is a check-list of do's and don'ts to help you properly specify snap-action switches for low-power loads.

The protectors—they safeguard equipment and components, Sidney C. Silver, Assoc. Editor, "Electronic Products," Vol. 11, No. 9, Jan. 1969, pp. 46-58. Here's a discussion of many types of protective elements, from fuses to zeners. Each protector has advantages for certain applications. A trend in their usage is to place them closer to the protected circuit, rather than to the power source. A trend in their design is to coordinate them into a single, multi-function package that handles the overall protection problem.

Computers and Peripherals

Semiconductor arrays get bigger and denser, Ury Priel, Signetics Corp., "Electronics," Vol. 42, No. 2, January 20, 1969, pp. 100-102. An overview of semiconductor memories brings out the solid-state thrust. Part IX of a continuing series, the article covers who-makes-what, the state of art, advantages and limitations, and application targets.

Mastering the man-machine interface, George Flynn, Sr. Assoc. Editor, "Electronic Products," Vol. 11, No. 9, Jan. 1969, pp. 20-30. The sophisticated display of information is closely associated with computers. You must pick out the significant data, and integrate them into a unified display. This article is a general discussion of that interface in a system where man talks to his machine, and how displays are and should be used, with emphasis on the crt.

A digital computer for antenna pointing, Dr. Narsingh Deo, Jet Propulsion Laboratory, "Electro Technology," Vol. 83, No. 2, Feb. 1969, pp. 53-54. The author describes the best way to handle trigonometric functions with an on-board computer. Output pulses from the computer are applied to a stepping motor which points the antenna.

MOS random-access arrays, Burton R. Tunzi, American Micro-Systems Inc., and **Cutting systems costs with MOS,** Lee Boysel, Fairchild Semiconductor, "Electronics," Vol. 42, No. 2, Jan. 20, 1969, pp. 102-108. Parts X and XI of the memory series focus on the place of MOS devices. The authors cover the state of art, applications, design flexibility, tradeoffs, and economics. Emphasis is placed on random-access, read-only, and read/write memory types.

Integrated Circuits

The American challenge on a chip, Michael Payne, London Editor, "Electronics," Vol. 42, No. 2, January 20, 1969, pp. 74-86. A four-part feature on the state of art of ICs in the United Kingdom. United States designers will have British chips at their disposal in the next decade, so this primer comes in handy. It covers major aspects of the technology, stressing fabrication and production. At present, U.S. chips dominate thinking, accounting for 75% of the "action." But the British intend to leapfrog into contention with ECL, LSI, advanced MOS, and sophisticated linears.

***IC regulator removes restrictions,** J. D. Lieux and R. D. Ricks, Fairchild Semiconductor, "The Electronic Engineer," Vol. 28, No. 3, March 1969, pp. 53-57. One of the fastest growing linear integrated circuits, the voltage regulator is becoming very popular because it allows users to regulate the voltage for even small loads for which he could not buy a power supply before. The IC voltage regulator this article describes boasts flexibility as its major improvement over the ones that have already appeared. Following the trend of the market, it offers wider voltages, better regulation, and better temperature compensation.

Applications for fully compensated op amp ICs, Mike English, Fairchild Semiconductor, "EEE," Vol. 17, No. 1, Jan. 1969, pp. 62-65. Until recently, most integrated circuit operational amplifiers had to be externally compensated by the user. However, new op amps coming into the market, such as Fairchild's μA 741, are compensated by the manufacturer. The author explains how to maintain the op amp stable in applications such as voltage-followers, integrators, differentiators, and error amplifiers for voltage regulators.

Build a programmable word generator, James J. Kubinec, National Semiconductor Corp., "Electronic Design," Vol. 17, No. 2, Jan. 18, 1969, pp. 62-67. When simple pulse generators are not enough, a programmable word generator can be used in test and checkout equipment to simulate data and commands. A 100-bit, 1-MHz generator can be built using MOS ICs and a few discretes. Step-by-step design procedures are given by the author.

MOS complex array system design, L. L. Boysel and G. P. Carter, Fairchild Semiconductor, "Electro Technology," Vol. 83, No. 2, Feb. 1969, pp. 35-37. It's becoming increasingly difficult to design an error-free high-gate-density circuit because of the complexity of IC arrays. However, with a properly designed building block you can breadboard the design before final IC commitment.

Materials

Transfer tapes streamline component packaging, K. Ettre and G. R. Castles, Vitta Corp., "Electronic Products," Vol. 11, No. 9, Jan. 1969, pp. 62-68. A typical transfer tape consists of a base layer, an adhesive film, protective paper, and another layer from which the tape takes its name, the transfer layer. The transfer layer may be glass, metal, ceramic or other inorganic material, plus binders. The tapes are useful in glass sealing, metallizing, preforming, and so forth, in the processing and housing of components (ICs for example). Delicate parts can be held and/or transported on the adhesive layer, or the tape itself can be punched to make preforms.

The compatibility of materials, Walter H. Kohl, NASA Electronics Research Center, "IEEE Spectrum," Vol. 6, No. 1, Jan. 1969, pp. 67-74. When the concept of compatibility is applied to materials, some modification of its meaning becomes necessary—two different materials must be compatible not only with each other but with their environment as well. This demand for more specialized, more durable substances for such critical projects as the space program has created a new materials technology.

***Heat shrinkable tubing chart,** EE Editors and Electronized Chemical Engineers, "The Electronic Engineer," Vol. 28, No. 3, March 1969, pp. 35-42. This handy, multi-colored wall chart will remove the mystery from selecting and using heat shrinkable tubing. The heart of the chart is a table describing what materials are used, and which compares their good and bad points for various applications. Many good application ideas are contained in the chart.

Microwaves and Microwave Products

Visible and near-IR laser modulation, Monte Ross, McDonnell Douglas Astronautics Co., "Electro Technology," Vol. 83, No. 2, Feb. 1969, pp. 21-28. Modulators and modulation must both be considered when dealing with modulation for the visible and near-IR wave lengths. Thus the author first deals with the physical principles of modulation. He does this by presenting the basic physical considerations in modulating a laser. Basic considerations in signal design then lead the reader to desirable laser modulation schemes.

Build broadband rf power amplifiers, James A. Benjamin, ITT Semiconductors, "Electronic Design," Vol. 17, No. 2, Jan. 18, 1969, pp. 50-54. Matching broadband rf power amplifiers to sources and loads is tough over a wide range of frequencies. However, filters, ferrite transformers, and hybrids can solve the problem. This article shows how.

Infrared modulation techniques, Thomas E. Walsh, RCA Electronic Components, "Electro Technology," Vol. 83, No. 2, Feb. 1969, pp. 29-33. Various modulation methods used to modulate IR light beams are discussed. With practical driving circuits these methods yield bandwidths to several hundred megahertz. Useful wavelength range has been limited to below 12μm for all methods except free-carrier modulation. It has been found that if the device is placed inside the laser cavity, a hundredfold increase in modulation sensitivity can sometimes be achieved.

Packaging

A systems approach to hybrid packaging, T. J. Dowling and D. A. Colling, Research Labs, Westinghouse Electric Corp., "Electro Technology," Vol. 83, No. 2, Feb. 1969, pp. 38-42. The hybrid IC packaging engineer must often solve problems in chemistry, electronics, physics, mechanical engineering and materials science if his design is to be reliable. The packaging engineer's role in improving reliability is analyzed.

Systems

Analyzing sampled data servos using stepper motors, Bernard F. Papa, Systems Div., Singer-General Precision Inc., "Electro Technology," Vol. 83, No. 2, Feb. 1969, pp. 50-52. You can use stepper motors to achieve positioning flexibility. This article shows you how to analyze and predict the performance of such systems.

***Telemetry Course, Part IV: demultiplexing and decoding,** George J. Slusarchyk, Radiation, Inc., "The Electronic Engineer," Vol. 28, No. 3, March 1969, pp. 63-71. This month's installment describes how the data is separated so that we again have one set of data for each data source. When separating this data we have a prime consideration—insuring data integrity and accuracy. How this is done is clearly described for our readers.

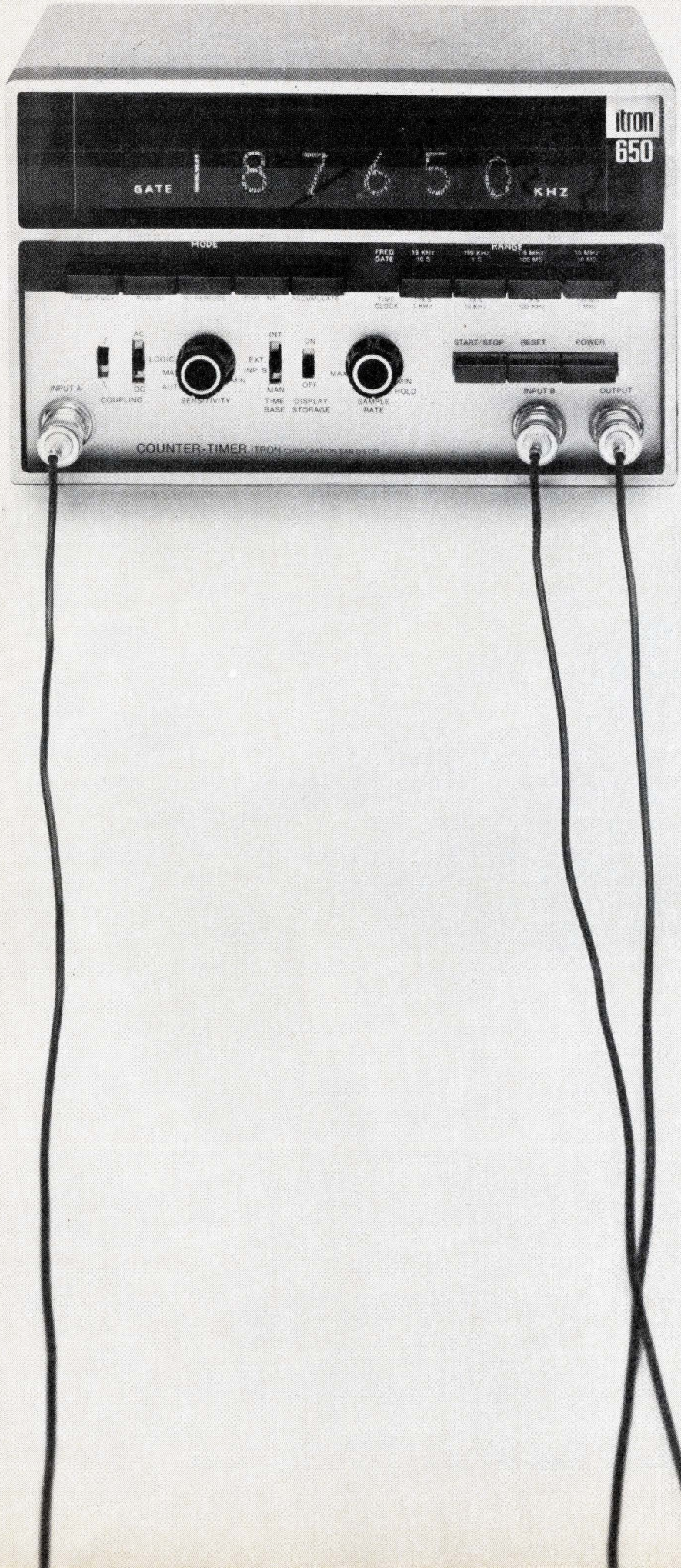
Test and Measurement

***A quick guide to environmental specifications,** Rudolph Wernick, Dept. of Defense, Canada, "The Electronic Engineer," Vol. 28, No. 3, March 1969, pp. 79-85. What kind of temperature range does MIL-STD-810B, Procedure II, specify? And how about MIL-E-52572-C? If these questions sound confusing to you, don't despair. They are also confusing, yet very important, to a great number of engineers who design equipment that must comply with military environmental specs. Usually, more than one spec applies to a piece of equipment, and they do not necessarily agree. To end the confusion, the author has prepared a series of charts that clearly show the temperature ranges each spec covers. He has found these charts of great help in his design work, and so will our readers.

Panel meters: design with a purpose. Staff Report, "Electro Technology," Vol. 83, No. 2, Feb. 1969, pp. 57-62. The job of selecting a panel meter shouldn't be taken lightly. The choice is no longer a simple one. There are many factors to be considered—both mechanical and electrical. This article should help you make your selection.

Infrared detector chart outlines materials and characteristics, Philip Shapiro, Aerojet-General Corp., "Electronics," Vol. 42, No. 2, January 20, 1969, pp. 91-96. Optoelectronic techniques are coming on strong in instrumentation systems, with infrared detectors lighting the way. Author Shapiro has compiled an applications-oriented chart on commercially-available devices. Materials, electrical and mechanical characteristics, price data, design equations, and who-makes-what are included. A supplementary text commentary provides added perspective.

Predicting error in a function of measurements, Helen Nelson, Sylvania Electronic Systems, "Electro Technology," Vol. 83, No. 2, Feb. 1969, pp. 43-44. You can determine performance errors during the system-design stage. The method described here is well-suited to computer use.



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EE NEW PRODUCTS

Frequency counter is also a computer

Computing circuits change precise time interval measurements into accurate frequency displays. An accessory keyboard makes use of these circuits, so that you can use the instrument as a real-time computer.

Is it true that if you build a better counter the world will beat a path to your door? Hewlett-Packard will find out next month, because that's when deliveries begin on their Model 5360A, which the company calls a Computing Counter.

Extensive computation is an integral, indispensable part of its measurement process. The 5360A measures time intervals, converting them to frequency by computation. Interpolator circuitry gives at least two orders of magnitude improvement in resolution over that of conventional frequency-counters.

Interpolation also improves the measuring-time vs accuracy tradeoff, as well as reducing by three orders of magnitude the signifigance of the ± 1 count ambiguity. And it allows an 11-digit display.

Frequency measurements

The basic range of the new counter is 0.01 Hz to 320 MHz. HP's already-familiar plug-ins extend the upper limit to 18 GHz. The readout automatically shifts about a fixed decimal point, and only digits within the accuracy of the control settings are displayed.

For instance, the computation process lets you measure a 320-MHz signal to three digit accuracy in only 300 ns—1/100 of the time formerly required. Conversely, if you are satisfied to use the customary time interval, your frequency measurement is 100 times more accurate than on conventional counters.

Conventional counters

The 5360A measures time intervals with an accuracy of better than a nanosecond, and with 100-ps resolution. For a conventional counter to readout with such resolution, it would require a 10-GHz clock with counting circuits operable at the same rate! Because, at present, the highest practical clock rates are about 10 to 100 MHz, conventional counters can resolve about 100 to 10 ns in measuring a period or a time interval.

A good example of such a counter is CMC's Model 901, introduced last year at Wescon. Its makers billed it as the industry's highest-frequency counter/timer: the 901 can go to a 200 MHz main-frame frequency without prescaling, heterodyning, or using plug-ins. But even this instrument, with its nine-digit readout (instead of the more usual eight), has a time-interval resolution of only 10 ns, as compared to 100 ps in the 5360A. (CMC, Division of Pacific Industries, 12970 Bradley Ave., San Fernando, Calif. 91342. (213) 367-2161.)

At the lower end of the spectrum, most conventional counting methods need a 1-s gate to get 1-Hz resolution on a 1-MHz measurement, with the usual 10-MHz clock. The 5360A, even though it too uses a 10-MHz clock, can make the same measurement, to the same resolution, with a 1-ms sample.

Interpolation is the key

How does this instrument come by its accuracy? Figure 2 tells the story. Suppose that you want to measure a frequency of period T. Now, in any counter, counting begins with the first clock pulse after the START pulse, and ends at the first clock pulse after the STOP signal.

It is unlikely that the unknown period would coincide exactly with the interval between the first and last clock pulses within some desired resolution. So T_1 and T_2 in Fig. 2 represent uncertainties that limit counter resolution. But if you could measure these small intervals, then you would know what corrections to apply, and

(Continued on page 100)

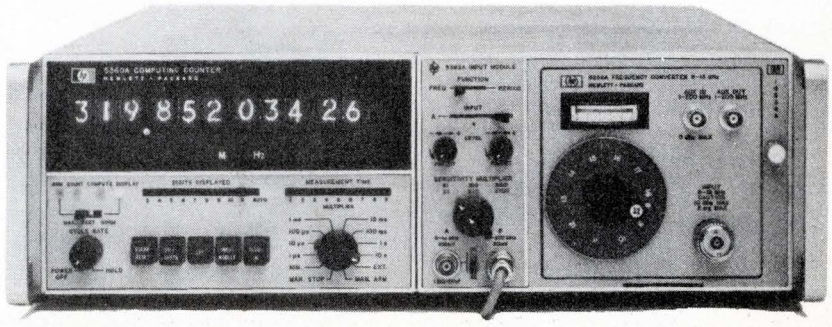


Fig. 1. HP's Model 5360A counter goes to 320 MHz, or, with standard plug-ins, to 18 GHz. The instrument's timing-interval accuracy is 1 ns, with 100-ps resolution on an 11-digit display.

(Continued from page 99)
thus be able to determine the period T with great precision. And this is the function of the interpolators; they determine T_1 and T_2.

The gross clock measurement, T_0, is determined by the first and last clock pulses, and stored in a register. But during the time T_1, a constant current charges a capacitor. Charging ends at the same time that the first clock pulse is counted, and discharge begins. But the discharge current is exactly 1/1000 of the charge current. So the discharge time is exactly 1000 times as long as the charge time, T_1.

The interpolator therefore multiplies T_1 by 1000 times, allowing it to be accurately measured by the 10-MHz clock pulses. T_1 is stored in a register. T_2 is similarly measured and stored, and later where the computing circuits combine.

In the 5360A, the unknown period is defined as $T = T_0 + T_1 - T_2$. The computing circuits perform the addition and subtraction, and give a result for T that is accurate to better than a nanosecond, and with a 100-ps resolution. And since time interval, period, and frequency are interrelated, knowledge of one is knowledge of all.

It's a computer, too

HP brings the 5360A's computing capabilities out for your use. Connecting an accessory keyboard to the instrument lets you add, subtract, multiply, divide, and take square roots. The latter is useful for rms calculations.

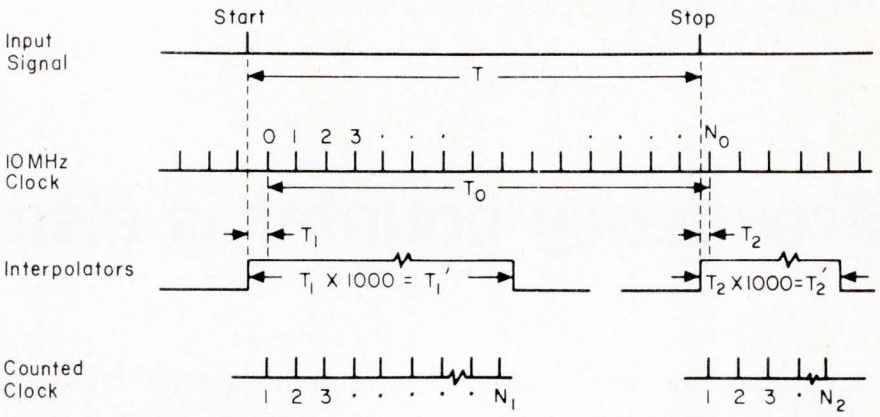


Fig. 2. The time-interval measurement sequence uses interpolation techniques to determine the usually uncertain times T_1 and T_2. Computing circuits solve the equation for the unknown period as $T = T_0 + T_1 - T_2$.

The instrument can display, in real time, the solution to equations whose input variables consist of the counter's measurement, along with externally-entered constants for processing. Examples include direct readout of phase, and fractional frequency deviation ($\Delta f/f$). Standard deviation calculations are also within the instrument's capability.

The 5360A's computing circuits have 32 commands that can be performed in any sequence, and with any length. The keyboard will have some data storage of its own. And you can store fixed programs in diode matrix boards.

The Model 5360A with the 5365A Frequency-Period Input Module costs $6500, with deliveries starting in April. The Model 5379A Time Interval plug-in will cost about $700, and will be available in June. Later in the year you'll be able to pick up the Model 10537A Keyboard. Its price is pegged somewhere between $800 and $1000. Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304. (415) 326-7000.

Circle 201 on Inquiry Card

Self-contained logic design/test system

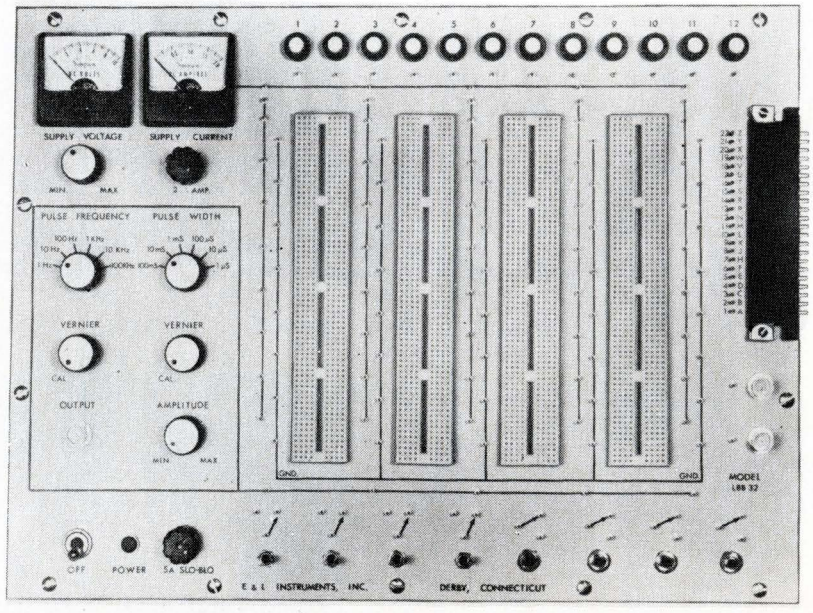
Are you tired of jury-rigging bench set-ups each time you try out a circuit idea? Such lash-ups can get messy, what with coax cables and power supply leads coming out every which way.

You can rid yourself of this clutter with a new desk-top instrument that contains everything you need to assemble and test your logic designs. It's also a quick way of putting together input-output simulators, test pattern generators, temporary interface assemblies, and so forth.

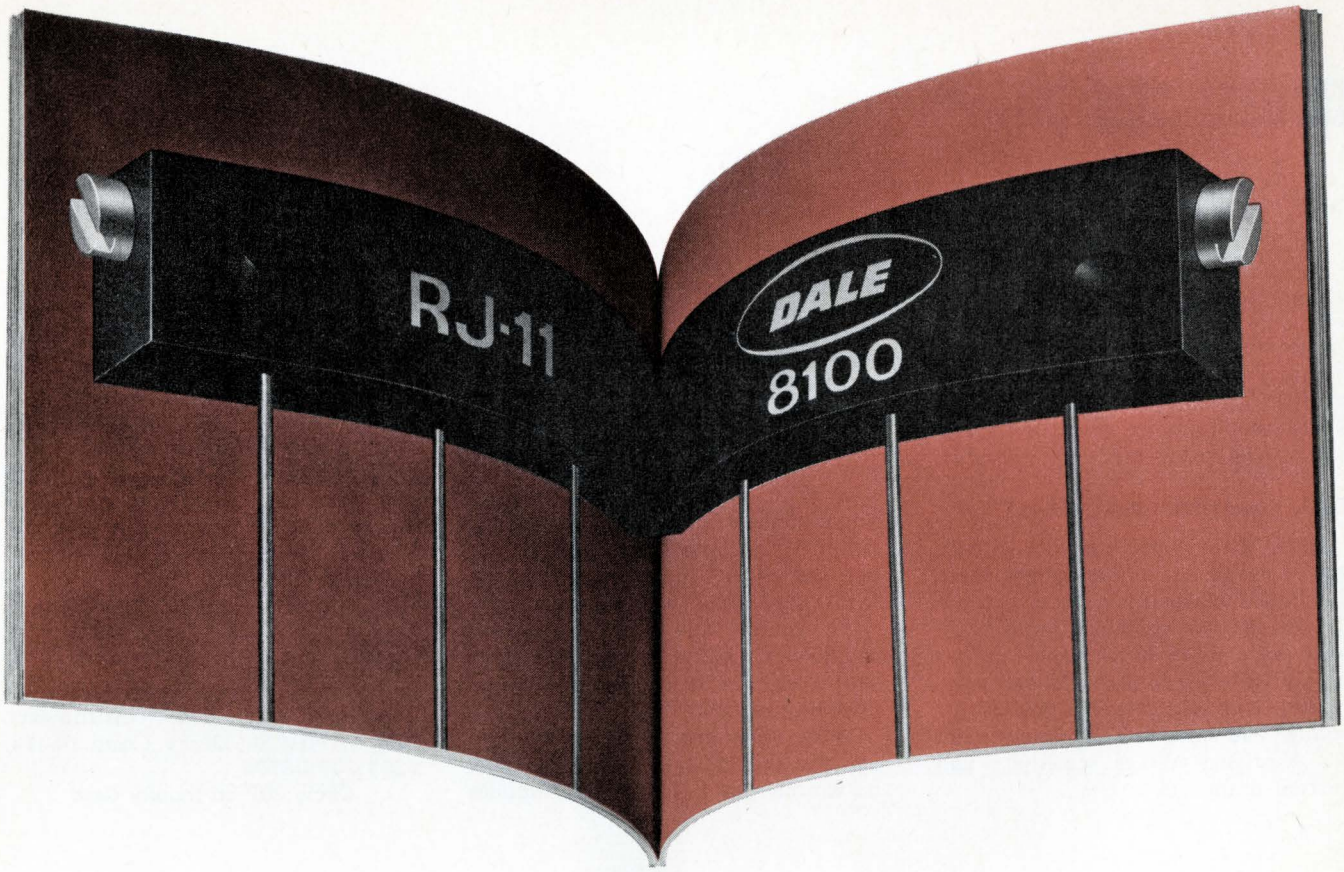
The Elite I has four columns of connectors which, together, hold a total of 32 14-pin, 28 16-pin, or 20 24-pin DIP packages. You can, of course, mix sizes. Additionally, the instrument can mount TO-5 devices and discrete components.

To connect these devices together as a circuit, you use ordinary 22-

(Continued on page 102)



The Elite I has all that you need to test and evaluate your logic designs.



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Resistance Tolerance: ±10% 100 ohms through 500K ohms; ±20% all other values

Resolution: Essentially infinite

Power Rating: .75 watt at 70°C, derating to 0 at 125°C

Operating Temperature Range: −65°C to +125°C

Mechanical Adjustment: 25 ± 2 turns. Clutch prevents overtravel damage

Dimensions: .28" H x .31" W x 1.25" L

Models: 8187, printed circuit pins; 8188, stranded vinyl leads; 8189, solder hook; 8184, panel mount version of 8189; 8186, panel mount version of 8188

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(Continued from page 100)

gauge solid hook-up wire. The wire is gripped by pin jacks on the panel, so, with this instrument, you needn't worry about running short of, or losing, special patch cords.

Test, power sources built-in

After you connect-up your circuit, you've got to test it. And here's where the Elite I makes life simple, because the test instrumentation is built-in. To start with, there is a variable power supply (2 to 10 V, 2 A, 25 mV max. ripple) with separate 2% meters for voltage and current. This is convenient for checking voltage sensitivity and current drain.

Next, there is a wide-range pulse generator independently variable in rep-rate and pulse width. The rep-rate range is 1 Hz to 1 MHz, and the pulse width range is variable between 0.2 μs and 100 ms. The output of this source is positive and variable from 1 to 6 V, with 50-ns max. rise-fall times. Besides being available to your circuit via the pin jacks, it is brought out for other uses (synch, and so forth) through a BNC connector.

To control and route the power supply and signals, there are four SPDT toggle switches, and four SPDT push-button contactors.

With your circuit operating, you can use the indicator lamps to show its various states. The Elite I supplies you with 12 indicators that have built-in lamp drivers (4.7-kΩ input impedance). The lamp OFF level is 0.5 V or less, while the ON level is 1.5 V or more. The maximum input signal range to the drivers is ±5 V.

To complete the package, there are two more BNC connectors and a 22-pin PC edge connector. You may use these as either input or output connectors.

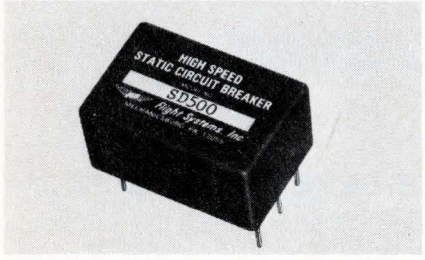
The Elite I sells for $650 with a 30-day delivery time. Its makers will ship it anywhere in the U. S. on a 5-day free trial basis, upon receipt of a purchase order. E & L Instruments, Inc., 61 First St., Derby, Conn. 06418. (203) 735-8774.

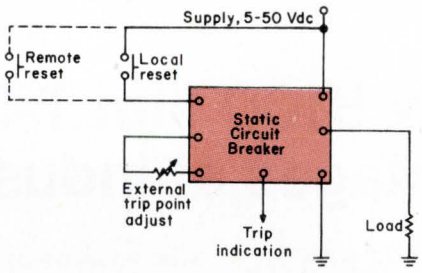
Circle 202 on Inquiry Card

High speed circuit breaker protects ICs from current overloads

Integrated and other solid-state circuits are often damaged by transients, shorts, and other current overloads. Unfortunately, many thermal and magnetic type breakers are too slow to afford a reliable means of protection. Now, however, a new high speed dc static circuit breaker has the ability to interrupt a circuit in 50 μs. In addition, it is so accurate that it will operate continuously at 100% of its rated value and trip when the current passes 105%. It is not damaged by a direct short circuit.

The breaker comes in five models, ranging from 25 mA to 1 A. The trip point of each of these can be adjusted from 50 to 150% of rated current by





connecting an external resistor to it. Thus, you can select the exact current level at which you desire protection.

A logic voltage trip indication (0.2 Vdc) appears simultaneously with the trip. Reset takes only 10 μs or less by a pulse or contact closure. When reset, the indication is 5 Vdc. A self-resetting option is available—the unit will automatically reset in any specified time after trip.

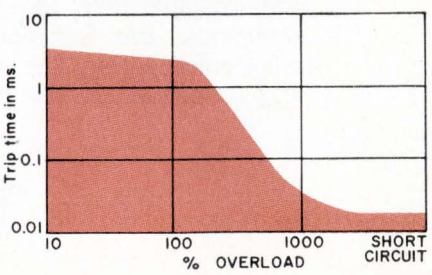
Another useful feature of this breaker is that the current sensor is completely isolated from the switch portion. Thus, if you wish, you can monitor the current in one circuit while protecting a different one from current overloads. The sensor responds to dc or peak ac currents, regardless of polarity. Remote sensing is also possible.

Internal power requirements are 35 mA at load voltage, but you can use external bias instead of sampling load voltage. Load voltage is 5 to 50 Vdc (min.-max.).

Many modifications are available, making it adaptable to most existing systems at low cost.

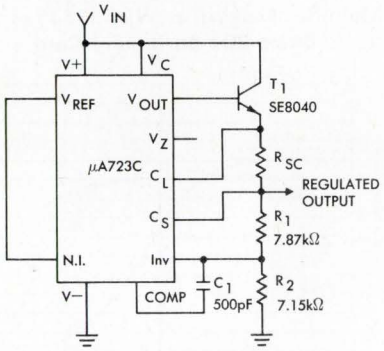
Delivery is stock—2 weeks ARO. Price ranges from $26.70 (1-3 units) to $18.90 (26-50 units). Flight Systems Inc., Box 25, Mechanicsburg, Pa. 17055. (717) 697-0333.

Circle 203 on Inquiry Card



Voltage regulation is no longer a make-or-buy decision.

POSITIVE VOLTAGE REGULATOR



Regulated Output Voltage: +15V
Line Regulation (ΔV_{IN} = 3V): 1.5mV
Load Regulation (ΔI_L = 1A): 15mV

The Fairchild μA723 Precision Voltage Regulator works better and costs less than any module you could make or buy to do the same jobs. Use it for series, shunt, switching or floating regulation — with positive or negative supplies — and get a regulated voltage anywhere in the range from 2V to 37V. Your design determines whether the output voltage is fixed or adjustable. The output current goes up to 150mA, but can be boosted by using an external pass transistor — PNP or NPN. And we've built-in provisions for adjustable current limiting, with or without foldback, and remote shutdown.

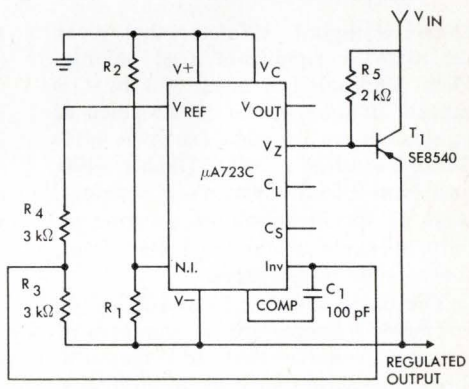
The μA723 is another product based on our Second Generation Linear technology. It uses FET's, MOS capacitors and exceptionally well-matched transistor pairs on the chip to give you a typical line and load regulation of 0.03% and a temperature coefficient of just 0.003%/°C. You get better system performance for every device dollar spent.

To show you how easy it is to use, here are two applications for the μA723.

Write for complete specifications and more applications information.

To order the μA723, ask your Fairchild distributor for:

NEGATIVE VOLTAGE REGULATOR



Regulated Output Voltage: −15V
Line Regulation (ΔV_{IN} = 3V): 1mV
Load Regulation (ΔI_L = 100mA): 2mV

PART NUMBER	PACKAGE	TEMPERATURE RANGE	PRICES 1-24	25-99	100-999
U5R7723312	TO-5	−55°C to +125°C	$22.50	18.00	15.00
U5R7723393	TO-5	0°C to + 70°C	6.50	5.20	4.25

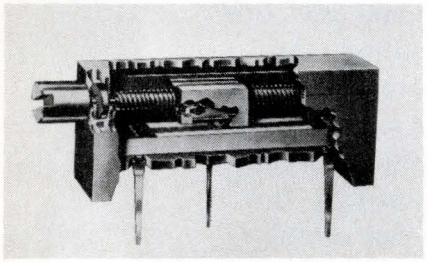
FAIRCHILD
SEMICONDUCTOR

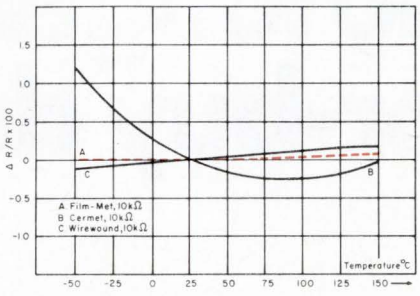
FAIRCHILD SEMICONDUCTOR A Division of Fairchild Camera and Instrument Corporation Mountain View, California 94040, (415) 962-5011 TWX: 910-379-6435

New trimmer features low TCR

A new trimmer offers a combination of characteristics not found in either cermet or wire wounds. It has infinite resolution and low TCR comparable to that of wire-wound and metal-film resistors. Distributed inductance and capacitance is low, making it especially useful in hf and pulse applications where phase shift and pulse distortion must be minimized (e.g., rf communications equipment, radar, and high speed computers). Also, having a homogeneous alloy characteristic, it has lower thermal and current noise then cermets.

The new ¾-in. "3811" trimmer recently announced by Amphenol features the company's Film-Met™ resistance element, which is of all-metal composition deposited on a ceramic substrate. Resolution is infinite and CRV (contact resistance variation) is low—2% of RT or 20 Ω, whichever is greater. This is significant for trimmers used in balancing circuits and in circuits related to the input of high-gain op amps.





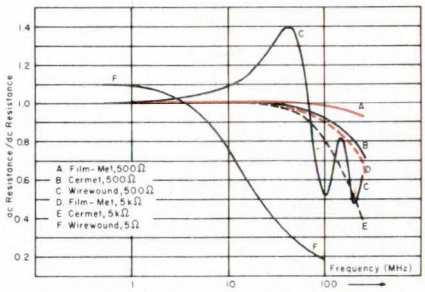
The 3811 operates over a temperature range of −55° through +125°C with its TCR guaranteed not to exceed 100 ppm/°C. Units which do not exceed 50 ppm TCR over the same temperature range are also available.

Another feature of this trimmer is that it exhibits both low thermal and current noises. This is very important in low-level circuits which are followed by high-gain amplifiers, where noise characteristics are particularly critical.

Another possible application for the 3811 is at the point of transmission line terminations. Due to its performance characteristics it can be used in impedance matching circuits.

The manufacturer feels that the Film-Mets will open many new areas for trimmer applications while simultaneously making improvements in existing areas. Amphenol Controls Div., The Bunker-Ramo Corp., 120 S. Main St., Janesville, Wis. 53545.

Circle 204 on Inquiry Card



Integrating DVM: The price is right

Here's a digital voltmeter that gives its users a significant cost savings. Data Technology's basic 350 DVM is tagged at about 60% of the price of equivalent instruments (such as HP's 3440, Fairchild's 7000, Dana's 4400, and Non Linear System's X2 series). And its specifications are as good as, and in some instances better than, those of its competitors.

The basic 350 is a 1- to 1000-V dc voltmeter. There are a number of options available that add measurement capabilities such as dc millivolts, ac volts, ohms, auto ranging, and ratio. The options have good specs too, and you still save money.

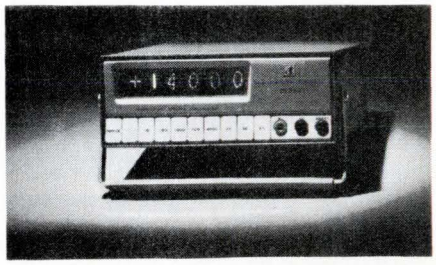
The DVM has four ranges for dc volts. The first reads 1.0000 V (i.e., 100-μV resolution), and has an input impedance of more than 100 MΩ. The last range reads 1000.0 V with 100-mV resolution and a 10-MΩ input impedance.

Accuracy is ±0.01% of reading ±0.01% f.s., with 40% overranging at the same accuracy; measurement time is 200 ms. Normal-mode rejection at 60 Hz is 60 dB min., while the dc- to 60-Hz common-mode rejection is 100 dB with a 1-kΩ source imbalance. The instrument has a guarded, isolated input.

The 350 DVM is basically a three-card machine. To add whatever option you may need, you simply plug in the appropriate extra card. With the acV option, you can read signal levels from 1 to 1000 V (to 100 kHz) with the same resolution as for dc volts. The input impedance is 1 MΩ/75 pF. Step response time is 3 s.

With the ohmmeter plug-in, you can measure resistances to 10 MΩ, while the preamplifier option gives you two low-level dc ranges: 100.00 mV (10 μV resolution) and 10.000 mV (1 μV resolution). Input impedance is greater than 100 MΩ.

Four Nixie tubes make up the display, and there is overrange, polarity, function, and decimal point indication. Electrical outputs are buffered BCD (1, 2, 4, 8) for data, decimal points, polarity symbols, and functions. Lighted push-buttons select ac power, range, and function. You can remotely control the instrument by grounding the appropriate line; the external read command signal is a 5 V level.



The basic 350 DVM costs $695. For the options, the prices run this way: A-1 auto range, $140; A-2 ac volts, $180; A-3 ohms, $145; A-4 preamp, $335; A-5 ratio, $75. Three other options are the A-6 rear panel signal connector for $25, the A-7 rack mounting kit for $40, and the A-8 input cable for $10. For more information, contact Tom Bakey, Data Technology Corp., 2370 Charleston Rd., Mountain View, Calif. 94040. (415) 321-0551.

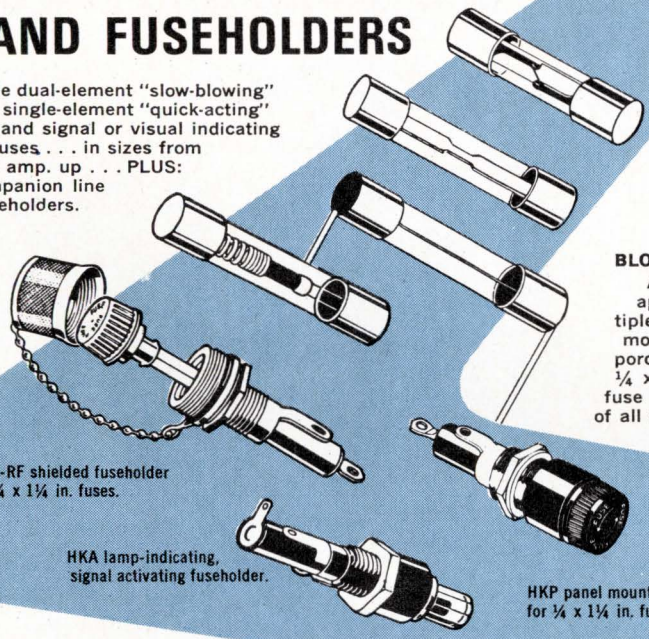
Circle 205 on Inquiry Card

The Single Source For Reliable Protection For Every Type Of Electronic And Electrical Circuit And Device

BUSS QUALITY

SMALL DIMENSION FUSES AND FUSEHOLDERS

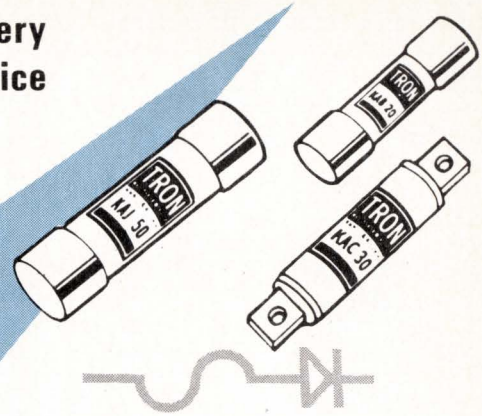
Include dual-element "slow-blowing" fuses, single-element "quick-acting" fuses and signal or visual indicating type fuses . . . in sizes from 1/500 amp. up . . . PLUS: a companion line of fuseholders.



HMR-RF shielded fuseholder for ¼ x 1¼ in. fuses.

HKA lamp-indicating, signal activating fuseholder.

HKP panel mounted fuseholder for ¼ x 1¼ in. fuses.

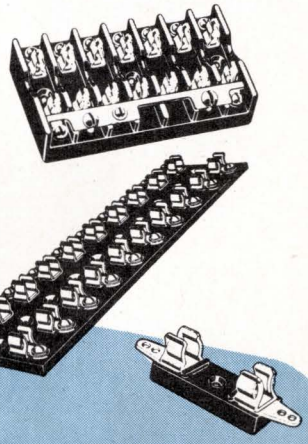


TRON Rectifier Fuses
For the Safe Protection of Solid State Devices

Provide extremely fast opening on overload and fault currents, with a high degree of restriction of let-thru current. Many types and sizes available. Ampere ratings from ½ to 1000 in voltages up to 1500.

BLOCKS FOR BUSS FUSES

All types available for every application. Single pole, multiple pole, small base, full base, molded base, laminated base, porcelain base for fuses from ¼ x ⅝ inches up. Also signal fuse blocks and special blocks of all types.



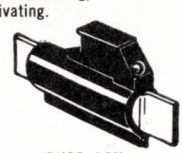
THE COMPLETE LINE OF SIGNAL-INDICATING ALARM-ACTIVATING FUSES

For use on computers, microwave units, communication equipment, all electronic circuitry.

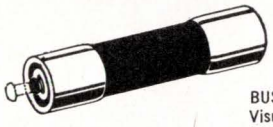
BUSS GLD-¼ x 1¼ in. Visual-Indicating, Alarm-Activating.

BUSS GBA-¼ x 1¼ in. Visual-Indicating.

BUSS Grasshopper Fuse, Visual-Indicating, Alarm-Activating.



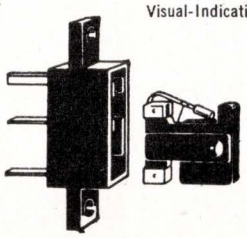
BUSS ACH Aircraft Limiter, Visual-Indicating.



BUSS MIN-13/32 x 1½ in. Visual-Indicating.

BUSS MIC-13/32 x 1½ in. Visual-Indicating, Alarm-Activating.

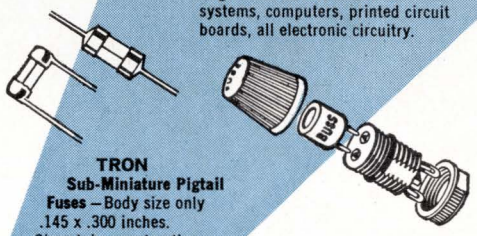
FNA FUSETRON Fuse 13/32 x 1½ in. slow-blowing, Visual-Indicating, Alarm-Activating. (Also useful for protection of small motors, solenoids, transformers in machine tool industry.)



BUSS GMT and HLT holder, Visual-Indicating, Alarm-Activating.

SUB-MINIATURE FUSES

Ideal for space tight applications, light weight, vibration and shock resistant. For use as part of miniaturized integrated circiut, large multi-circuit electronic systems, computers, printed circuit boards, all electronic circuitry.



TRON Sub-Miniature Pigtail Fuses — Body size only .145 x .300 inches. Glass tube construction permits visual inspection of element. Hermetically sealed. Twenty-three ampere sizes from 1/100 thru 15.

BUSS Sub-Miniature GMW Fuse and HWA Fuseholder. Fuse size only .270 x .250 inches. Fuse has window for visual inspection of element. Fuse may be used with or without holder. 1/200 to 5 amp. Fuses and holders meet Military Specifications.

FOR MORE INFORMATION ON THE COMPLETE BUSS LINE, WRITE FOR BUSS FORM SFB

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis, Missouri 63107

FOR FUSES AND FUSEHOLDERS OF UNQUESTIONED HIGH QUALITY FOR EVERY PROTECTION NEED INSIST ON . . .

SUPPLIED THE ECONOMICAL WAY . . . THRU DISTRIBUTORS

BUSS QUALITY FUSES

"See us at IEEE Show Booth 3B24"

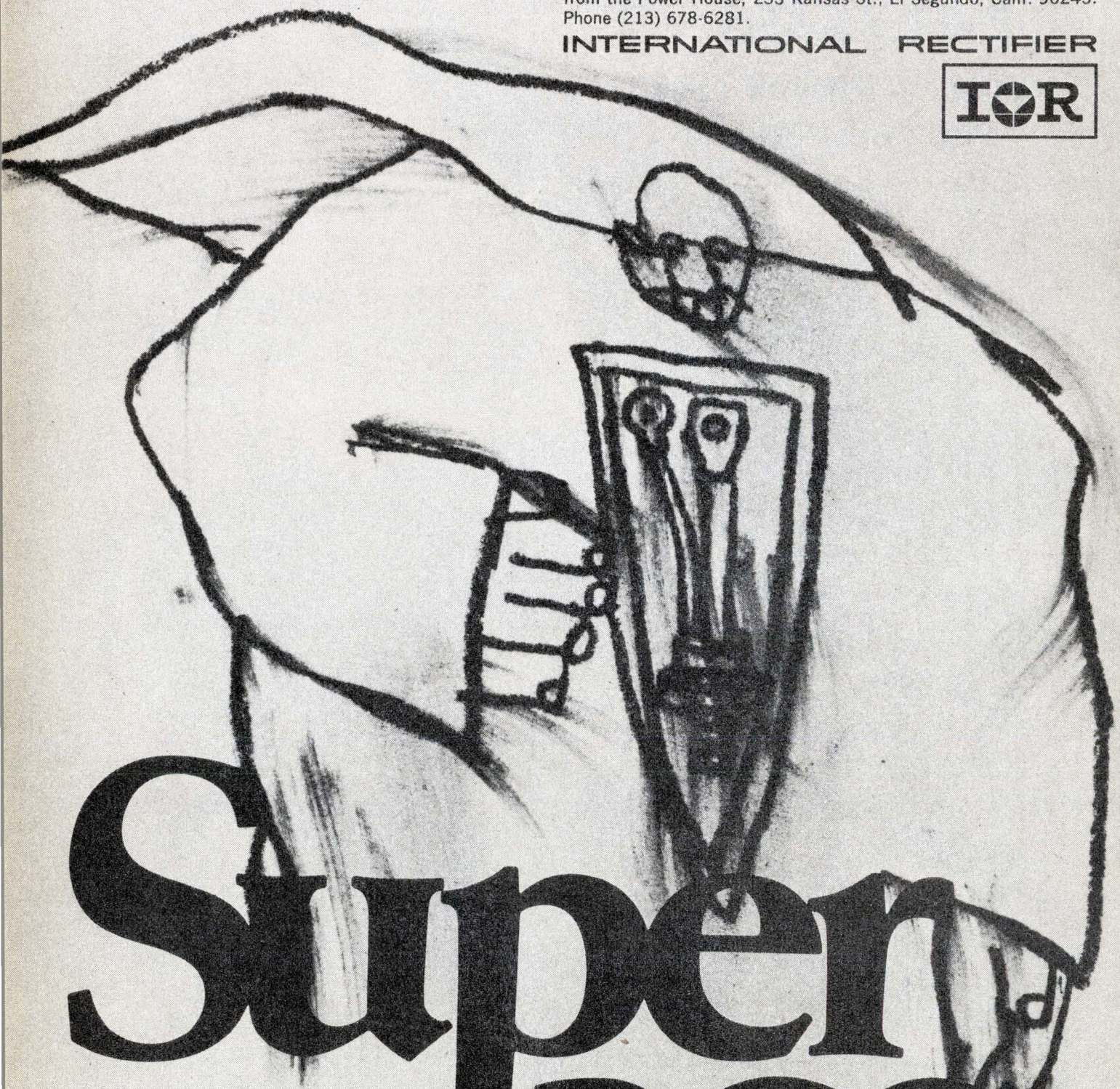
***accelerated Cathode excitation SCR from the Power House.**

Meet the tradeoff eliminator: our new 80-ampere-average ACE® SCR in a TO-94 case. Now you can toss out complex hard firing circuits, get more power output per SCR. In other words, get maximum power at lowest system cost.

The ACE SCR allows low amplitude soft firing, and has the industry's highest di/dt (800 A/μs per JEDEC #7) along with high frequency performance to 10 kHz (250 amperes peak at 60 Hz and 210 amperes peak at 5 kHz). It's rated to 1200 V and provides 200 V/μs dv/dt with 40 μs turnoff time. Advance specifications from the Power House, 233 Kansas St., El Segundo, Calif. 90245. Phone (213) 678-6281.

INTERNATIONAL RECTIFIER

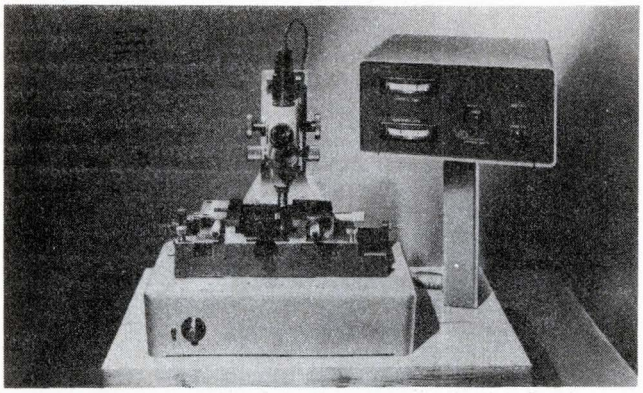
IOR



Super ace*

SLIDE ALIGNMENT FIXTURE

Operates electronically with photocell sensors.



This fixture positions 1.5- or 2-in.^{2} reticles in a single segment slide for use in the company's 4M mask-making machine.

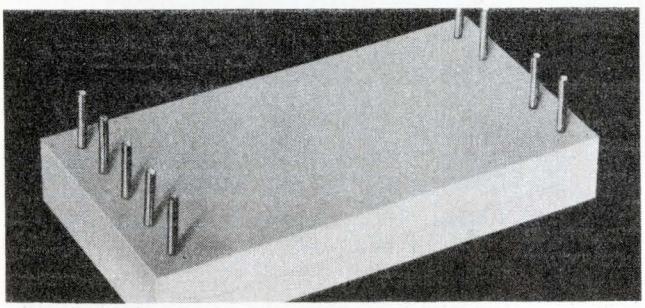
The maker claims that its Offstage Alignment Fixture is consistently accurate to ± 0.00002 in. The operator uses an optical viewer for preliminary positioning only. Photcells then take over and transmit deviations from true center to 0 two microvoltmeters. When both meters null on zero, the glass slide is locked in position and ready for use in any model of the company's step-and-repeat equipments. Adjustments to the reticle are made by separate micrometer thimbles.

The instrument is adaptable to any special requirements of the customer. The Jade Corp., Huntingdon Valley, Pa. 19006. (215) 947-3333.

Circle 206 on Inquiry Card

HYBRID POWER AMPLIFIER

Output of 5 W rms from a 14 V source.



This hybrid IC audio amplifier is designed for 14-V power supply operation. It is suitable for automotive, marine, industrial, and consumer applications where input signals may be as low as 15 mV.

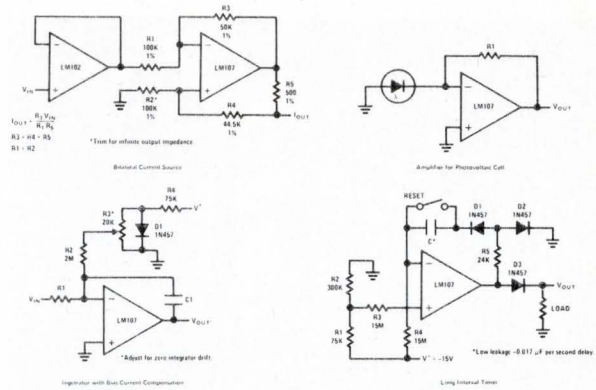
The BHA0004 thick-film, class-B complementary amplifier has internally-set idle current and needs only three external components. A 65% operating efficiency and low power dissipation give you 5-W output at case temperatures to 100°C. Packaged in its maker's standard modular configuration, the frequency response is 25 Hz to 15 kHz. Distortion is less than 1%, and power gain is 85 dB.

The BHA0004 costs $6.23 ea. in lots of 100-999 pcs. Immediate delivery. Bendix Semiconductor Div., South St., Holmdel, N. J. 07733. (201) 946-9400.

Circle 207 on Inquiry Card

MONOLITHIC OP AMP

Frequency compensation is built-in.



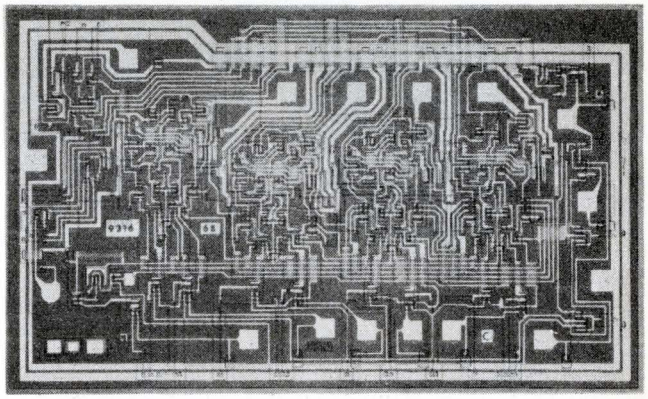
Like the recently introduced LM101A, this op amp offers input current advantages: a guaranteed 100-nA bias current with a 20-nA offset current, over the full military temperature range. And, the manufacturer claims, with no sacrifice in drift or offset voltages. These are also guaranteed over the full temperature range: 3-mV offset, and 15-μV/°C offset voltage drift.

The LM107 has its frequency compensation built into the chip. The unit is a plug-in replacement for the 709, 741, LM101, and LM101A. Available from all stocking distributors, the LM107 costs $50 ea. (1-24 pcs.), or $33 ea. (100-999 pcs.). The LM207 (0° to 70°C) costs $20 and $13 in the same respective quantities. National Semiconductor Corp., 2950 San Ysidro Way, Santa Clara, Calif. 95051. (408) 245-4320.

Circle 208 on Inquiry Card

MSI CIRCUITS

For synchronous digital counting.



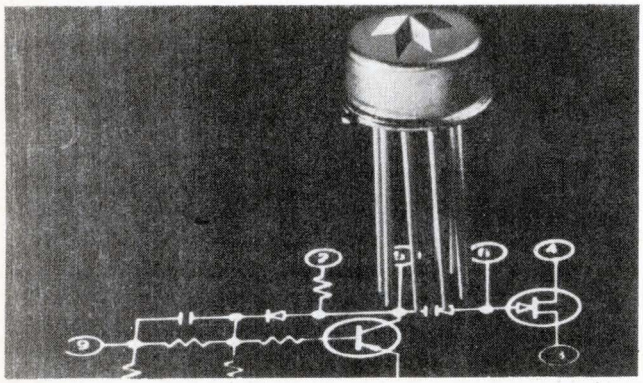
Two CCSL *(compatible current-sinking logic)* circuits offer speeds greater than 15 MHz. You can use the 9310 BCD and the 9316 binary hexidecimal counters in multistage operations without external logic or degradation in speed over a single stage. An asynchronous master reset can reset all stages, overriding all other inputs. Both circuits come in a 16-pin DIP and Flatpak. Prices range from $46 for the full temperature range Flatpak in unit quantities, to $14 ea. for the limited range DIP in 100-pc. lots. Fairchild Semiconductor, 313 Fairchild Drive, Mountain View, Calif. 94040. (415) 962-3562.

Circle 209 on Inquiry Card

← Circle 47 on Inquiry Card

ANALOG GATES

Operate from DTL or TTL logic.



Using all military-grade semiconductors, this SPST FET switch is designed for analog gating. Either DTL or TTL logic can drive it directly.

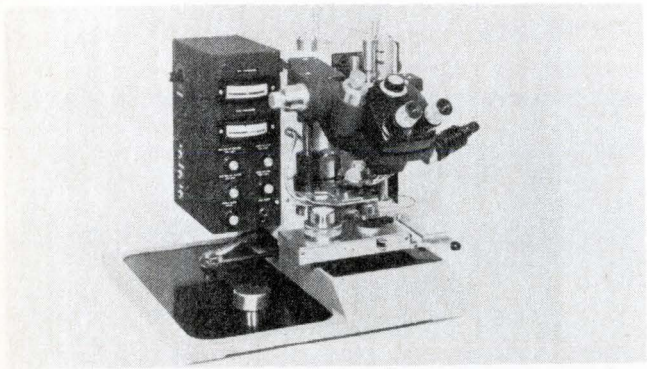
A hybrid thin-film circuit, the CAG10 has 50-ns max. turn-on and turn-off times, zero offset voltage, and ON-resistance of 30 Ω max. Preconditioning of the semiconductors in chip form ensures reliable operation over the full military temperature range.

The CAG10 costs $42 ea. (1-99 pcs.), or $28 ea. (100-999 pcs.). Delivery is from stock. Crystalonics, 147 Sherman St., Cambridge, Mass. 02139.

Circle 210 on Inquiry Card

BEAM LEAD BONDER

A single tool motion bonds all leads.



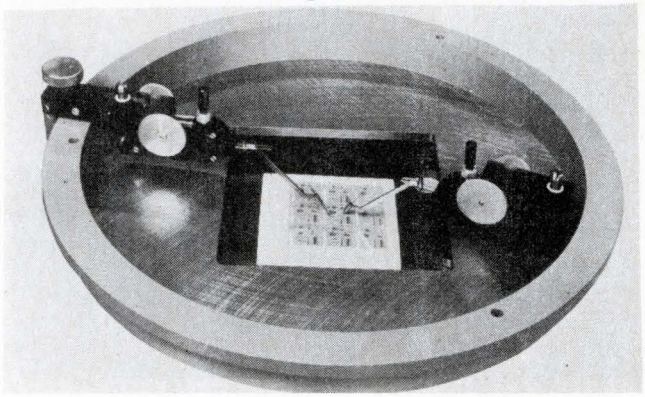
Bonding by thermocompression wobble-tool action is adaptable to semi-automatic setups. The operator aligns the die's beam leads with the leads of the workpiece, then pushes a button on the chessman x-y manipulator. The motor-lowered heated tool presses the beam leads against the workpiece. Then the top end of the tool tilts 1° and rapidly rotates twice, applying a uniform, controllable pressure sequentially to all leads.

Model 573 has a reflex optical system that shows the device pattern superimposed on the workpiece pattern. Variable light sources illuminate both the tool and the workpiece. Portions of the heating mechanism are water-cooled to prevent dimensional changes. Kulicke and Soffa Industries, Inc., Fort Washington, Pa. 19034.

Circle 211 on Inquiry Card

PROBING DEVICE

Permits variety of testing operations.



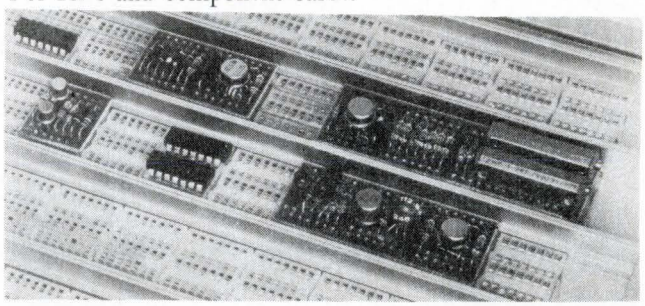
This 30-point probing station allows sequential indexing and testing of similar circuits on a single substrate, either manually or automatically. Actual contact with the item under test is through a newly developed probe positioner on the master probe station. You can adjust the pressure at the probe tip from a few tenths of a gram to 20 gm. (The company plans to market the probe positioner separately, as well as with the master station.)

The 30-point station lets you perform a number of tests during various processing stages. CGS Units, Inc., 73 Saginaw Dr., Rochester, N. Y. 14623.

Circle 212 on Inquiry Card

PACKAGING SYSTEM

For DIP's and component cards.



This high-density packaging system is specifically for DIP packages, and discrete packages mounted on plug-in cards. Six styles of plug-in modules are: Style A, PC card direct mounted; Style B, PC card with receptacles; C, plate-mounted receptacles without covers but with two position wire-wrap; D, same as C except with cover; E, same as D but with three position wire-wrap; F, PC card with receptacles, back-to-back.

Universal plug-in cards mount diodes, transistors, resistors, and so forth. You can use them with component-carrying boards, along with the standard carrier sticks. The boards take components with lead space of 0.6 in. on 0.1 in. centers, or TO-5 type circular mounting patterns. This Dual Inline Packaging System offers new bussing techniques, multi-purpose hardware, and automated wiring. Scanbe Mfg. Corp., 1161 Monterey Pass Rd., Monterey Park, Calif. 91745. (213) 264-2300.

Circle 213 on Inquiry Card

micro-pak™

Short on size, but long on life. The dot on the "I" is a life-sized picture of our newest transistor package, the Fairchild Micro-Pak. Just 80mils on a side, our Micro-Pak is the only plastic transistor in this size that passes rigid military reliability tests. Plastic, but with all the reliability of a metal can.

The high degree of shock resistance inherent in its inert single-block construction makes it ideal for warhead fuzes or missiles. Small, light and reliable, the Micro-Pak is the best way to go for applications from missiles to computers, submarines to satellites. And anything in-between.

Listed on the right are 26 popular transistor types available in the Micro-Pak. Electrical characteristics are similar to those of metal can equivalents. The transistors can operate with junction temperatures up to 175°C and dissipate up to 300mW doing it. Three radial ribbon leads make it easy to incorporate into PC board layouts, hybrid modules and other high density configurations. Write for full specifications.

Or, if you already know what you want, see your Fairchild distributor. He's got them in stock, in quantity.

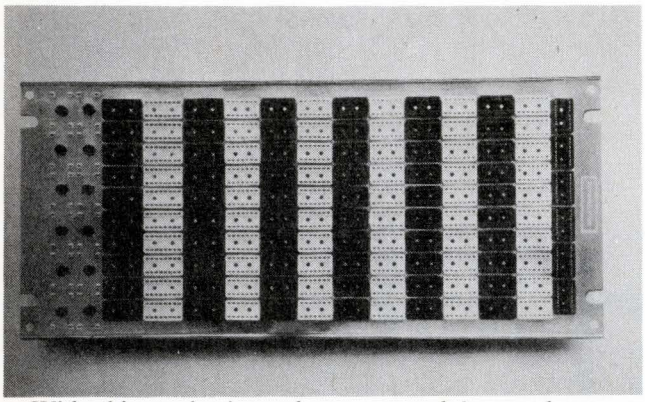
FAIRCHILD
SEMICONDUCTOR

PART NUMBER	PRICE (100-999)	PART NUMBER	PRICE (100-999)
FX3299	1.60	FX2894A	3.00
FX3300	2.00	FX4960	6.00
FX3962	2.40	FX918	2.20
FX3963	3.20	FX2483	2.00
FX3964	3.20	FX2484	2.40
FX3965	3.70	FX709	2.00
FX3724	4.00	FX2368	1.20
FX3725	5.00	FX914	1.20
FX4046	3.00	FX2894	2.00
FX4047	4.00	FX4034	1.60
FX3013	5.00	FX4207	3.00
FX3014	3.00	FX3502	3.00
FX2369A	1.30	FX3503	5.00

FAIRCHILD SEMICONDUCTOR / A Division of Fairchild Camera and Instrument Corporation ■ 313 Fairchild Drive, Mountain View, California 94040, (415) 962-5011 ■ TWX: 910-379-6435

STANDARD PACKAGING SYSTEM

Accepts 14- and 16-pin DIPS and new MOS circuits.



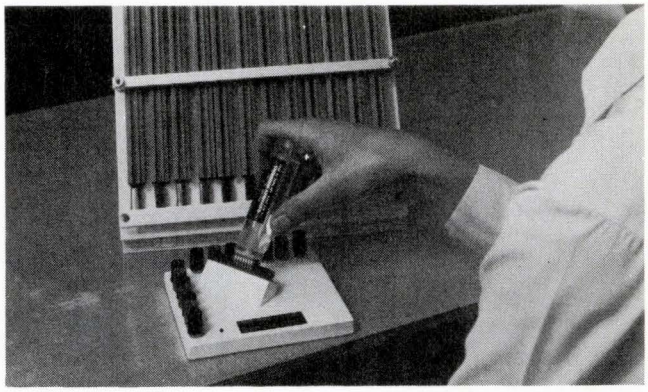
With this packaging scheme, a module can have any combination or arrangement of 14-, 16-, or 24-pin sockets and transistor-discrete component receptacles. You may use several interchangeable modules in multiple to achieve a specific optimal configuration.

The chassis of the 2900/5800 series direct-entry DIP packaging system are produced by numerically-controlled equipment. This equipment is automatically programmed by the alphanumeric part designator generated by the customer to specify his configuration. The designator also sets-up machine wire-wrap programming. Thus, even one-of-a-kind modules can be built to your specs with no design, engineering, or tooling charges. Also, the packages can be wired on the company's wire-wrap machine. Interdyne Co., Inc., 2217 Purdue Ave., Los Angeles, Calif. 90064. (213) 477-6051.

Circle 214 on Inquiry Card

DIP INSPECTION DEVICE

Speeds handling and testing.



Lightweight and portable, the Inspection Master 5000 handles DIPS as received in their shipping magazines. With no electronics of its own, the 5000 works with your test equipment.

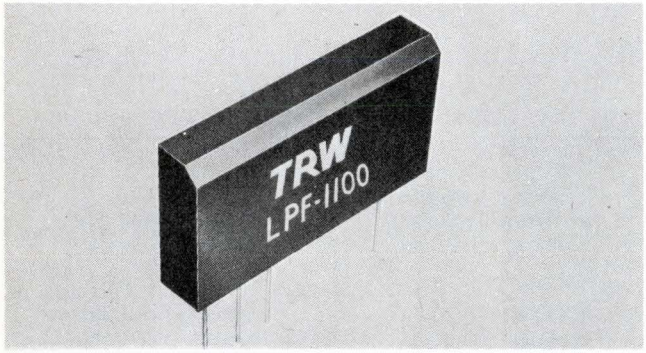
Up to 12 magazines are held in a slanting board. The DIPS feed by gravity onto saddle blocks. The operator presses the hand tool onto the bottom DIP and carries it to the test block, where spring-contacts connect the IC to pre-connected test circuits.

Indexing on the blocks is positive, with polarity indicated. Leads are neither bent nor twisted. When the operator finishes testing the DIP, she returns it (still in the hand tool) to the top of its magazine. Rejects can be quickly set aside. $69.95 f.o.b. from G. D. Patrick Enterprises, Box 23054, San Diego, Calif. 92123. (714) 279-8856.

Circle 216 on Inquiry Card

ACTIVE FILTER

Package measures less than 0.2 in.^{3}



An epoxy-encapsulated package contains an active low-pass filter combined with a notch filter. This network gives you 54 dB/octave roll-off near cut-off.

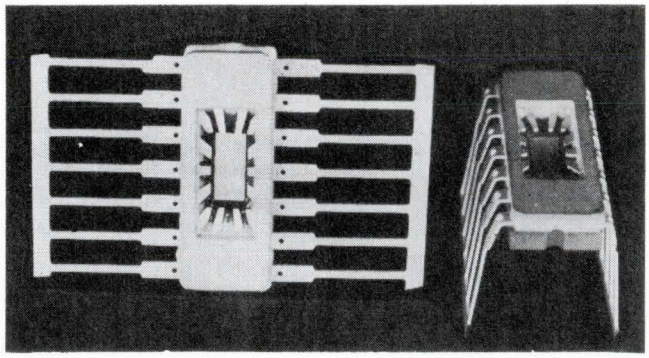
Type LPF-1100 operates between −30° and 70°C, and has a supply voltage range of 10 to 15 Vdc. You can have the device with cut-off frequencies up to 20 kHz.

The LPF-1100 costs $16 ea. in 100-pc. quantities. Delivery is 60 days a.r.o. TRW Microelectronics Div., 14520 Aviation Blvd., Lawndale, Calif. 90260.

Circle 215 on Inquiry Card

DUAL-INLINE PACKAGE

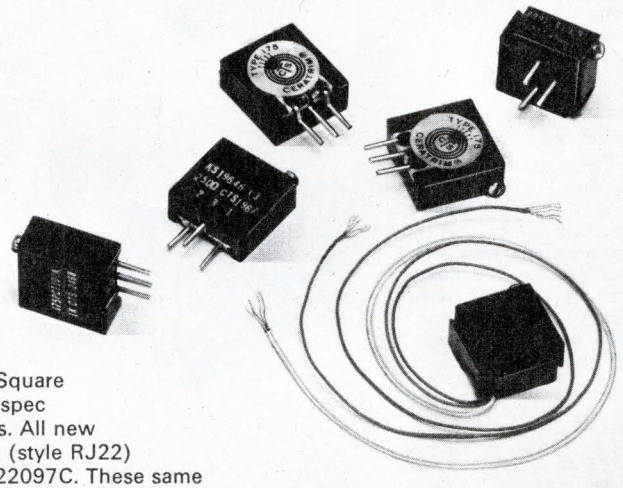
For 14-lead circuits.



This DIP housing for ICS has a rugged, monolithic alumina ceramic base. In addition, a 200-μ microinch gold-clad heat spreader gives excellent die-attach properties. The lead tips are coplanar for faster, more reliable lead bonds. Sealing preforms and lids are available for this TO-116 package, as is a 16-lead version. Mitronics, Inc., 132 Floral Ave., Murray Hill, N. J. 07974. (201) 464-3300.

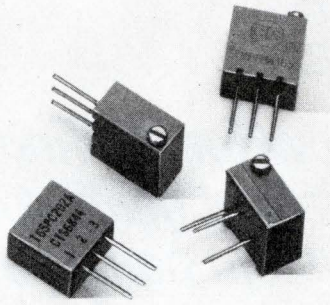
Circle 217 on Inquiry Card

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



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

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



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

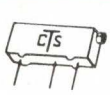
*Check these prices for 4-6 week production delivery. (Small quantities from stock)

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

CTS CORPORATION
Elkhart, Indiana

Other CTS Cermet Trimmers include:

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



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

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

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

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

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

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

EE NEW LAB INSTRUMENTS

SWEEP-LOCK SYNCHRONIZERS

Phase-locks sweepers 30 MHz apart.

Models 243-T and 247 provide a wide dc error-voltage swing for phase-locking two microwave or rf sweep oscillators 30 MHz apart. The 40-V error-voltage swing can drive most available sweeps through their entire spectrum. The 30-MHz offset is the i-f of the two models of the sweep-lock synchronizers. Each sweep oscillator is fed to a mixer, producing the 30-MHz signal. Its stability is better than 12 Hz deviation over a 150-MHz bandwidth, and 300 Hz over a 20-kHz disturbance bandwidth. With this i-f substitution method, you get increased speed and efficiency in dynamic measurements of gain and attenuation. You place the device under test at one input to the mixer, and compare it to a standard placed in the i-f channel. A high-performance 30-MHz receiver and an oscilloscope can then display the device's characteristics vs frequency. Sage Labs., Inc., 3 Huron Dr., Natick, Mass. 01760.

Circle 299 on Inquiry Card

FOUR-DIGIT DVM

Five dc ranges with 0.01% readout accuracy.

This automatic-ranging digital voltmeter has a sample rate of 10 samples/s, 10 μV sensitivity, with a readout accuracy of 0.01% over its five dc ranges. The display neither blinks nor has running numbers.

Model 4250A has 4-digit readout. It uses a temperature-stabilized pulsed oscillator-voltage to time conversion system that maintains the instrument's accuracy and absolute display accuracy. The DVM measures from 99.99 mV to 999.9 V with automatic ranging and polarity indication. It has a 20% overscale readout capability.

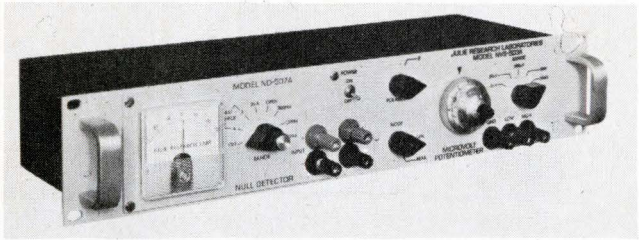
Front-panel controls adjust and hold the sample rate, and calibrate and zero the instrument. The DVM also has dual switchable inputs for instant A or B readouts, or instant input-output comparisons.

Model 4250A costs $995 f.o.b. The Model 4250AP (with printer output option) is $1090. Trymetrics Corp., 204 Babylon Tpk., Roosevelt, N.Y. 11575. (516) 378-2800.

Circle 300 on Inquiry Card

POTENTIOMETER/NANOVOLT SOURCES

Have 0.2 nV-resolution.



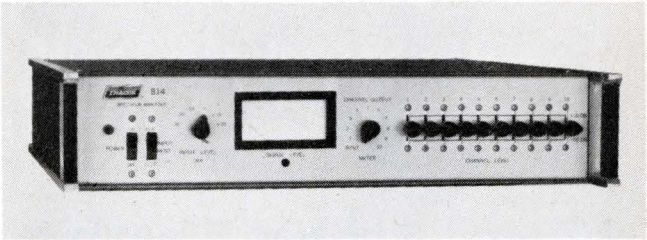
These additions to the company's line of low-priced instruments offer very fine resolution-0.2 nV-with 0.05% accuracy without the need for external auxiliary equipment. You can use them either as nanovolt sources or as potentiometers. Model NVS-503A covers 5 μV to 500 mV full-scale in six ranges. The NVS-1103A covers 11 μV to 1.1 V full-scale, also in six ranges.

Completely self-contained, each model includes a solid-state galvanometer, power supply, and working-current source. The null-detector is removable for general-purpose use. There is direct standardization against reference cells with no auxiliary instruments, and a 5-digit concentric control and readout dial gives 10-ppm potentiometer linearity and resolution. Price is $625 for each unit. Julie Research Labs., Inc., 211 W. 61st St., New York, N.Y. 10023.

Circle 301 on Inquiry Card

SPECTRUM ANALYZER

Covers 0.1 Hz to 100 kHz.

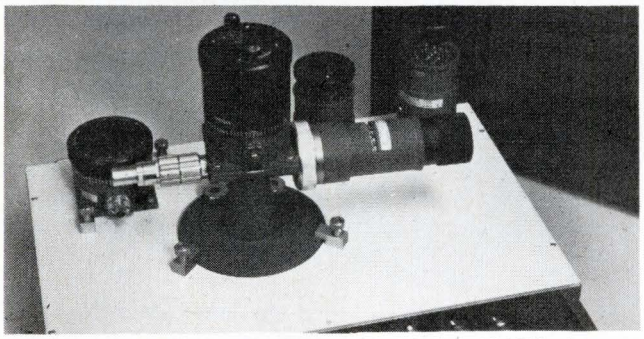


This instrument contains all of the basic elements for real-time spectral analysis of complex waveforms. Each Model 814 unit has ten filter-channels. You can connect together as many units as you wish (by means of plug-in cables) to cover all or part of the spectrum, in 1-, ½-, 1/3-, or 1/6-octave contiguous or separated segments. Also, all channels can operate in parallel for simultaneous and continuous analysis. You can combine the Model 814 analyzer with the company's Model 844 data scanner/monitor display unit. This gives you sequential sampling, display, and recording of each channel. Each 10-channel unit is housed in a 3.5 in. high x 19 in. wide x 14.5 in. deep cabinet. The instrument weighs about 20 lb., and draws only 10 W. Narrow-band-filter sets to 1/30-octave are available on special order. Tracor, Inc., 6500 Tracor Lane, Austin, Tex. 78721.

Circle 303 on Inquiry Card

STANDING-WAVE DETECTOR

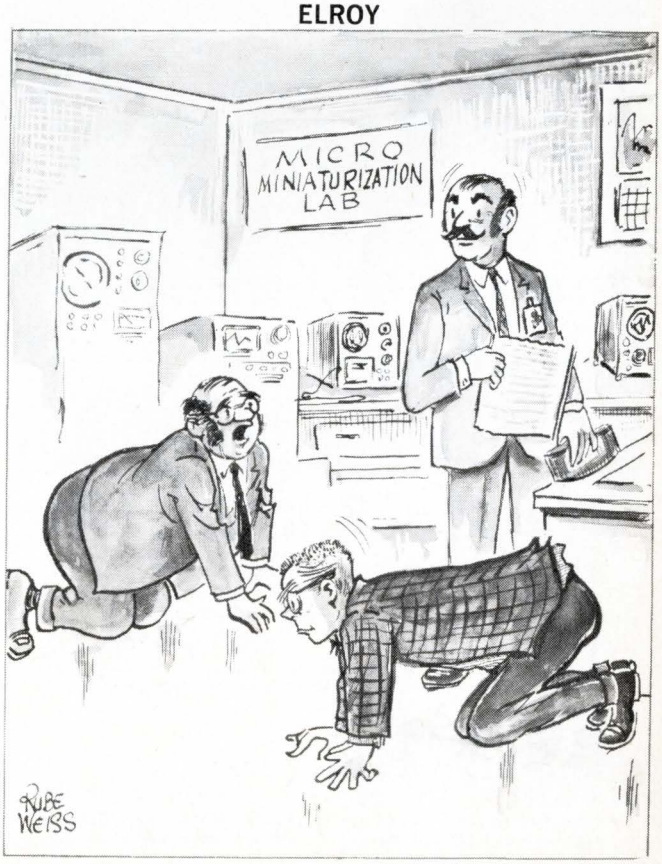
From 10 to 2300 MHz.



Now available in kit form, the Model 2219K detector measures VSWR and reflection angle coefficient with a sensitivity of 5 mW (at 10 MHz). A great advantage of the detector is that it eliminates coaxial slotted lines, which are simply too cumbersome to work with at the lower frequencies. The components of the 2219K can be configured to cover three frequency bands. A formica carrying case houses the detector, its accessories, and its adapters. The adapters mate the 2219's output connector—a GR900—to all standard coaxial transmission lines. These include BNC, C, N, TNC, OSM, SC, and APC-7. A standard load termination and short come with the detector, and mount on its base. In addition to its use in measuring VSWR and impedance of coaxial components, the Model 2219K has application in the measurement of many types of antennas. PRD Electronics, Inc., 1200 Prospect Ave., Westbury, N.Y. 11590. (516) 334-7810.

Circle 302 on Inquiry Card

ELROY

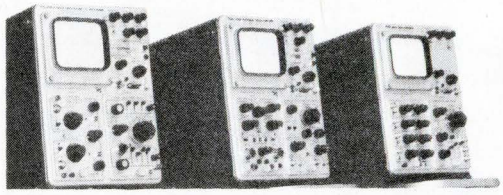


"Don't move! . . . Elroy dropped the experimental radio!"

EE NEW LAB INSTRUMENTS

OSCILLOSCOPES

Can be used with more than 25 plug-ins.



The all solid-state 561B Oscilloscope, Type 564B Storage Oscilloscope, and Type 564B Storage Oscilloscope with automatic erase feature large screen 8 x 10 cm cathode-ray tubes, new 1½% amplitude and 1% time calibrator, and reliable operation with low-heat dissipation through the use of solid-state components. Amplifier plug-ins include multitrace, differential, sampling and spectrum analyzer plug-ins plus special purpose units. The Type 561B offers conventional measurement capabilities with an 8 x 10 cm display. The Type 564B Storage Oscilloscope has the added advantage of split-screen storage. The 564B features the same screen and a storage writing speed of up to 500 cm/ms. Recommended storage time is 1 hr. or less. Prices: 561B is $560; 564B is $980; 564B with automatic erase is $1125. Tektronix, Inc., P. O. Box 500, Beaverton, Oregon 97005. (503) 644-0161.

Circle 279 on Inquiry Card

LINEAR IC TESTER

With percentage-of-limit display.

Model 1410 is primarily an op amp tester for pre-production testing: it is automatic and simple to program and operate. Its three modes of operation tell the operator what tests are programmed for pass/fail indication, whether a unit passed or failed, and how well that unit passed or failed as a percentage relative to the programmed limit for that test.

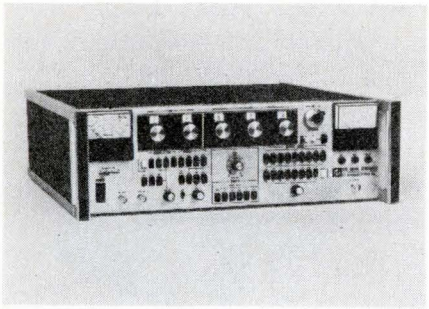
The tester automatically performs 14 dc and dynamic tests to better than 1% accuracy. Slew-rate tests are included. Each test can be independently programmed into the final pass/fail indicator. A single plug-in board with a Barnes test socket accomplishes complete programming. The basic 1410 test system is under $7000; delivery is 60 days a.r.o. Pre-wired program board prices vary with the device. Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif. 94086.

Circle 280 on Inquiry Card

Booth numbers at the end of product descriptions on this and the following pages refer to the IEEE show, where these instruments will be shown for the first time.

SYNTHESIZER/SIGNAL SOURCE

Three instruments in one.

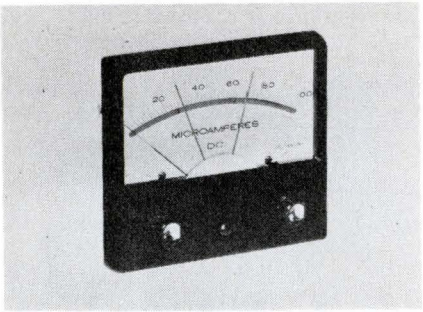


The RF-808 frequency synthesizer is also a sweeper and standard signal generator. From 0.05 to 80 MHz in 1 kHz steps, with vernier readable in Hz. Manual or auto. sweep; a-m, fm, or pulse modulation. Output into 50 Ω: 0.1 μV to 10 Vrms, auto. leveled. Everything remotely programmable. $2980. RF Communications. Booth 2C01.

Circle 281 on Inquiry Card

INDICATING LEVEL CONTROL

For control, testing, and monitoring.

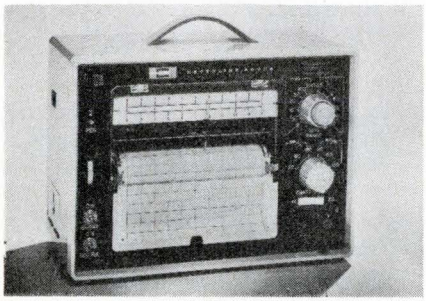


The Ultimeter has a 1% linear meter movement and a 0.5% linear pot, both calibrated to the meter scale. Set pointers operate the pot contact wipers. User's circuitry (IC op amps, Schmitt triggers, etc.) triggers a control action whenever signal level equals set-point value, even if meter movement fails. API Instruments. Booth 2G34.

Circle 283 on Inquiry Card

SERVO RECORDER

Portable, battery-operated.

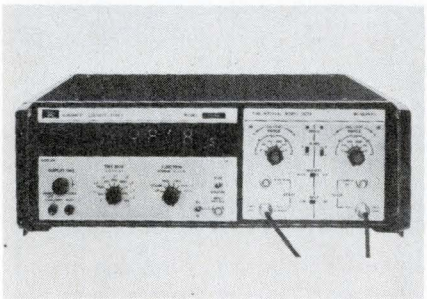


This recorder operates on rechargable NiCad batteries for 20 h, on ordinary 1.5-V D-cells for 8 h, or on ac. It weighs 15 lb., is 12.5 in. wide, 9.5 in. high, and 6.5 in. deep. There is a 12-speed chart-drive and a sliding bobbin that carries the slide wire wiper. The rotary servo-motor is very simple, with only two pulleys. Pen response is 0.5 s full-scale. Model T171B Port-A-Graph has 2 mV full-scale sensitivity, with 14 positions on the voltage-scale switches. There are adjustable controls for gain, damping, and calibration. A linear, high turn density feedback pot provides good resolution. Power input is 2.8 VA. $750. Esterline-Angus, Box 24000, Indianapolis, Ind. 46224.

Circle 282 on Inquiry Card

70-MHz COUNTER

Can totalize to 10^6 counts.

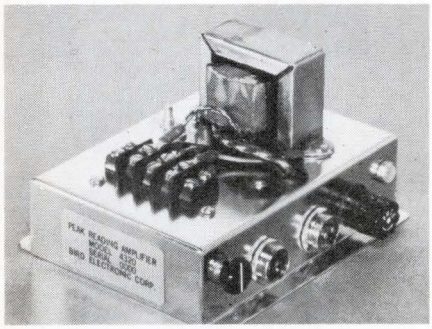


Part of the maker's 1500 Series of counter/timer instruments, the Model 1515A runs from dc to 70 MHz, and can totalize to 10^6 counts. Frequency ratio is 10^{-6} to 10^6, and sensitivity is 100 mV. The crystal aging rate is one part in 10^7 per day; one in 10^8, three in 10^9, or one in 10^9 are available as options. An internal time base output scaled from 0.1 Hz to 10 MHz in decade steps is brought out to the rear panel. You can also supply, externally, a sine-wave time base from 100 Hz to more than 10 MHz. Six digit readout is standard; 7- and 8-digit readouts are available. BCD output is optional. $1695. Monsanto Electronic Instruments, 620 Passaic Ave., West Caldwell, N. J. 07006.

Circle 284 on Inquiry Card

PEAK READING AMPLIFIERS

Models for rigid & flexible cable.

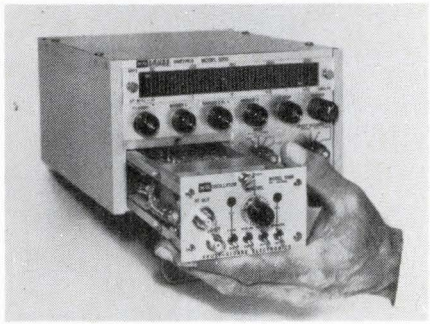


Add peak power measurements to your Thruline average rf power meter. Models 4320, 4321 sense peak rf, deliver dc to meter. Pulse widths down to 0.4 μs at rep-rates of 30 pps or higher give 0.8% o.f.s. accuracy. $365. Bird Electronic Corp. Booths 2E40-42.

Circle 285 on Inquiry Card

OSCILLATOR PLUG-IN

Sweep range is ±21 MHz max.

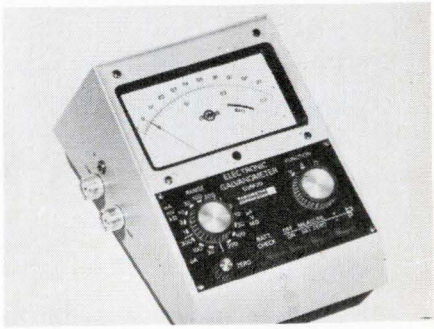


Model 5008-1 plugs into company's Model 5000 sweeper, covers 100-500 MHz with fundamental-frequency oscillator. Has 0-20 mW output, with calibrated power dial; is internally leveled to 0.2 dB. Harmonics, 27 dB down; non-harmonics, 60 dB down. $1390. Kruse-Storke. Booth 2K29.

Circle 286 on Inquiry Card

ELECTRONIC GALVANOMETER

Also a differential voltmeter.

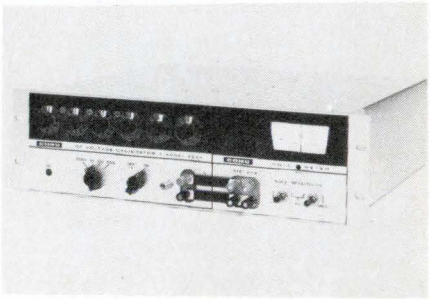


The GVM30 is a small lab meter that measures dc currents from 30 pA (f.s.) to 300 μA; voltages, 1 mV to 300 V; resistances, 1 kΩ to 300 MΩ. Both inputs are floating. The unit runs off of six type-C batteries, and has a recorder output. The London Co. Booth 2H26.

Circle 287 on Inquiry Card

DC VOLTAGE CALIBRATOR

With nullmeter.



Combining a dc calibrator with a passive null indicator gives you an instrument that measures unknown voltages by differential comparisons. Mounted in a standard 19-in. rack enclosure, the unit features a null indicator with shaped pole-piece meter, high center-scale sensitivity, and dual sensitivity switches to avoid meter overload. Model 324AN has sensitivities of 300 μV/mm in the high range, 12 mV/mm in the medium range, and 500 mV/mm in the low range. The voltage calibrator can run independent of the nullmeter, and gives voltages from 0 to 1100 V. Accuracy is better than 0.001%; stability is within 30 ppm/24 h, 50 ppm/30 days. $1150. Cohu Electronics, Inc., Box 623, San Diego, Calif. 92112. (714) 277-6700.

Circle 298 on Inquiry Card

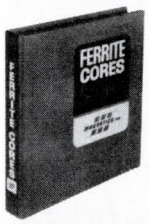
Let us throw you a curve

If you've problems with LC circuits, Magnetics' new Iso-Q contour curves speed ferrite pot core selection.

No more squinting at tangles of curves on log paper to find the ferrite pot core size you need. Magnetics' new Iso-Q contour curves let you zero in on your target size in seconds. We've plotted over 100 of these time-savers to handle more than 90% of normal design requirements. They're all contained in our new Ferrite Cores Catalog, first of its kind in the industry.

Magnetics' high purity ferrites cover frequencies up to 2 megahertz. Linear temperature coefficients on 750, 1400 and 2000 permeability materials are guaranteed from −30° to +70°C. Flat temperature coefficient on 2300 perm material is guaranteed from +20° to +70°C.

Magnetics' wide selection of ferrites comprises eight international standard sizes and five additional sizes—175 part numbers for design freedom. We can give you quick delivery from our large inventory that includes both gapped and ungapped cores in your most asked-for sizes. Of course, we provide one-piece clamping hardware for most sizes. Finally, we offer you a complete choice of tuning assemblies, bobbins and shapes—toroid, E, U and I.



Get your set of our new Iso-Q Curves. You'll like their curvilinearity. Magnetics Inc., Butler, Pa. 16001

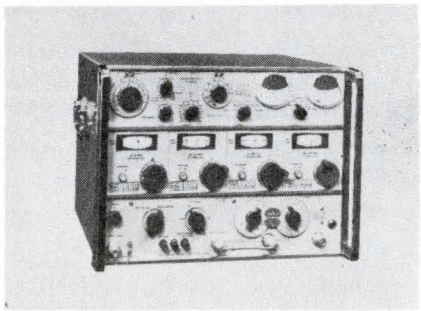
MAGNETICS inc.®

Tape, Powder, Bobbin, Ferrite Cores • Laminations • Photo-etched Parts • Specialty Metals • Engineered Control Systems

EE NEW LAB INSTRUMENTS

SIGNAL GENERATOR

Direct reading fine frequency control.

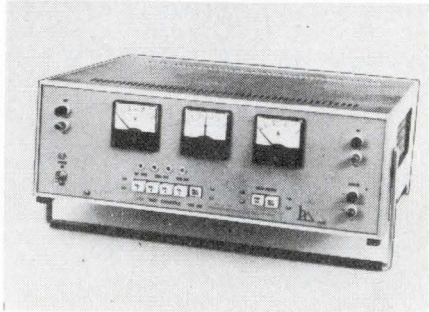


For testing all types of fm receivers, Model 2006 covers a total range of 4 to 1000 MHz with plug-in oscillators. Crystal calibrator with visual indication of zero-beat; counter output of 100 mV/50 Ω to 600 MHz, 50 mV to 1000 MHz. FM noise less than 40 Hz flat (12 Hz FIA); microphony less than 12 kHz at 0.5 g acceleration. Output variable from 0.1 μV to 100 mV/50 Ω. Marconi. Booths 2D02-08.

Circle 288 on Inquiry Card

AF DIGITAL WATTMETER

Converter drives DVM, potentiometer.

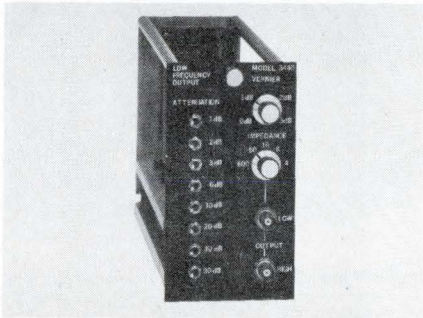


Type 2885 changes input watts to output dc volts. Linearity is ±0.02%, dc to 2 kHz; 0.1% to 10 kHz. Circuit procedure allows use with power factors from unity to zero, with less than 0.02% degradation. A 150-V, 5-A input for 1-V out is standard; other ranges are available. Output to be fed to 5- or 6-digit DVM, or dc potentiometer. From $1500. Hallmark Standards. Booths 2E07-09.

Circle 290 on Inquiry Card

AUDIO SWEEPER MODULE

A plug-in control.



This output module is a solid-state plug-in for the manufacturer's Model 2003 sweep/signal generator. The 2003 operates in the sub-audio, audio, and ultrasonic range, dc to 200 kHz. The new module, Model 3440, controls the 2003's output signal. A series of toggle switches on the 3440 lets you select up to 102 dB of attenuation, in 1-dB steps. There is also a potentiometer that gives you three dB more. Output impedance of the Model 3440 is switch-selectable to 4, 8, 16, 50, or 600 Ω. Output levels for these values are, respectively, 0.5, 1.1, 5, 7, and 3.5 V. An auxiliary output gives you 2 to 11 V p-p across 1 MΩ. Telonic Instruments, 60 N. First Ave., Beech Grove, Ind. 46107.

Circle 289 on Inquiry Card

VOLT/OHM METER

Accurate to 0.1% of reading.

This instrument is the company's first entry in the digital voltmeter market, and offers a packaging concept quite different from its other lines. The Model 9000 is housed in an ABS resin case on a removable pedestal. You can panel mount the unit (without its pedestal), use it on your bench, or mount it high over you, pointing down. A quick-response input amplifier eliminates hunting, and enables the DVM to track varying inputs. Dual slope integration gives 80-dB noise rejection with an accuracy of 0.1% of reading on both dc and ohms, and a speed to 6 samples/s. $395 f.o.b. factory. Systron-Donner Corp., 888 Galindo St., Concord, Calif. 94520. (415) 682-6161.

Circle 291 on Inquiry Card

NEW LAB INSTRUMENTS

DIGITAL PLUG-INS

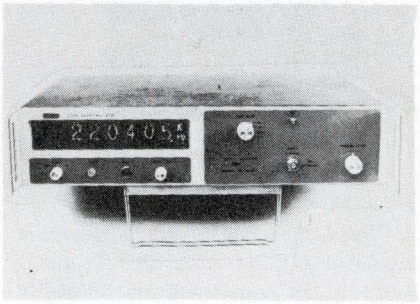
Line now includes ten types.

Here are five more plug-ins for the DMS 3200 digital measuring system. The DP 110 and DP 130 measure, respectively, dc and ac microvolts to kilovolts. The D 310, when used with the DP 110, measures nanoamperes to amperes. The DP 160 is an 80-MHz frequency counter, and the DP 210 shows interval/period from 10 μs to 999 s. Hickok Electrical Instr. Booths 2C18-20, 2C25-27.

Circle 292 on Inquiry Card

DIGITAL FREQUENCY METER

Covers dc to 220 MHz.



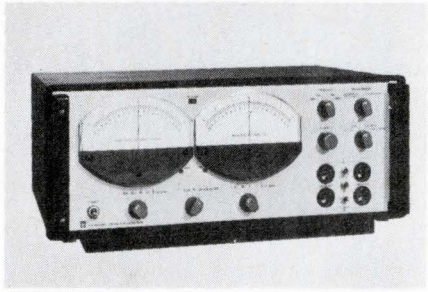
Designed for most measurement applications in communications and other frequency monitoring industries, Model 6397 gives you simple and accurate, direct frequency measurement. Typical uses for the 220-MHz counter include calibration of communications equipment, digital monitoring of am and fm radio and TV transmitter carrier frequencies, monitoring of local oscillator drift, and so forth. Model 6397 has an automatically-positioned decimal point, a 1-ms to 1-s gate time, and a 50-Ω input impedance. Modular design permits future expansion of capabilities. $1900. Technical Information Section, Electronic Instruments Div., Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif. 94804.

Circle 293 on Inquiry Card

EE NEW LAB INSTRUMENTS

IMPEDANCE COMPARATOR

Useful for automatic go/no-go tests.

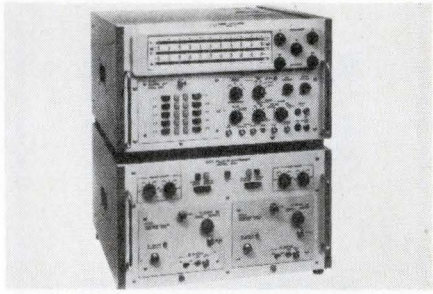


Type 1654 impedance comparator indicates the difference, in both magnitude and phase, between two external impedances. The two impedances are usually a standard and an unknown. The instrument provides 0.003% impedance difference resolution. General Radio. Booths 2E26-36.

Circle 294 on Inquiry Card

PROGRAMMABLE SWEEPER

Quick head changing.

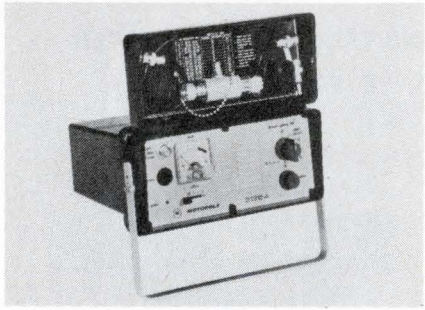


This microwave sweep system consists of the Model 650 sweeper, any combination of up to ten 650 series plug-in oscillators (250 MHz-40 GHz), the 9510 push-button control, and the 9511 plug-in container unit. Alfred Electronics. Booths 2C12 and 2C14.

Circle 296 on Inquiry Card

FREQUENCY CALIBRATOR

100 kHz to 500 MHz spectrum.

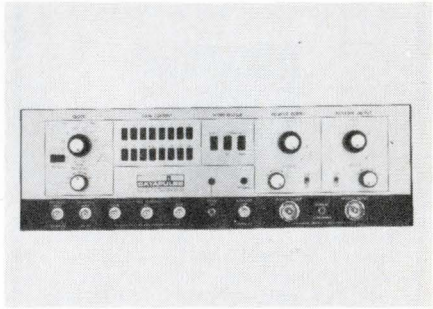


With a fast warm-up, high-stability oscillator as the source, this frequency calibrator generates a spectrum of precise frequencies selected by the position of the channel switch. This spectrum includes all assigned frequencies within the band selected by the channel switch. In use, the source frequency beats against the spectrum of frequencies, producing a zero-beat with the correct frequency when properly adjusted. Model S1315A is accurate to 0.00001% in three minutes; daily drift rate is better than 0.000002%. Weight is 7 lb.; battery or optional ac operation. Frequencies generated cover aircraft and mobile bands. Motorola Communications and Electronics, Inc., 1301 Algonquin Rd., Schaumberg, Ill. 60172.

Circle 295 on Inquiry Card

DATA GENERATOR

Internal clock rate to 75 MHz.

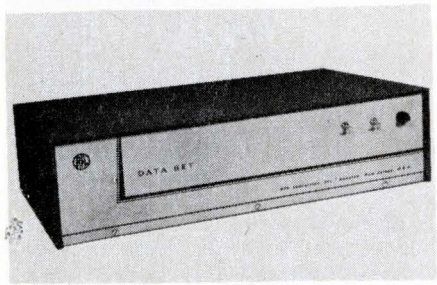


Features of this Model 212 data generator are an internal clock rate to 75 MHz and rise/fall times of 1.3 ns. Data length is 16 bits, but may be extended. Panel push-buttons set continuous, command, or manual recycle modes, as well as the data content of each bit. Simultaneous ±5 V outputs are provided: NRZ with 5 V for positive TRUE, and −5 V for negative TRUE. Independent dc offset is variable from 2 to −2 V. The baseline can be positioned at ground by a panel switch. Normal/complementary output functions are also selectable from the panel. Model 212 sells for $2715. Datapulse Div., Systron-Donner Corp., 10150 W. Jefferson Blvd., Culver City, Calif. 90230. (213) 836-6100.

Circle 297 on Inquiry Card

DATA SETS

Connect directly to telephone line.

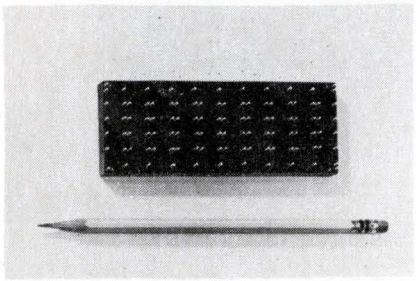


These data transmission sets will directly substitute for present leased models. They are also compatible and will transmit into other manufacturers' sets. Series 2056 data sets are two and three state (suited to return to zero operation). They operate at bit rates of 60, 85, 110, 150, 300, 600, 1200, and 1800. Digital interfaces may be either positive neutral, negative neutral, or polar (EIA/RS-232B). Prices start at $350 with delivery from 4 to 5 wks. Robert Coppoletta, RFL Industries, Inc., Boonton, N.J. 07005. (201) 334-3100.

Circle 218 on Inquiry Card

1000 ns DELAY

High density, lumped constant device.

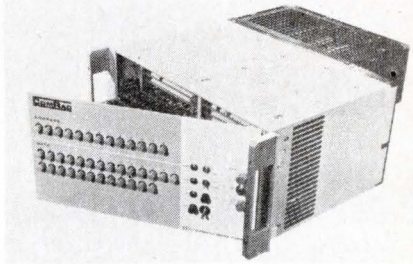


It is 1.90 x 5.10 x 0.030 in. in size. The new series, at 200 Ω impedance, is designed with cut-off frequency at 65 MHz and displays low attenuation and minimum distortion. Operating temp. range is −55° to +125°. The component is terminated with gold-plated pins and is encapsulated with epoxy in a diallyl phthalate housing. It incorporates stand-off feet to permit flush cleaning of solder flux residues after the soldering operation. Delivery is about 3 weeks. Engineered Components Co., 2134 W. Rosecrans Ave., Gardena, Calif. 90249.

Circle 219 on Inquiry Card

CORE MEMORY SYSTEM

Access time is 450 ns.



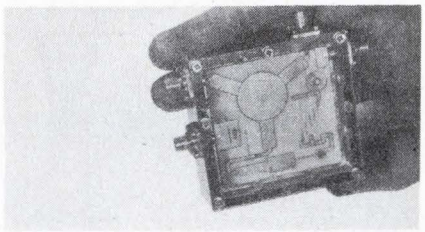
The ComRac 200 memory has a 1 μs full cycle time with bit capacities up to 8k x 36 or 4k x 72 in and 8¾ in. high, 19-in. rack mount chassis. The memory has front panel access to the functional plug-in boards. It uses 3D selection, fast switching, 20-mil cores, and ICs to achieve high speed, reliability, and density. Operating modes are read/restore, clear/write, buffer read, and buffer write. Operating temp. is 0° to 50°C. Trevor Hendershot, Sales Mgr., Information Control Corp., 1320 E. Franklin Ave., El Segundo, Calif. 90245. (213) 322-6930.

Circle 220 on Inquiry Card

EE NEW PRODUCTS

PARAMETRIC AMPLIFIER

Good low noise characteristics.

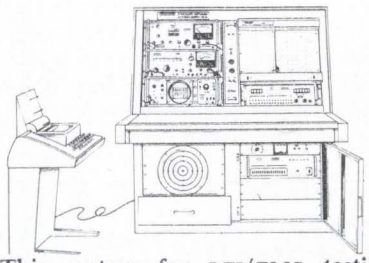


S-band paramp is built in hybrid microwave IC (MIC) format. Components are a ferrite junction circulator, input matching networks, a high cutoff freq. varactor diode, pump and idle freq. filter, and an avalanche diode oscillator pump source. American Electronic Laboratories, Inc., Colmar, Pa. Booths 3K21-22.

Circle 221 on Inquiry Card

RFI/EMC SYSTEM

It's computer-controlled.

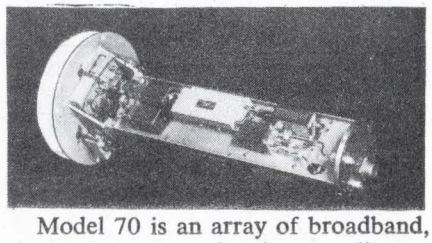


This system for RFI/EMC testing and spectrum monitoring is fully programmable. It consists of the Fairchild Spectrum Surveillance System Model FSS-250, interfaced with a Hewlett-Packard Model 2116B computer. It covers the freq. range of 20 Hz to 1000 MHz. Fairchild Electro-Metrics Corp., 88 Church St., Amsterdam, N.Y. 12011. (518) 843-2600. Booths 2D03-05.

Circle 222 on Inquiry Card

MONOPULSE FEED

Five-element array.

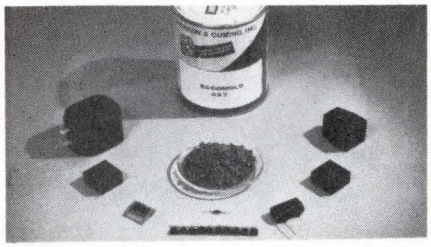


Model 70 is an array of broadband, dual-polarized, cavity-sleeve radiators. Each radiating element operates over the 1435 to 2300 MHz band. The feed has a circular symetric radiation characteristic with 6 dB beamwidths of about 127° at L-Band and about 90° at S-Band. Scientific-Atlanta, Inc., Box 13654, Atlanta, Ga. 30324.

Circle 223 on Inquiry Card

EPOXY MOLDING POWDER

Has low shrinkage.

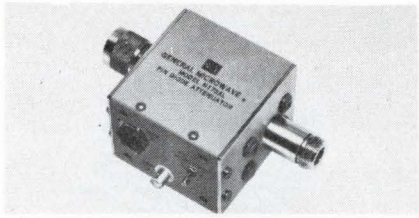


Eccomold 23T in its molded form is machinable and has essentially the same dimensions as the mold. Molding temp. is in the 275° to 324°F range with molding pressure adjustable from 150 to 1000 psi. Shrinkage from the mold dimensions is 0.004 in./in. Emerson & Cuming, Inc., Canton, Mass. 02021.

Circle 224 on Inquiry Card

PIN DIODE ATTENUATOR

Features built-in driver.

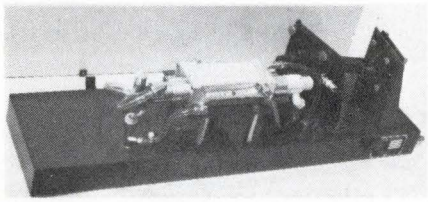


Model N172AL attenuator/modulator uses a driver module with a log transfer function which lets the attenuation level be controlled with a single dc voltage at a 10dB/V rate. It operates from 0.05 to 8 GHz, with a dynamic atten. range in the matched mode approximating 35 dB. General Microwave Corp., 155 Marine St., Farmingdale, N.Y. 11735. (516) 694-3600.

Circle 225 on Inquiry Card

LASER SYSTEM

Peak power out is 300 MW.



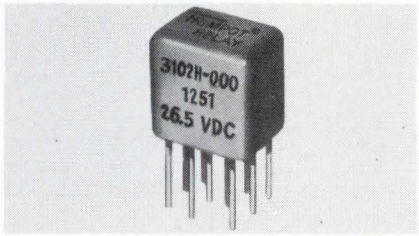
PRQ-1 laser uses either ruby or neodymium glass rods. Capable of 10 to 15 ns and subnanosecond Q-switching, it has an energy output of 1.8 to 3 joules with a pulse rate of 1 to 2 or up to 120 ppm. The laser has a 2 to 3 milliradian beam divergence. Raytheon Co., 190 Willow St., Waltham, Mass. 02154.

Circle 226 on Inquiry Card

EE NEW PRODUCTS

LATCHING RELAY

Only 0.430 x 0.400 x 0.330 in.

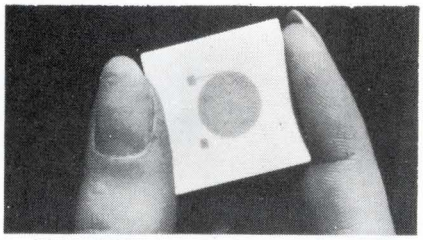


Model 3102 magnetic latching relay has a 1-A, DPDT contact rating, a 0.1-in. pin spacing, a latch/reset sens. of 160 mW, and an operating temp. range of −65° to +125°C. Relays can be placed side by side without magnetic interference between units. Contact res. is 50 mΩ max. Bourns Inc., Trimpot Products Div., 1200 Columbia Ave., Riverside, Calif. 92507. (714) 684-1700.

Circle 227 on Inquiry Card

CERAMIC GOLD PASTE

For thick-film production.

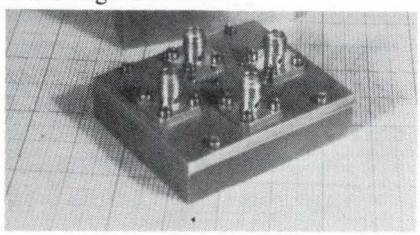


ESL #8831 paste has good conductivity and low resistivity for fine line printing and chip bonding. It accepts most bonding methods (except tin-lead solder) including binary gold alloy solders, thermal compression bonding, parallel-gap welding, and ultrasonic bonding. Electro-Science Labs, Inc., 1133 Arch St., Philadelphia, Pa. 19107. Booth 1-F-24.

Circle 228 on Inquiry Card

MINIATURE HYBRIDS

Have high isolation.

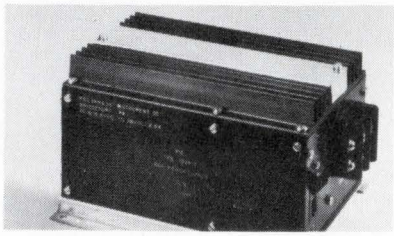


Type 3024 miniature hybrids cover the range of 125 MHz to 4 GHz in octave bands. They are lightweight, rugged, and have minimum 30-dB isolation and equal power split (magnitude and phase). Alford® Mfg. Co., 120 Cross St., Winchester, Mass. 01890.

Circle 229 on Inquiry Card

POWER SUPPLY

With storage battery source.



Rugged supply is for mobile test instrumentation and circuits requiring 28 Vdc.

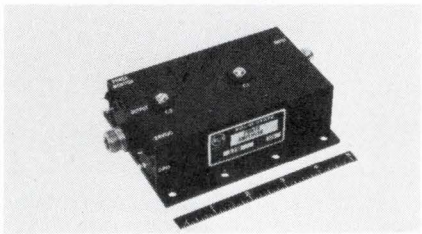
Input: 10.5 to 15.5 Vdc.
Output: 28 Vdc ± 1V line/load.
Power: 350 W cont., 400 W, 30 s.
Ripple: 10 mV rms max.
Spikes: 100 mV max. pk-pk.
Temp.: −20° to 130°F.

Polyphase Instrument Co., Bridgeport, Pa. 19405. Booth 4E08.

Circle 230 on Inquiry Card

POWER AMPLIFIER

For communications systems.

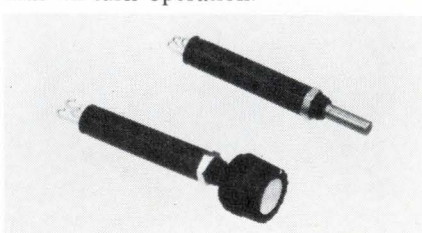


S230 microwave transistor amplifier functions as a transmitter. When it's factory tuned to any freq. between 1850 to 2000 MHz, 2-W output can be obtained at room temp. For field tunable applications a 1.6-W output is possible over the 1850- to 1990-MHz range. RCA/Electronic Components, 1000 S. Second St., Harrison, N. J. 07029.

Circle 231 on Inquiry Card

PRECISION POT

Has 42-turn operation.

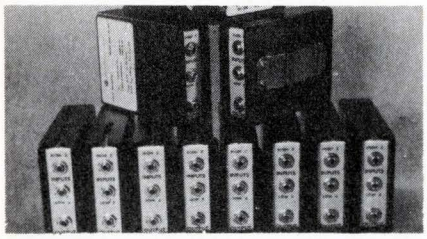


Series 241H multiturn pot is ¼ in. in dia. and 1¼ in. long. It is panel mounted with a ⅛-in. dia. shaft for knob operation. Setability is high with 42-turn operation. Available from 10 Ω to 100 kΩ ±5% std. tol. Nu Tron Electronics Co., 790 Hemmeter Lane, Mountain View, Calif. 94040.

Circle 232 on Inquiry Card

AGC AMPLIFIER

Has a 60-dB AGC range.

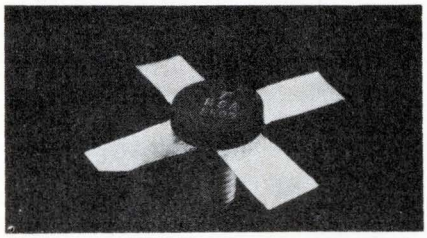


Micronoise® Model MN-120AG general-purpose audio and instrumentation amplifier produces a 0.5-V rms output into a 600-Ω load from inputs of 25 μV to 25 mV within 0.5-dB accuracy. An attenuator switch extends the dynamic range to 25 V rms at the input. Attack time is 20 ms and recovery time 200 ms. Roveti Instruments, Annapolis, Md. 21401. Booth 2H35.

Circle 233 on Inquiry Card

RF POWER TRANSISTOR

Avoids "second breakdowns".

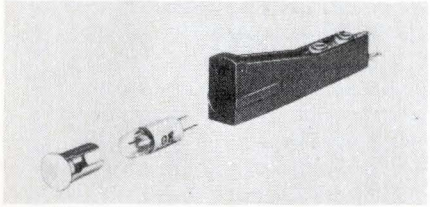


New transistor prevents costly secondary breakdowns in an operating voltage range to 30 V. MSA 8505 has a "Maximum Safe Area" built into it by means of discrete emitters with thin film nickel-chromium stabilizing resistors. It operates at 400 MHz with a 5.6-dB power gain. Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. 94040.

Circle 234 on Inquiry Card

LAMP SOCKETS

Front of panel relamping.



"Tini-telephone" lamp Jax accept industry std. T-1 ¾ bi-pin lamps. Jack features a molded one-piece housing built with fins for ample heat dissipation and strength. Nickel-silver contact springs are tensioned for optimum pressure on the lamp pins. Switchcraft, 5555 N. Elston Ave., Chicago, Ill. 60630.

Circle 235 on Inquiry Card

DESOLDERING TOOL

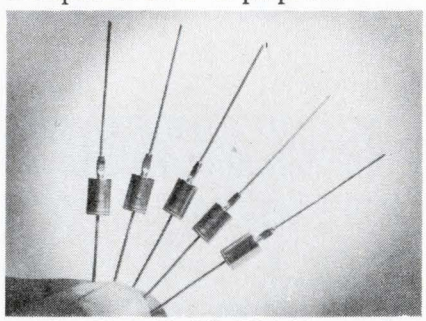
Draws up solders.

Wik-It desoldering tool is specially-treated (with Mil Spec chemicals) tinned braid that quickly draws up solder when heat is applied with an ordinary soldering iron. It acts as a heat sink to protect delicate components, and leaves the joint resolder-ready. It cuts costs of equipment down-time, rework, trouble shooting, quality control and prototype building. It is sold as service kit or spool rolls; a sample is available on request. Wik-It Electronics Corp., Box 414, Fremont, Calif. 94537.

Circle 236 on Inquiry Card

TRANSIENT SUPPRESSORS

Dissipate 1500 W of pk power.

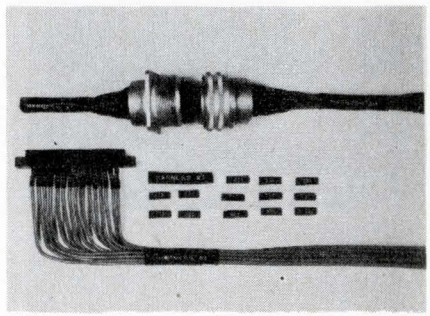


The TransZorb® 704-34 transient suppressors were designed mainly for airborne applications where large voltage transients, as described in MIL-STD-704A, endanger voltage-sensitive circuits or components. It comes in the standard DO-13 package, has a clamping voltage of 34 V, and requires only 1Ω source impedance. Price in 100 piece quantities is $3.25. General Semiconductor Div., Silicon Transistors Corp., Box 3077, Tempe, Ariz. 85281. (602) 966-7263.

Circle 237 on Inquiry Card

WIRE MARKERS

Are heat shrinkable.

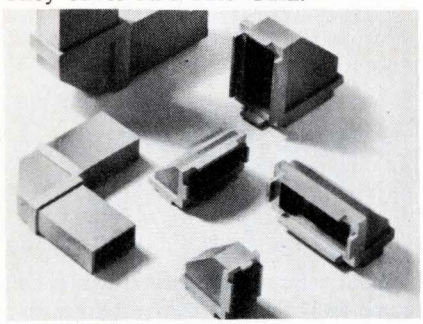


To permanently install the markers in skin-tight fit, simply slip them over the objects to be marked and apply moderate heat. Average shrink range runs from 35% to as much as 50%, depending upon material used. Heat needed for shrinking may be supplied by heat guns, contact tools, infra red radiation units, or ovens. Satisfactory shrink is achieved in 5 seconds with 450°F applied. E.C.P. Corp., 4726 Superior Ave., Cleveland, Ohio 44103. (216) 391-0444.

Circle 238 on Inquiry Card

90° BENDS

They cover 3.95-18.0 GHz.

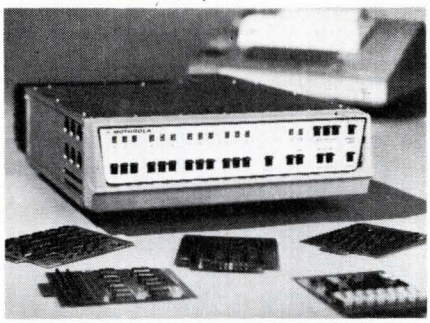


A complete line of cast 90° E and H bends covering the 3.95-18.0 GHz frequency range with a vswr of 1.05 max. are available. E and H plane units are available cast in either brazeable aluminum or beryllium copper alloy. Standard units come in 3 mechanical configurations: Style 1 has accurately machined fences on both ends, Style 2 one fence and one waveguide extension, and Style 3 has waveguide extensions on both ends. All units may be pressurized upon special request. Alpha Industries, Inc., 381 Elliot St., Newton Upper Falls, Mass. 02184.

Circle 239 on Inquiry Card

SMALL-SCALE COMPUTER

Sells for about $8,000.

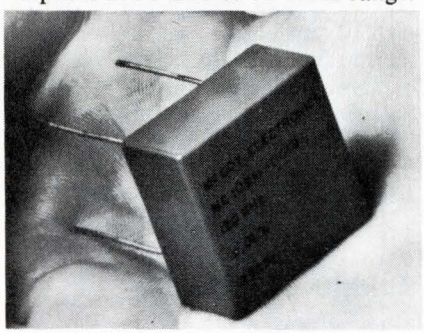


Digital computer MDP-1000 has a variety of I/O options; a 4096-word random-access memory (exp. to 16k) with a cycle time of 2.16 μs; six programmable 12-bit registers; a parallel adder; two accumulators; and a priority interrupt system. A "shared command" technique permits the use of 8-bit memory words and 12-bit register words in such a manner that only one 8-bit word of memory, corresponding to a 12-bit instruction of in-line coding, is needed to specify an instruction. Motorola Instrumentation and Control Inc., a Subsidiary of Motorola Inc., Box 5409, Phoenix, Ariz. 85010.

Circle 241 on Inquiry Card

COMPUTER CLOCK OSCILLATOR

Output is in 30 kHz to 50 MHz range.

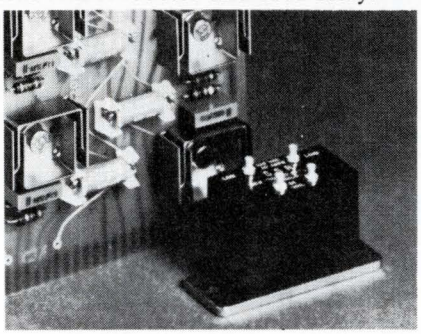


Designed for stacked printed circuit board mounting assemblies, the new low profile oscillator, Series MC109A1, measures only 1.0 in. sq. by 0.5 in. high. It weighs less than 1 oz. Operationally, it will hold ±150 PPM max. over −55°C to +150°C over the range of 30 kHz to 650 kHz. From 180 kHz to 50 MHz the unit will hold ±50 PPM max. over −55°C to +125°C. Requiring an input voltage of only 5 Vdc (±5%), clock oscillator output is compatible with DTL, RTL or TTL logic. Delivery is 2 to 6 weeks. McCoy Electronics Co., subs. of Oak Electro/Netics Corp., Mt. Holley Springs, Pa. 17065.

Circle 240 on Inquiry Card

HYBRID RELAY

Has semiconductor and reed relay.

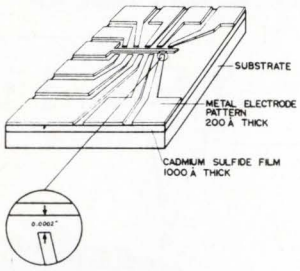


Each SSR consists of a bi-directional semiconductor switch gated by an NPE reed relay. The panel mount module measures 31/32 x 1 13/16 x 1 7/16 in. high, to allow mounting on 1 in. centers. The isolated control circuit requires less than 200 mW to switch 115 V, 6 A, 10 A or 15 A loads. The PC module will switch 115 V, 2A loads. Standard control voltages of 6, 12 and 24 V can be accommodated. Switching speed is 1 ms, and life expectancy is in excess of 500 million operations. List price of the new SSR devices is about $10 to $40 each. Delivery is 2 to 6 weeks. Wabash Magnetics, Inc., Wabash, Ind. 36992.

Circle 242 on Inquiry Card

PHOTOCONDUCTOR ARRAYS

Have high spatial resolution.



Typical photoconductive array.

New cadmium sulphide thin film photoconductor arrays can resolve spots as small as 0.0002 in.

Made by a vacuum deposition technique, the arrays provide high photosensitivity at low light levels. They also feature fast response times, controllable linearity, and good stability under adverse temperature conditions. For example, they can withstand 135°C for 100 hours with less than 10% change in photoconductivity.

The films have achieved a light-to-dark conductivity ratio of $> 10^7$ at one-foot candle illumination. A photoconductive gain of $> 10^6$ and rise times in the millisecond range have been attained.

A single cadmium sulphide chip can be made to contain complex geometrical arrangements of photoconductors, while retaining high spatial resolution. Complex, multi-electrode patterns can also be deposited with a resolution of better than 0.0002 in. Units as small as a few mils square have been made.

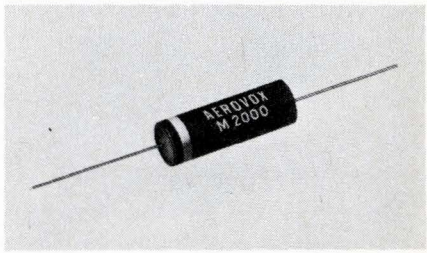
The arrays are now being used as detectors in planet and star trackers. However, they have application in a variety of areas including encoders, decoders, pattern recognition systems, and automatic celestial navigation systems.

Only 1 to 10 volts ac or dc are needed for operation. Allen-Bradley Co., Electronics Div., Milwaukee, Wis. 53204.

Circle 243 on Inquiry Card

MICA CAPACITORS

Tubular configuration.

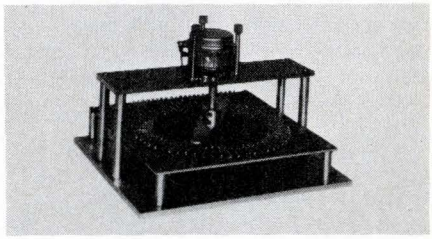


Plastic-cased miniature capacitors come in both bulk and reel form in a capacitance range of 1 pF to 1000 pF and working volt. of 500, 300, and 100 Vdc. They are all 0.312 in. dia. x 0.515 in. long. Aerovox Corp., New Bedford, Mass. 02741. Booth 4E04-06.

Circle 244 on Inquiry Card

SEQUENTIAL SWITCHES

Are motor driven.

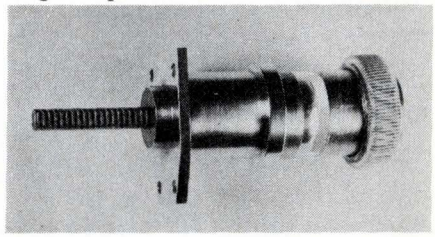


Roto-Reed® switches have drive speeds from 1 to 1000 r/min using compactly mounted synchronous type motors. Standard sizes are from 10 to 100 hermetically sealed reed-type contacts mounted on a PC board. Standard switch reeds are rated for 250 V, 0.5 A max., with a 10-W limitation. Ansley Div. of aci, Inc., Perkasie, Pa. 18944.

Circle 245 on Inquiry Card

TUNING CAPACITORS

High rf power.



Power-C series capacitors handle up to 2000 V and 16 A at 30 MHz. Using push-pull tuning which may be gear driven for servo applications, they come in sizes up to 50 pf (2 pf min.). JFD Electronics, 1462 62nd St., Brooklyn, N. Y. 11227. Booths 4D35-36.

Circle 246 on Inquiry Card

Circle 67 on Inquiry Card

Circle 68 on Inquiry Card ⟶

Speech therapy for computers.

Our new printer is designed for original equipment manufacturers. It makes it easier for computers to talk to people and easier for people to talk back to their computers.

It's the UNIVAC® 0769 Incremental Printer

It's a low-speed asynchronous device that can print at a rate of up to 25 characters per second. Making it a pretty fast low-speed printer.

Its basic simplicity of design makes it very flexible. For example you can use it with a keyboard as a remote input device to a central processor.

Or it can be a low-speed output printer. Or an integral part of a communications terminal. Or part of a magnetic-tape data recording system.

It has a changeable font. So if your customers suddenly decide to talk to their computers in mathematical symbols, they can.

The UNIVAC 0769 can handle up to 132 print positions. 52 positions more than you usually get.

It has an ink-impregnated roller that takes only a few seconds to change.

And we designed it to produce an original and five good clean copies.

We're offering the 0769 to OEM customers as a basic mechanism, without controlling electronics, power supplies or cabinetry. We can also supply intimate electronic circuits for the 0769, primarily amplifiers and drivers, on a single plug-in printed circuit assembly.

If all this sounds interesting, write to Univac, OEM Marketing Department, P.O. Box 8100, Philadelphia, Pennsylvania 19101.

We offer Readers, Punches, Printers, Communication Terminals, Graphics, Memory Devices and, of course, a little therapy.

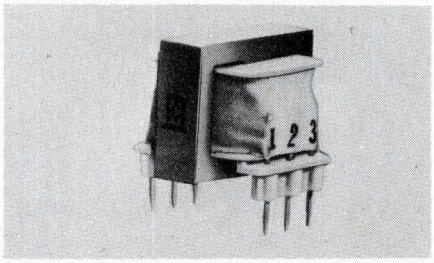
UNIVAC

SPERRY RAND

EE NEW PRODUCTS

PC POWER TRANSFORMERS

Low power 60 and 400 Hz plug-ins.

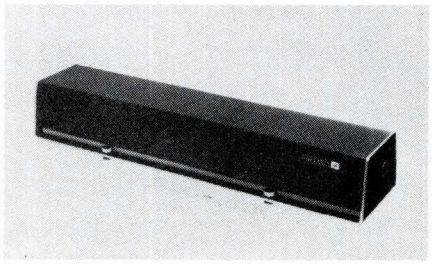


These transformers provide step down and isolation from power lines at power levels ranging from 0.325 to 7.5 VA. Output voltages range from 3 to 116 C.T. Vac. Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N.N.Y. 11582. (516) LO 1-6050. Booth 3F18.

Circle 247 on Inquiry Card

CO_2 LASER

Single-frequency, single-wavelength.

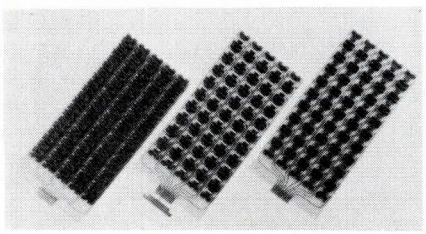


Model 948 has a freq. stab. better than 30 kHz short term and 15 MHz long term. Amplitude stab. is <0.1% short term and 5% long term. It emits >5 W in a TEM_{00q} mode at a single wavelength near 0.6 μm. It is freq. tunable by ±25 MHz. Sylvania Electronic Systems, Electro Optics Orgn., Box 188, Mountain View, Calif. 94040. (415) 966-2312.

Circle 248 on Inquiry Card

IC BREADBOARDS

Available from stock.

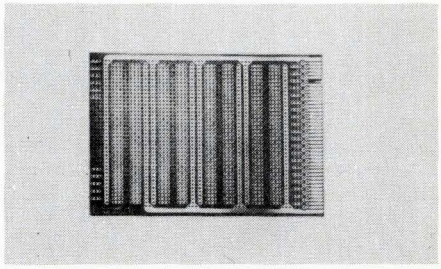


These three boards are built in sizes to mount 25, 50, or 70 flatpacks, DIPs or TO-5 ICs. The boards are completely pluggable throughout with common power and ground sockets at each position. Robinson-Nugent, Inc., 802 E. 8th, New Albany, Ind. 47150.

Circle 249 on Inquiry Card

DIP BREADBOARD

Has a 0.1 x 0.1 hole pattern.

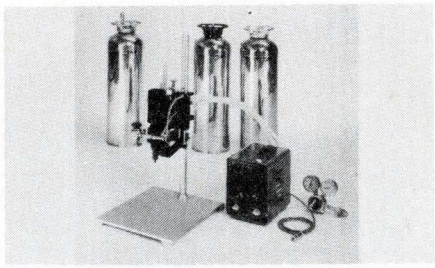


First of a new line of Veroboards is for use with DIL packages. Circuitry is located on continuous rows. Power and ground busses and test points are provided. Vero Electronics Inc., 176 Central Ave., Farmingdale, N.Y. 11735. (516) MY 4-6550. Booth 1B22.

Circle 250 on Inquiry Card

RESIN DISPENSERS

For potting and encapsulation.

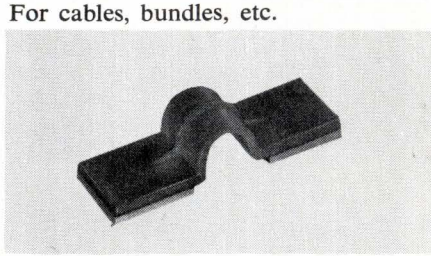


Model 410 Microshot dispenser has precision-machined metering cylinders that deliver 0.5 to 15 g/shot of two-component thermosetting plastics. Stainless steel containers (2½ gal.) deliver components under constant pressure to the metering system. Fluidyne Instrumentation, 3685 Mt. Diablo Blvd., Lafayette, Calif. 94549. (415) 284-5824.

Circle 251 on Inquiry Card

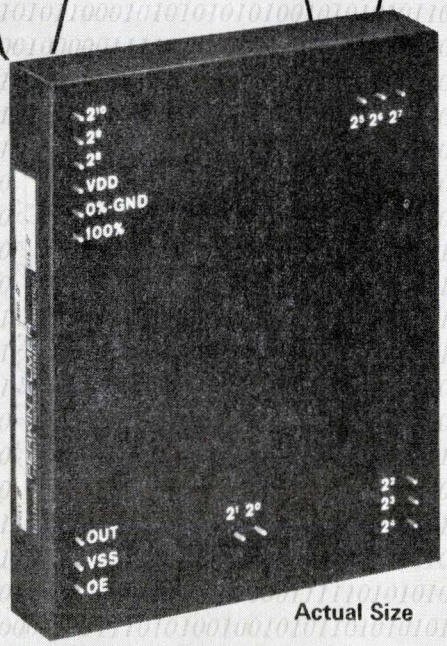
PLASTIC PRESS CLIPS

For cables, bundles, etc.



Fast and easy to use all-purpose clip is backed with two-sided foam adhesive to provide permanent bonding even to irregular surfaces. Also comes in a one-pad design. Weckesser Co., Inc., 4444 W. Irving Park Rd., Chicago, Ill. 60641. (312) 282-8626. Booth IE 24.

Circle 252 on Inquiry Card



Actual Size

AC Digital/ Analog Conversion.

11 Bit Resolution, 1/2 Bit Accuracy, In 3.2 Cu. In.

The Model D/A 011 (patent applied for) is unique in its design, combining a previously unmatched level of resolution and accuracy in a small package.

It employs a combination of transformer windings and MOS integrated circuits. It is fully compatible with DTL and TTL computers. No voltage level offset is required. Specifications for the D/A 011 are shown below. Why not let us show you how it, and related units, can help solve your interface problems. Use the handy reader service number below or write or call, Electronic Products Division, The Perkin-Elmer Corporation, 131 Danbury Road, Wilton, Conn. 06897. (203) 762-6574.

ADDITIONAL SPECIFICATIONS—MODEL D/A 011

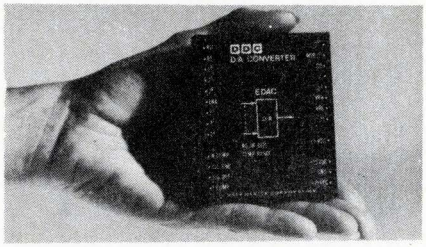
Input Voltage — ±3.5 volts 400 CPS
Input Impedance — 90KΩ Minimum
Output Impedance Without Amplifier — 2000Ω Maximum
Operating Temperature — −55C to +125°C
Logic Level (on) — +5 Volts DC
Logic Level (off) — 0 Volts DC
Channel Switching Time (typical) — 1μs
Weight — 3 oz.

PERKIN-ELMER

EE NEW PRODUCTS

D/A CONVERTERS

Accuracies to ±0.025% of FS.

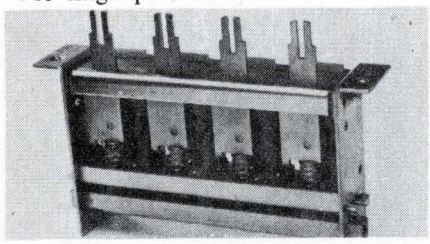


EDAC Series converters provide 8-, 9-, 10-, 11-bit accuracy, with 11-bit resolution; have temp. coeff. as low as ±0.0025%/°C. Input logic is DTL or TTL; coding is one's complement, two's complement, binary parallel. Short-circuit proof output is ±10 V at 5 mA. Data Device Corp., 100 Tec St., Hicksville, N. Y. 11801. Booths 3B11-12.

Circle 253 on Inquiry Card

PUSHBUTTON MODULES

Use single-pole reed switches.

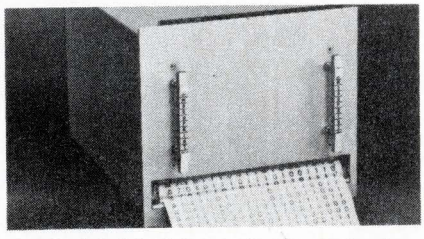


Modular concept lets you create your own custom layouts. Light pressure (5 oz.) and short strokes result in optimum operators' convenience and positive input of data. Basic module lets you use one to three switches in either momentary or alternate "push-ON-push-OFF" action. Alco Electronic Products, Inc., Box 1348, Lawrence, Mass. 01845. Booth 4G23.

Circle 254 on Inquiry Card

EVENTS RECORDER

Records 24 h in 10-min. intervals.

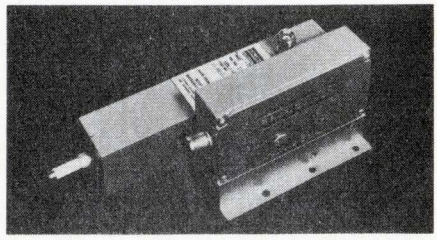


Model C4-183 panel-mounted printer contains up to 17 columns of information. Printing can be either continuous or upon demand with separate paper advance. Printing is on a 6-in. wide roll at rates up to 3 lines/s. Practical Automation, Inc., Shelton, Conn. 06486. (203) 929-1495.

Circle 255 on Inquiry Card

PHASE LOCKED OSCILLATOR

Is mechanically tuned.

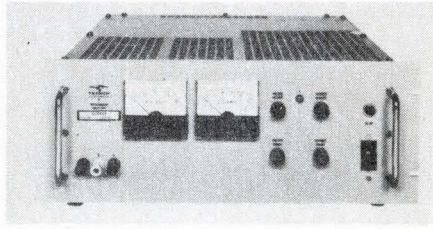


MO(L)-100XE fundamental oscillator is for tropospheric scatter or line of sight radio relay uses. It operates at 685 to 1055 MHz with an 80 mW min. power out over a temp. range of −30 to +60°C. FM residual noise characteristics are good; FM noise is 6 Hz in a 3 kHz bandwidth. Fairchild Microwave Products, 2513 Charleston Rd., Mountain View, Calif. 94040.

Circle 256 on Inquiry Card

PRECISION POWER SUPPLY

It's fully programmable.

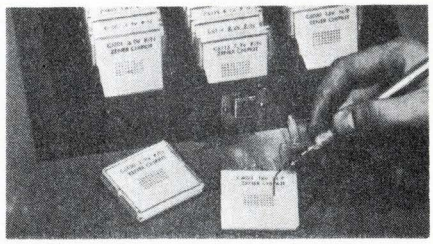


Model M7C160 is a 0 to 160-Vdc, 0 to 15-A regulated supply in a 7-in. panel height. The all-silicon unit has constant voltage/constant current and precision performance. It has 0.005% reg., and 0.015% stab. with full power to 60°C without derating. Ripple is less than 1 mV rms. Trygon Electronics, Inc., 111 Pleasant Ave., Roosevelt, N.Y. Booths 2H47-49.

Circle 257 on Inquiry Card

ZENER CHIP DIODE KIT

For development projects.



Fifty chips each of the 30 most popular zener voltages are contained in this kit. All diodes are individually compartmented within the trays. Product data sheets are included. Price is $187.50. Centralab Semiconductor Div., 4501 N. Arden Dr., El Monte, Calif. 91734.

Circle 258 on Inquiry Card

Circle 72 on Inquiry Card ⟶

Here's the DVM they won't dare mention

$695
Model 350

Why?

Is it because it offers equal or superior performance at a savings of typically $500?

The 350 performs to:

An ACCURACY of .01% of reading ± .01% of full scale

A RESOLUTION of 100 microvolts standard (1 microvolt option)

An INPUT IMPEDANCE of 1000 megohms

And, available options include mV, DCV, ACV, ohms and ratio.

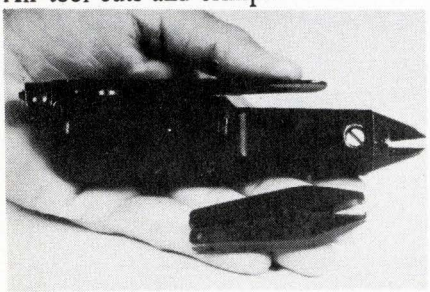
Hard to believe? Try us!
Call collect: (415) 321-0551 x 216

DATA TECHNOLOGY CORPORATION

1050 East Meadow Circle
Palo Alto, California 94303

PRODUCTION TOOL

Air tool cuts and crimps.

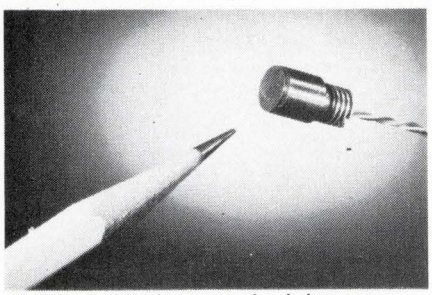


Miniature Squeez-Eze air tool is for cutting and crimping in deep, inaccessible places. Model MSP-1 speeds production, improves work precision, and reduces operator fatigue in PC and electronic assembly. Weighing only 8 oz., it has interchangeable jaws, operates at 40 to 100 psi, and comes in both hand- and footswitch-operated models. Two-piece jaws can be resharpened. Standard jaws include 15° cutter dykes and a vertical cutter and crimper. Special jaws, soon to become standard, include a sub-miniature cutter and crimper and 45° cutter dykes. Simonds Machine Co., 258 Worcester St., Southbridge, Mass. 01550.

Circle 259 on Inquiry Card

PRESSURE TRANSDUCERS

For mounting into probes.

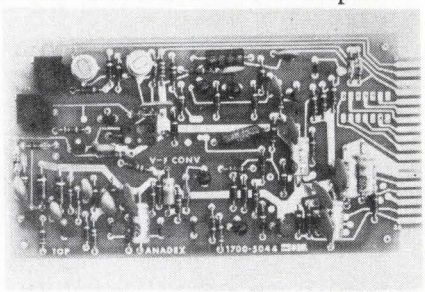


Flush diaphragm subminiature pressure transducers, Model SA-SA, are temperature compensated. Both absolute and differential models are available in pressure ranges from ±2 psid up to 5000 psia. They can operate at temperatures to 300°F. The diaphragm has a pressure sensitive area of only 0.028 in.^{2}, providing point source data. Semiconductor strain gages are bonded to the diaphragm to enable the unit to withstand severe environments, and to offer low sensitivities to vibration and acceleration forces. Sensotec Div. of Scientific Advances, Inc., 1400 Holly Ave., Columbus, Ohio 43212. (614) 294-5436.

Circle 260 on Inquiry Card

DC-TO-FREQUENCY CONVERTER

Device features 0-1 MHz output.



The plug-in dc-to-frequency converter board is designed primarily for use in analog-to-digital conversion systems. Board provides linear conversion from 0-10 Vdc to 0-1 MHz freq. in a compact, modular plug-in package. Linearity is 0.01% and operating temp. range is −10°C to +65°C. It requires a power supply of ±15 V source at less than 50 mA. Zero and full scale controls are mounted on the board. Input amplifier options are available for increased sensitivity. Board is $195. Delivery is 4 weeks. Contact Kenneth Mathews, Anadex Instruments Inc., 7833 Haskell Ave., Van Nuys, Calif. 91406.

Circle 261 on Inquiry Card

the lowest priced military-quality IC voltage regulator

$9.95 each

at quantities of 1000

HYBRID POWER

General Instrument, the "#1 Power" in hybrid microcircuitry, introduces the NC-531 hybrid voltage regulator, the first and only "Class A" integrated circuit voltage regulator available at a "Class C" price. Internally set to 15V ±100 mV, the NC-531, unlike monolithic IC voltage regulators, requires *no external components* for normal operation. Provisions have been included in the design to allow the user to obtain other voltages and currents easily with a minimum of additional components in order to provide maximum versatility in the widest variety of applications.

The NC-531 in a TO-100 package is immediately available in quantity, off-the-shelf from your authorized General Instrument distributor. For full information on the NC-531 and the broadest line of hybrid ICs available anywhere, write for your "Hybrid Power" data-pak today.

PARAMETER	MAX	MIN
Input Voltage	40	—
Output Voltage (externally adjusted)	38v	8v
Load Current	250ma	0ma
Operating Temperature	+125°C	−55°C
Storage Temperature	+175°C	−65°C
Power Dissipation T_a = 25°C (without heat sink)	500mw	—

CIRCUIT PERFORMANCE RATINGS:

T_a = +25°C V_{in} = +19v I_L = 40ma
(unless otherwise noted)

CHARACTERISTIC	TEST CONDITION	MIN	TYP	MAX	UNITS
Output Voltage	Internally Set	14.9	15.0	15.1	Volts
Input/Output Differential	V_{in}-V_{OUT} (without external pass transistor)	2	—	—	Volts
Line Regulation	V_{in} 19v ±10%	—	.5	1	%
Load Regulation	0 to 40ma	—	.05	.075	%
Load Regulation	0 to 100ma	—	.1	.25	%
Ripple Rejection		—	40	—	db
Output Z	DC to 100KC	—	.2	.5	Ω
Temperature Coefficient		—	0.9	1.5	mv/°C

(In Europe write: General Instrument Europe S.P.A., Piazza Amendola 9, 20149 Milano, Italy.)

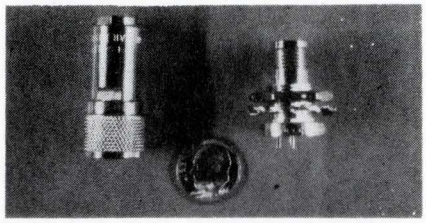
GENERAL INSTRUMENT

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

EE NEW PRODUCTS

TRIAXIAL CONNECTORS

Meet MIL-C-39012.



New miniature connectors have the following parameters:

Nominal imp.—50Ω.

VSWR—1.3:1 max. from dc to 7.5 GHz.

Op. volt.—500 Vrms

Ins. res.—10,000 MΩ at 500 Vdc.

RF leakage—90 dB min.

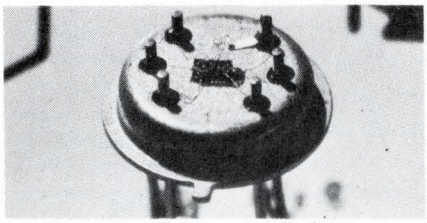
Insertion loss—0.1 dB max.

Gremar Mfg. Co., Inc., 7 North Ave., Wakefield, Mass. 01880.

Circle 262 on Inquiry Card

SS ISOLATORS

Are optically coupled.



Two new high-gain isolators are capable of replacing low-power relays and transformers. The TIXL102 and TIXL103 provide isolation of ±100 V with an internal resistance $>10^{12}\Omega$ and a capacitance of 4 pF. They have no moving parts or fragile wiring. Texas Instruments Incorporated, 13500 N. Central Expressway, Dallas, Tex. 75222. (214) 238-3741.

Circle 263 on Inquiry Card

MICROWAVE CIRCULATORS

Stripline, coax ferrite devices.

These circulators and isolators operate from 300 to 6000 MHz over bandwidth ranges from 10 to 20% and more, and at cw power levels up to and exceeding 300 W. They are available miniaturized and magnetically shielded. General Electric Co., 1 River Rd., Schenectady, N. Y. 12305.

Circle 264 on Inquiry Card

HV POWER SUPPLY

For CRT display systems.

Model 1579 furnishes stable, low noise corona-free voltages between 10 kV and 30 kV. Specs include: Max. out. curr. of 1 mA; 0.0025% reg. for line or load variations; <250 mV ripple pk-to-pk; output volt. drift <100 ppm/h and 300 ppm/24 h; and repeatability of 100 ppm. Power Design, Inc., 1700 Shames Dr., Westbury, N. Y. 11590. (516) ED 3-6200. Booths 2G10-11.

Circle 265 on Inquiry Card

SHAFT ANGLE ENCODER

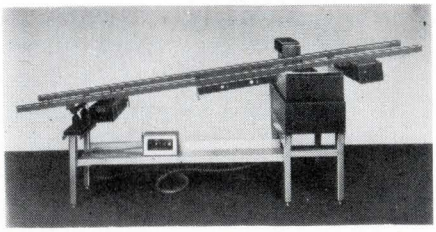
Completely solid state.

New encoder translates shaft rotations to a high accuracy direct decimal readout, binary visual readout, and/or a digital output compatible with computer, printer, or other off-line interfaces. Angle output is absolute and returns to the correct position even when a power interruption occurs. Astrosystems, Inc., 6 Nevada Dr., New Hyde Park, N. Y. 11040. Booth 2C15.

Circle 266 on Inquiry Card

SOLDERING SYSTEM

Handles PC boards up to 14 in. wide.

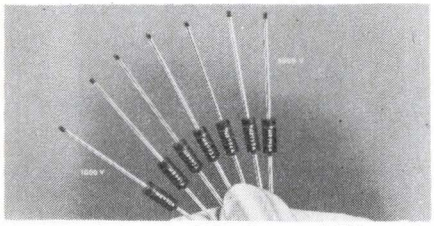


Series TDB systems have a ¾-in. deep solder wave. Features include close control on oil/solder intermix meter, large solder base capacity (450 lbs.), two remote control panel options, preheater with variable temp. settings, and 13 speed settings on the conveyor. Hollis Engineering, Inc., Nashua, N.H. 03060. Booth 302.

Circle 267 on Inquiry Card

HV RECTIFIERS

Cost less than $1.

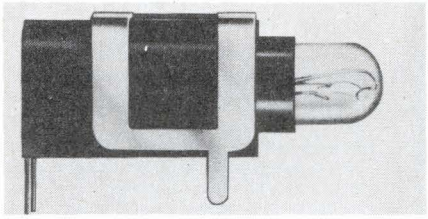


Subminiature, HV Surmetic™ rectifiers have max. peak repetitive reverse voltage ratings ranging from 1 to 5 kV. They handle continuous forward currents of 0.25 A at amb. temp. to 75°C and withstand current surges up to 15 A. A passivated p-n junction minimizes leakage current and stabilizes breakdown voltage. Motorola Semiconductor Products Inc., Box 955, Phoenix, Ariz. 85001.

Circle 268 on Inquiry Card

BI-PIN LAMP SOCKET

For printed circuits.

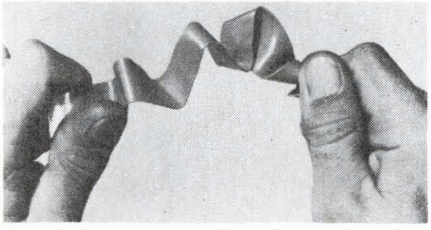


This socket permits instant replacement of most T-1 ¾ bi-pin base lamps. For display or readout purposes, it provides exact positioning of the lamp. Socket measures 0.625 x 0.343 x 0.385 in.; thus it and the lamp require only slightly more space than the lamp alone. Grayhill, Inc., 543 Hillgrove Ave., La Grange, Ill. 60525. Booths 4G03-05.

Circle 269 on Inquiry Card

EPOXY COATING POWDER

Flexible and tough.



DK8 epoxy Dri-Kote® powder also features thermal shock resistance and good electrical values. Applied by aerated bed, flow coating, or electrostatic deposition, it is well suited for insulation and protection of flexible conductors. Hysol Div., The Dexter Corp., Franklin St., Olean, N.Y. 14760.

Circle 270 on Inquiry Card

EE NEW PRODUCTS

CROSSBAR SCANNER

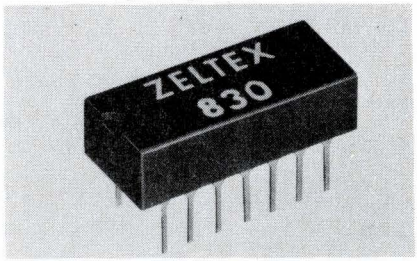
Speeds to 60 channels/s.

Model 409 Scannex can be controlled from the front panel, or by 1, 2, 4, 8 BCD inputs from a remote station. Combinations available are: 600 1-wire channels; 300 2-wire channels; 200 3-wire channels; 100 6-wire channels. Cunningham Corp., Honeoye Falls, N. Y. 14472. (716) 624-2000. Booth 3A12.

Circle 271 on Inquiry Card

FET OP AMP

In a DIL epoxy package.

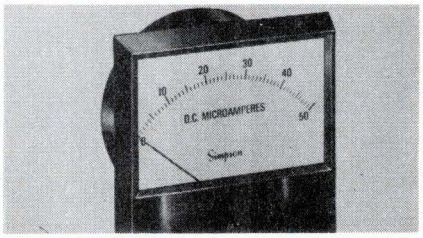


Model 830 fully-compensated op amp is the first in a series. Specs are: volt. gain of 300,000, drift of 20 μV/°C, input bias current of 15 pA, slew rate of 6 V/μs common mode volt. of 10 V, and output of 10 V at 5 mA. Zeltex, Inc., 1000 Chalomar Rd., Concord, Calif. 94520. (415) 686-6660. Booths 2C06 and 2C08.

Circle 272 on Inquiry Card

PANEL METERS

Self-shielding movements.



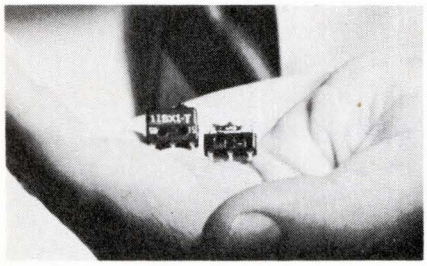
Century series meters can come with the following movements: dc annular, shock resistant taut band; dc annular, spring-backed pivot and jewel; ac, annular rectifier; ac, iron vane, magnetically damped; and ac, dynamometer, single phase. Simpson Electric Co., 5200 W. Kinzie St., Chicago, Ill. 60644. Booth 2C-17.

Circle 273 on Inquiry Card

EE NEW PRODUCTS

SUBMINIATURE SWITCH

Has low-differential travel.

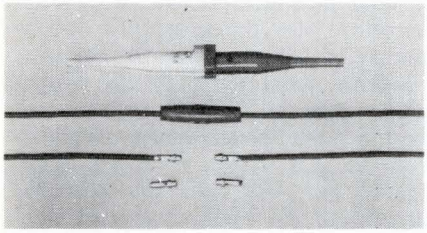


The 11SX1-T SPDT switch features a differential travel of 0.001 in. Ratings are: 28 Vdc—3 A resistive, 2 A inductive; 115 Vac—3 A. It weighs 1/28 oz. and operates within a temp. range of −100° to +250°F. Micro Switch, a div. of Honeywell Inc., 11 W. Spring St. Freeport, Ill. 61032. Booths 2G48 and 2G50.

Circle 274 on Inquiry Card

WIRE JUNCTIONS

Wire connections without splicing.

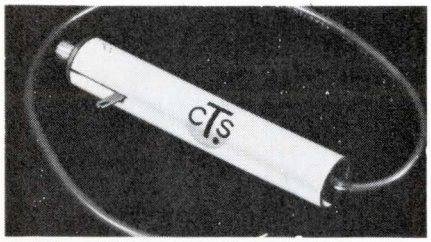


New Jiffy Junction is made of lightweight, specially formulated rubber that hugs the wire. One crimping tool and a simple plastic insert-removal tool are all that you need to quickly make permanent environmental wire unions that won't pull apart. The Deutsch Co. Electronic Components Div., Municipal Airport, Banning, Calif. 92220.

Circle 275 on Inquiry Card

SPIRAL RESISTOR

High resistance, high voltage.



The 680 series Cermide™ resistor is for operating voltages up to 30,000 V with loads as high as 3½ W. It is for bleeder resistor, voltage divider networks and other high voltage applications. Resistance ranges are 20 KΩ through 1000 MΩ. CTS Corp., Elkhart, Ind. 46514. (219) 293-7511. Booths 3B48-49.

Circle 276 on Inquiry Card

EE LITERATURE

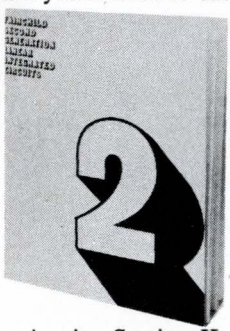
PC connections

This 20-page catalog gives suggestions for solving printed circuit connection problems. Various methods for PC connections are described. Also included are schematics and application ideas. Molex Products Co., 5224 Katrine Ave., Downers Grove, Ill. 60515.

Circle 321 on Inquiry Card

Linear integrated circuits

Users of linear ICs will want to obtain this 28-page brochure, which describes Fairchild's second generation devices. The publication is organized into three parts. Section I covers seven off-the-shelf linear ICs, providing the data you'd need to incorporate



them into circuits. Section II discusses their applications, and Section III outlines electrical characteristics and parameters that will appear in tomorrow's standard products. A page of ordering information is included. Fairchild Semiconductor, Distribution Services, Box 1058, Mountain View, Calif. 94040.

Circle 322 on Inquiry Card

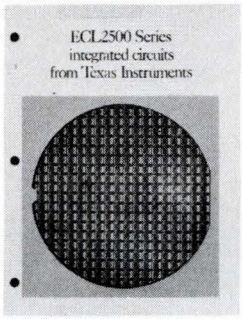
Phototransistors

Application Note AN-440 (12 pages) discusses both the theory and the characteristics of phototransistors. It briefly presents the history of the photoelectric effect, and then analyzes the effect in bulk semiconductors, pn junctions, and phototransistors. Typical characteristics of the phototransistor are also detailed. A useful appendix describes the relationship of irradiation and illumination and a second appendix defines optoelectronic terms. Technical Information Center, Motorola Semiconductor Products, Inc., Box 20924, Phoenix, Ariz. 85008.

Circle 323 on Inquiry Card

ECL integrated circuits

This 30-page brochure contains design information on the ECL2500 Series integrated circuits. It describes



the logic configurations and typical characteristics of the series, which includes 29 ultra-high-speed (2-3 ns) device types. Texas Instruments Incorporated, Box 5012, Dallas, Tex. 75222.

Circle 324 on Inquiry Card

Logic cards

A 64-page catalog provides technical information on a line of 34 T^2L logic cards. Specifications, schematics, and a price list are included. Applications assistance and systems design service are also discussed. Wyle Labs., Systems Div., 128 Maryland St., El Segundo, Calif. 90245.

Circle 325 on Inquiry Card

Microwave energy

A 36-page bibliography lists works dealing with industrial applications of microwave energy. Literature on such subjects as microwave heating theory, effects of microwave radiation, loss factors and dielectric constants, and industrial processing is included. Varian, Industrial Microwave Operation, 301 Industrial Way, San Carlos, Calif. 94070.

Circle 326 on Inquiry Card

Pulse instrumentation

This 1968-69 condensed catalog covers a line of pulse generators and data generators. The 4-pager includes product descriptions and photos, as well as a handy spec table. Also included is a 4-page facilities and capabilities insert. Datapulse Inc., 10150 W. Jefferson Blvd., Culver City, Calif. 90230.

Circle 327 on Inquiry Card

Switching solutions

Switching related to computers, communications, instrumentation, and automatic testing is the subject of a 40-page "Problem Solutions Manual." Emphasis is on scanning, crosspoint switching, and interfacing. A T-Bar® switch/relay selection guide, product data sheets, and typical applications are other features of the handbook. Electronic Controls, Inc., Dept. HB, 141 Danbury Rd., Wilton, Conn. 06897.

Circle 328 on Inquiry Card

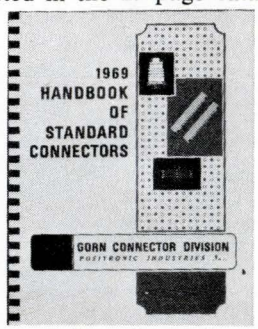
Reference junctions

The principles and applications of thermocouple reference junctions are covered in a comprehensive bulletin. Described are the principles of operation of various types of reference junctions, from ice baths to electrical compensators. Their application in thermocouple temperature measurment circuits is also reviewed. Schematics show the basic thermocouple circuit and the various types of electrical reference junction compensators. Consolidated Ohmic Devices, Inc., 115 Old Country Rd., Carle Pl., N.Y. 11514.

Circle 329 on Inquiry Card

Connectors handbook

Featured in this 1969 handbook is a line of removable contact connectors which conform to MIL-C-22857. Also listed in the 29-page catalog are

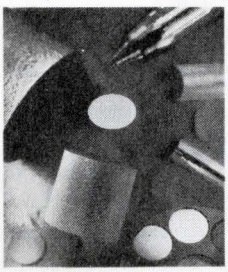


miniature rack and panel connectors which conform to MIL-C-8384, edge board PC connectors, and printed wiring test point connectors. A handy decimal equivalent chart is included. Positronic Industries Inc., Gorn Connector Div., Box 3338, Springfield, Mo. 65804.

Circle 330 on Inquiry Card

Semiconductor silicon

A 32-page brochure (10-040) covers hyper-pure silicon crystal and other semiconductor materials. Main product sections cover polycrystalline silicon, single crystal silicon, and epitaxial materials. The manufacturing process for these products is described and illustrated. Dow Corning Corp., Electronic Products Div., Hemlock, Mich., 48626.



In production... *today*

Circle 331 on Inquiry Card

Flat flexible cable

This design guide for flat conductor flexible cable will help you select a cable suitable for your specific requirements. Topics in the 8-page reference include cable description and selection, applications, insulations and conductors, continuous and etched specifications, and so forth. Hughes Aircraft Co., Box 90515, Los Angeles, Calif. 90009.

Circle 332 on Inquiry Card

DTL IC tester

The Model 714, a go-no-go tester for DTL integrated circuits, is the subject of a 4-page brochure. This unit is capable of testing 930 Series modules at a rate of 3600 per 8-hour day and sells for under $900. It performs a variety of dynamic, functional tests. E&L Instruments, Inc., 61 First St., Derby, Conn. 06418.

Circle 333 on Inquiry Card

EE LITERATURE

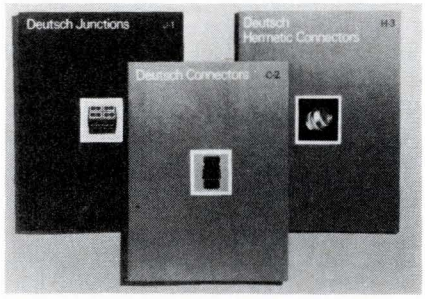
Microcircuits manual

"Designing Hybrid Microcircuits" is the title of a 12-page guide which describes the essentials involved in developing a custom hybrid microcircuit. Circuit design philosophy, component compatibility, circuit characterization and test methods, packaging, and reliability are discussed. The manual also shows typical circuits and packaging configurations. Circuit Technology, Inc., 160 Smith St., Farmingdale, N. Y. 11735.

Circle 334 on Inquiry Card

Connectors

Three separate catalogs itemize the manufacturer's lines of terminal junctions, miniature and subminiature connectors, and hermetic connectors. Each



booklet illustrates the product types, describes their advantages and, in chart form, provides data on application, sizes, and operating characteristics. The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif. 92220.

Circle 335 on Inquiry Card

Current probes

Current probes for commercial, military, laboratory, and related applications are discussed in an 8-page brochure. Major specs, an introductory discussion of the devices, and applications are included. Components/Genistron Div., Genisco Technology Corp., 18435 Susana Rd., Compton, Calif. 90221.

Circle 336 on Inquiry Card

Cabinets catalog

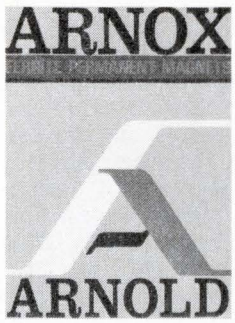
Covered in a 28-page brochure is the Series 40 Modu-Mount modular cabinets. These are designed for rack-mounting electronic, radar, and other sensitive equipment. Four basic types of frames are discussed: straight front, slope front, wedge, and sloping wedge. Honeywell, Apparatus Controls Div., 2727 S. Fourth Ave., Minneapolis, Minn. 55408.

Circle 337 on Inquiry Card

EE LITERATURE

Permanent magnets manual

Using several graphs, an 18-page catalog describes the company's line of ferrite permanent magnets. Typical



applications, advantages, and properties of the magnets are included, as is a glossary of magnetic terms. Arnold Engineering Co., Marengo, Ill. 60152.

Circle 338 on Inquiry Card

Precision pots

A selection of single and multi-turn wirewound potentiometers in servo and bush mounting styles are covered in a nonlinear function data sheet (4 pages). Standard functions, resistance ranges, and conformity tolerances are listed in chart form. Bourns, Inc., Trimpot Products Div., 1200 Columbia Ave., Riverside, Calif. 92507.

Circle 339 on Inquiry Card

Transistor tester

An automatic transistor test instrument, the T217, is a high speed, go-no-go device. As described in a 12-page bulletin, it is for testing and classifying semiconductors on the production line or at incoming inspection. The instrument is also capable of performing measurements on diodes and FETs. Teradyne, Inc., 183 Essex St., Boston, Mass. 02111.

Circle 340 on Inquiry Card

Detectors and lasers

A product file folder contains data on the company's infrared detectors and semiconductor lasers. Discussed are both coherent and incoherent gallium arsenide emitters, indium arsenide lasers, photoconductive infrared detectors, detector preamplifiers, and gas-shielded dewars. Raytheon Company, Laser Advanced Development Center, Foundry Ave., Waltham, Mass. 02154.

Circle 341 on Inquiry Card

Testing facilities

Facilities for qualification testing are covered in a 28-page brochure. Described in detail are the pyrotechnic, electronic component, environmental, power systems, engine generator, and vehicular laboratories. General Testing Laboratories, Inc., 5252 Port Royal Rd., Springfield, Va. 22151.

Circle 342 on Inquiry Card

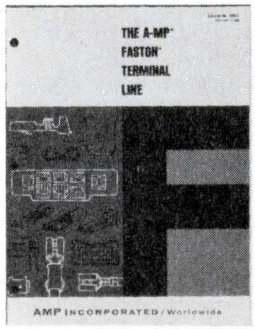
Power supplies

A 56-page catalog covers instruments and systems for laboratory, test equipment, and OEM applications. Given are specs, prices, and ordering information for over 300 models of power supplies, including a new line of integrated circuit power supplies and power systems. A handy selection guide and applications data are also provided. Lambda Electronics Corp., 515 Broad Hollow Rd., Melville, N.Y. 11746.

Circle 343 on Inquiry Card

Terminals

A 32-page reference provides data on the Faston™ terminal line. Catalog 308-5 covers straight and right angle receptacles, tabs, insulating sleeves,



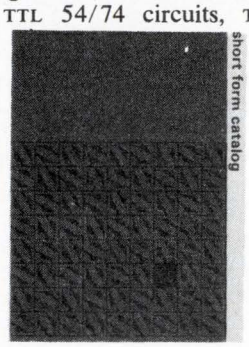
quick disconnect splices, multi-position connectors, and special purpose items. Descriptions, electrical and mechanical specs, and dimensions are given. AMP, Incorporated, Harrisburg, Pa. 17105.

Circle 344 on Inquiry Card

EE LITERATURE

Integrated circuits

A 24-page short form catalog contains data on the company's IC products—linear, MOS, and digital. Among the products listed are op amps, voltage regulators, communication circuits, TTL 54/74 circuits, TTL MSI



types, MOS memories, analog switches, and logic elements. Applications information and specification guides are included for each. National Semiconductor Corp., Marketing Services Dept., 2950 San Ysidro Way, Santa Clara, Calif. 95051.

Circle 345 on Inquiry Card

Power supplies supplement

A 16-page supplement to Catalog B-678 covers IC regulated power supplies. Details are given for voltage regulators, current regulators, operational power amplifiers, computer power supplies, and precision voltage standards. Kepco, Inc., 131-38 Sanford Ave., Flushing, N.Y. 11352.

Circle 346 on Inquiry Card

Magnetic memory element

Engineering Bulletin MP-10 describes a new plated wire magnetic memory element. The 2-page data sheet gives specs, design hints, and a table of test pulse amplitudes and driving currents for two plated wire grades. Indiana General Corp., Sales Dept., Electronics Div./Memory Products, Crows Mill Rd., Keasbey, N. J. 08832.

Circle 347 on Inquiry Card

Careers catalog

A 384-page manual lists and describes a variety of engineering and industrial correspondence courses. Although the courses aren't intended for graduate engineers, the catalog will be a great help to engineering supervisors who must design training programs. International Correspondence Schools, Scranton, Pa. 18515.

Circle 348 on Inquiry Card

Product directory

A 48-page reference lists the company's products and sales offices. It also features purchasing information and technical data. The latter includes a conversion factors table; a list of mathematical constants; a bare copper wire table; a list of decibels and power, voltage, and current ratios; a table on the international system of units adopted by NBS; and other helpful data. Beckman Instruments, Inc., Electronic Instruments Div., Technical Information Sect., 2200 Wright Ave., Richmond, Calif. 94804

Circle 349 on Inquiry Card

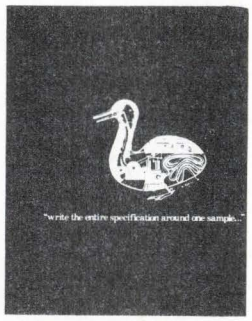
Network analyzers

"Low-Frequency Network Analysis with the 675A/676A," a 13-page application note, discusses the basic measurements that can be made with these instruments. It describes how HP's Model 675A sweeping signal generator and Model 676A phase/amplitude tracking detector work together to measure the gain/attenuation and phase response characteristics of networks. Also shown is how these techniques are applied to the measurement of gain, insertion loss, envelope delay, and common-mode on a swept-frequency basis. Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304.

Circle 350 on Inquiry Card

Relays

"Break the Cliché Habit" is the title of a 10-page booklet that provides relay application hints and an insight to improved relay specifications.

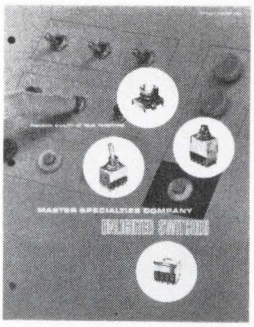


Such factors as sensitivity, contact configurations and ratings, environmental conditions, and mounting methods are considered. Photographs and drawings humorously illustrate the clichés that restrict the proper use of relays. Ohmite Mfg. Co., 3601 Howard St., Skokie, Ill. 60076.

Circle 351 on Inquiry Card

Precision switches

Catalog No. 2023 covers a range of unlighted switches for aerospace, aviation, military, industrial, and commercial equipment. The 8-page bulletin includes electrical and mechanical characteristics, dimensions, and ordering information. Master Specialties Co., 1640 Monrovia, Costa Mesa, Calif. 92627.



Circle 352 on Inquiry Card

Pulse transformers

Type 55Z DST pulse transformers, a series of low-power wideband devices, are for use in digital circuits, radar equipment, electrical calculators, and computers. An 11-page bulletin (No. 40351) gives design information so that users can optimize circuit performance by giving exact specifications of transformers to meet their individual circuit needs. Sprague Electric Co., Marshall St., North Adams, Mass. 01247.

Circle 353 on Inquiry Card

Coppermetals index

The 12th edition of the "Coppermetals Specifications Index" is divided into three sections. One lists the company's most generally used alloys and products, together with applicable specs. Another section of the 32-page index lists specs in numerical order. A third lists the alloys in numerical order and includes their nominal chemical compositions. Anaconda American Brass Co., Box 830, Waterbury, Conn. 06720.

Circle 354 on Inquiry Card

Heat shrinkable materials

A 12-page brochure covers Scotch-Tite® heat shrinkable insulation systems. Products include tape, tubing, and film. Especially useful is a 4-page table of specs for these products. 3M Co., Dielectric Materials & Systems Div., 3M Center, St. Paul, Minn.

Circle 355 on Inquiry Card

Computer programming

If you need an introduction to programming, you will want to obtain this 425-book. It contains a complete course on programming digital computers, particularly the PDP-8 family. Digital Equipment Corp., Dept. P, 146 Main St., Maynard, Mass. 01754.

Circle 356 on Inquiry Card

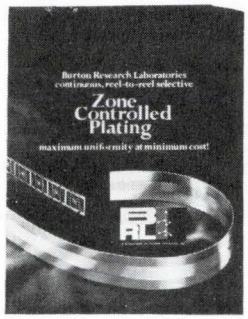
Plastic fasteners

Engineering data on a range of plastic fasteners — including screws, nuts, washers, screw insulators, and rivets—is given in a 12-page catalog. Also described are plastic-headed metal machine and self-tapping screws. Details on individual fastener types, and on engineering properties of nylon and other thermoplastics used by the manufacturer, are supplied in Catalog No. 2031. Gries Reproducer Co., Div. of Coats & Clark, Inc., 400 Beechwood Ave., New Rochelle, N.Y. 10802.

Circle 357 on Inquiry Card

Plating process

A specialized plating process—called "Zone Controlled Plating"—is the subject of a 6-page brochure.



Principles and advantages of the technique, as well as case histories, are detailed. Burton Research Labs., 11240 Playa Ct., Culver City, Calif. 90230.

Circle 358 on Inquiry Card

Digital systems

"Digital Systems Come of Age" is the title of the prime article in this 15-page issue of "Service Scope." It describes a family of digital system components that meets IC testing needs in manual, semi-automatic, and fully-automated measurement systems. Another article, titled "Verifying Oscilloscope Performance," discusses the factors which contribute to measurement accuracy. There is also a Service Notes section. Tektronix, Inc., Box 500, Beaverton, Ore. 97005.

Circle 359 on Inquiry Card

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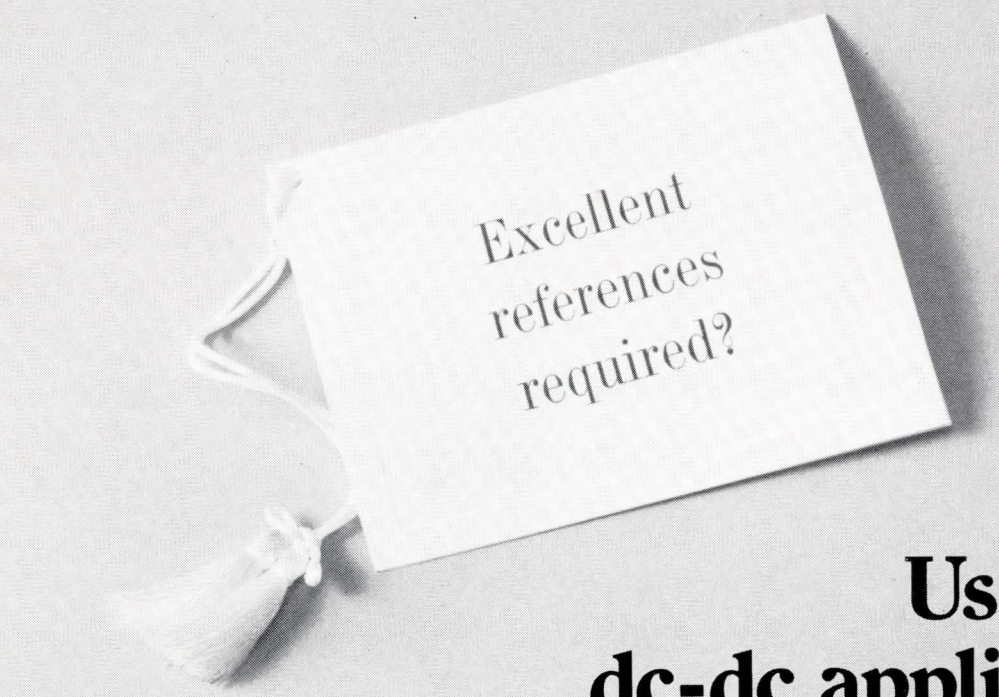

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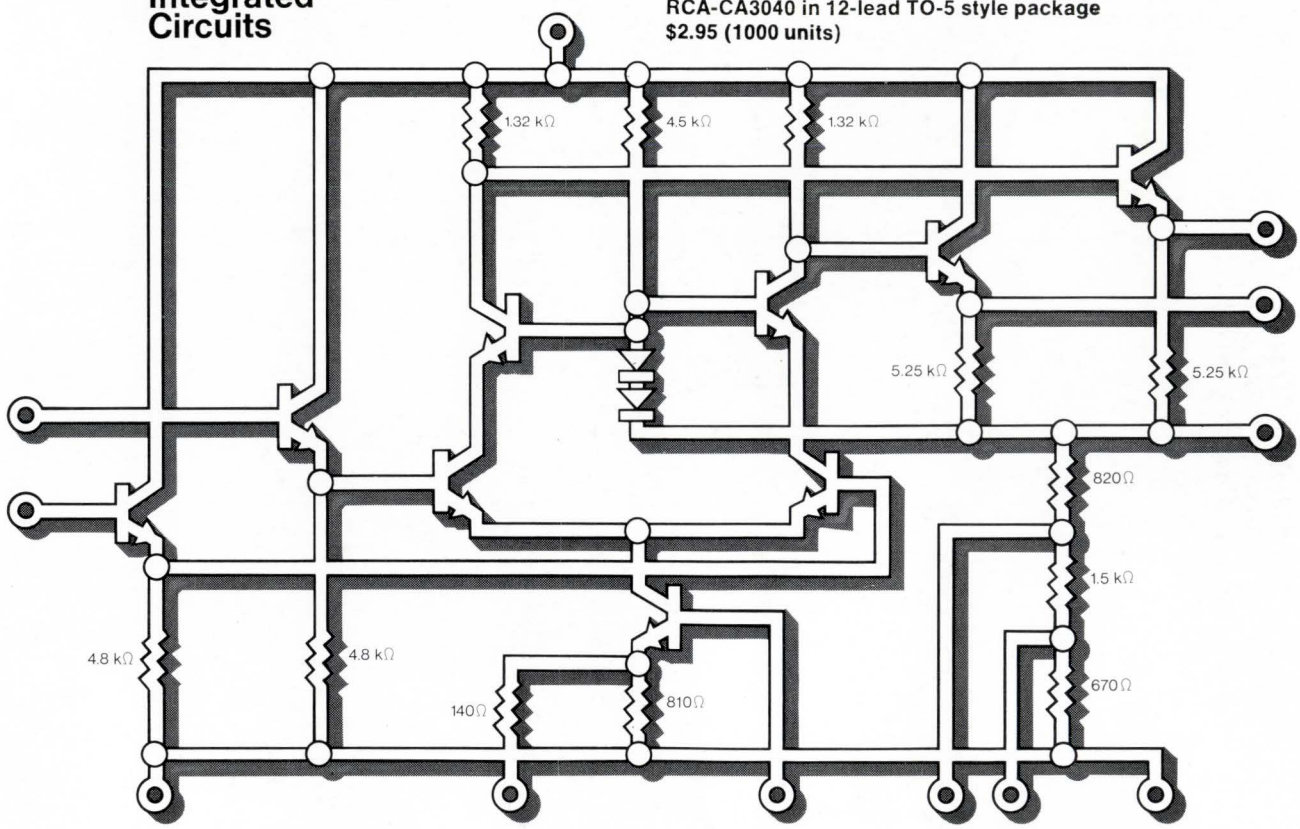

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