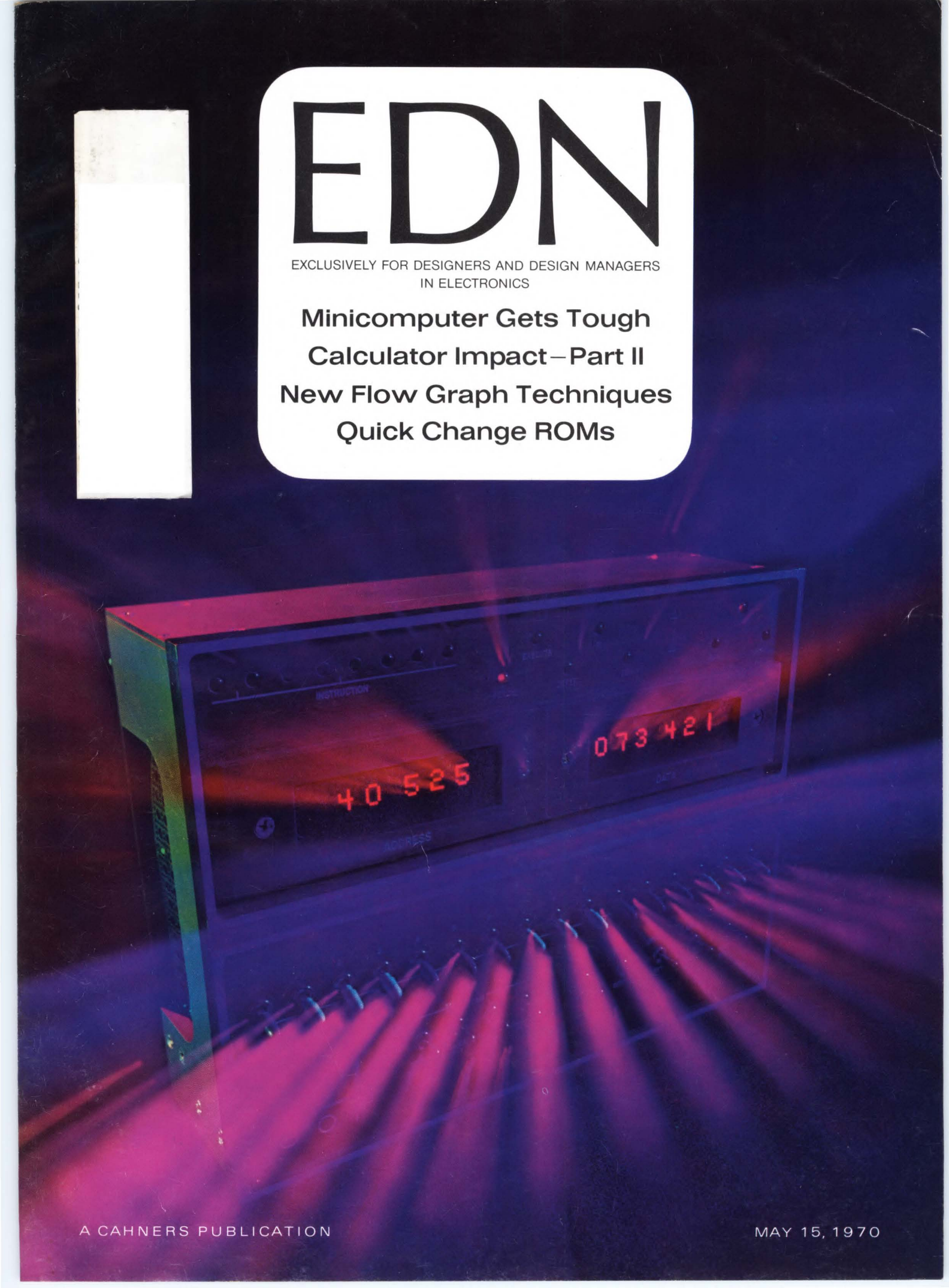
EDN

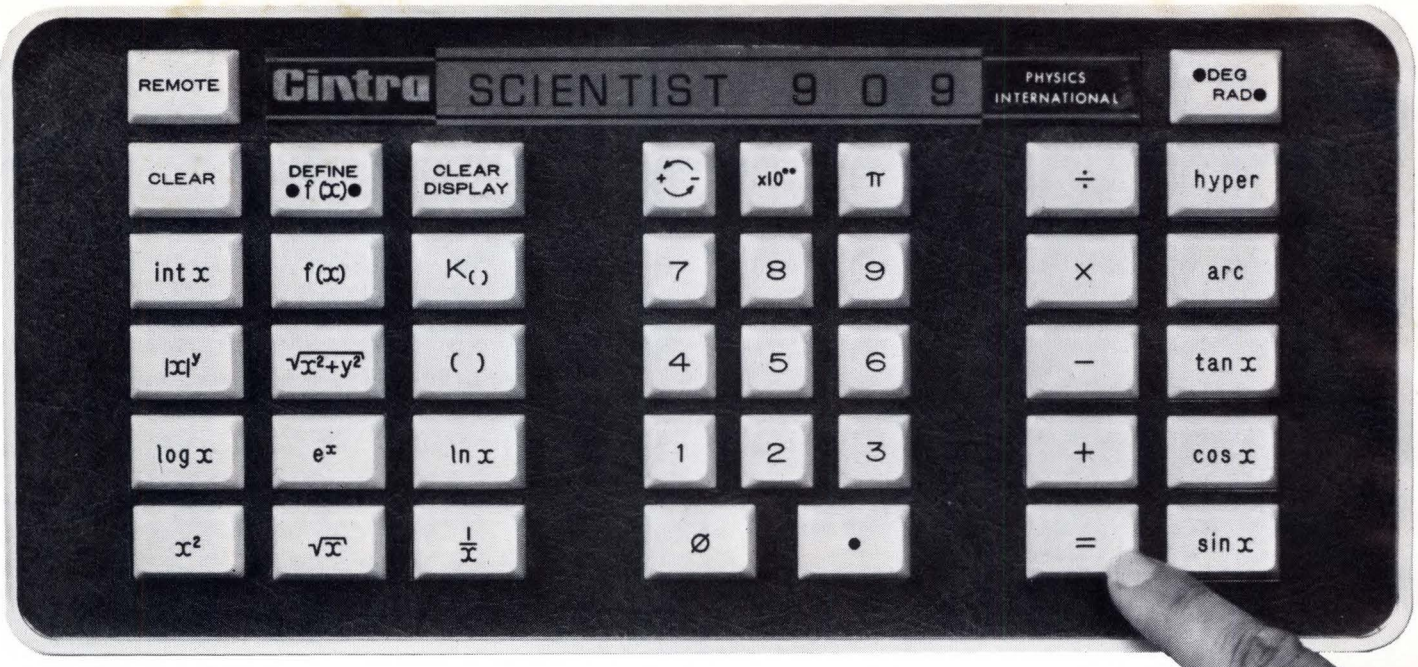
EXCLUSIVELY FOR DESIGNERS AND DESIGN MANAGERS IN ELECTRONICS

Minicomputer Gets Tough
Calculator Impact—Part II
New Flow Graph Techniques
Quick Change ROMs



A CAHNERS PUBLICATION

MAY 15, 1970



Talk to me, Cintra Scientist.

What should I ask you?

Ask a lot. Ask, for example, the solution to $(A + B \times C)^{(D+E\times F)} =$, where A, B, C, D, E and F can be data or any combination of keyboard functions such as sin X, log X, e^X, etc. Just key it in exactly as written and you'll have the answer by the time your finger is off the equals key. The Scientist's dynamic range is 200 decades with 10 significant figure accuracy.

Try it yourself. Take an everyday slide rule operation such as $286.4 \times 10^{20} \div .004612 \times 10^{12} =$. The answer is immediate! Your entered data can be in scientific notation, floating point or combinations of both. The Scientist will keep track of decimal points and exponents for you. All keys are hardwired, and note how logically they're arranged. Power? **Ultra-power** is more like it.

Stored constants? You get 26 with the basic model, up to 122 optional.

No machine language to learn! The Cintra Scientist talks your language. Press the keys and find out for yourself in just five minutes.

Behind the keyboard? Hermetically-sealed MOS/LSI and integrated circuitry assures reliable, trouble-free performance.

Can you operate as a computer, too? Certainly. With the Cintra Model 927 Programmer, up to 25,600 consecutive steps can be performed automatically in addition to loops, branches and subroutines. Furthermore, the modular design allows expansion into a mini-computer with peripherals such as the Cintra 941 Printer, plotters, and A to D converters for on-line/off-line applications.

Just $3,780 puts the power of the Cintra Scientist at your fingertips. Now ask yourself a question. Shouldn't I find out more about the Cintra Scientist?

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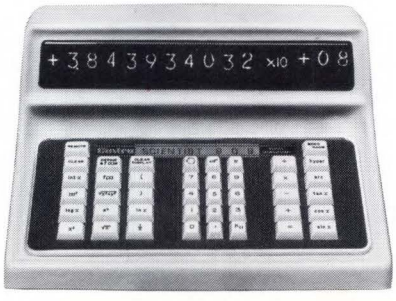
xlo^●● An **order of magnitude** more versatile. Enter floating point and scientific notation data, or any combination interchangeably.

= **Equate the value.** Press the key and immediately see the result of a long complicated expression.

( ) **In a bracket by itself,** this key allows any other key to operate on a group of terms.



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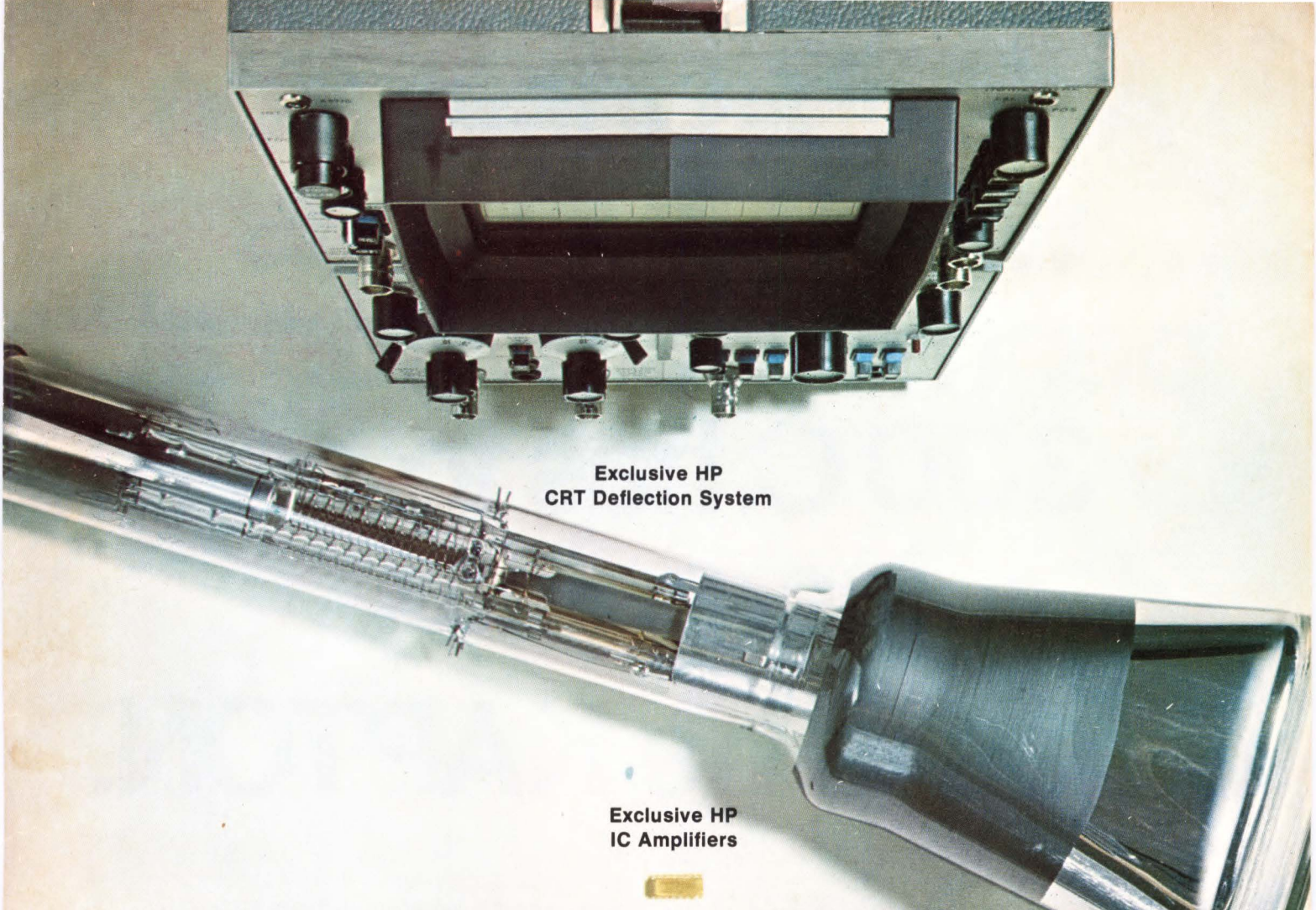
CIRCLE NO. 17



Exclusive HP CRT Deflection System

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Two key reasons why the HP 183 is the fastest real-time scope, 250 MHz ...today's performance champ!

080/7

Here is today's undisputed leader in scope performance: DC to 250 MHz bandwidth, 10 mV sensitivity, less than 1.5 ns risetime, 4 cm/ns writing speed and 11 compatible plug-ins.

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Use of micro-circuitry also has reduced the number of high frequency calibration adjustments—to only two for the vertical amplifier, instead of typically up to 30 or 40.

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EDN is edited exclusively for designers of electronic products, equipment and systems. EDN presents news, methods, ideas and products only as they relate to the present and future job responsibilities of designers and design managers.

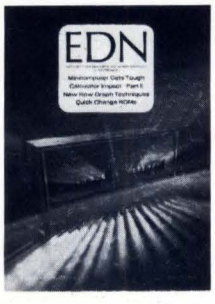
EDN DESIGN ACTIVITY FILING SYSTEM

This system uses three words to categorize all feature editorial. It is unique in that it is based on design "activity" rather than on "things" designed. The system consists of these words:

DESIGN ACTIVITY	"OF" or "WITH"	MODIFIER	FREQUENCY
DESIGN	MATERIALS	PASSIVE	(where applicable)
TEST	COMPONENTS	ACTIVE	
PACKAGE	CIRCUITS	LINEAR	
ANALYZE	FUNCTIONS	DIGITAL	
SURVEY	SYSTEMS	COMMUNICATION	LOG_{10} f (Hertz)
COMPARE		SERVO	
		RELIABILITY	
		HARDWARE	

TEST/SYSTEMS/COMM 8, for example, is the designation for filing an article under the Communications Systems Testing at 10^8 Hertz.

This system is compatible with most "personal" filing methods. Very few designers need to use all classifications, when their own individual requirements are overlaid on the system. In many cases two or even one level of classification is sufficient.



Front cover photo created by Ron Sloan depicts Rolm Corp. rugged minicomputer. Designing a minicomputer that can virtually go anywhere and operate in harsh field environments demands innovative packaging. See article, "Minicomputer Gets Tough!", on p. 58 for details.

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ABP CP MCB BPA

ibpa International Business Press Associates

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Design Features

Programmable Calculators – The Engineer's Personalized Computer (Part II) . . . . . Compare/Systems/Digital 35

What happens when a dedicated engineer is teamed up with a programmable calculator? Five engineers provided with a calculator for a month tell in detail actual design problems that they solved with these machines.

Streamline Flow Graphs for Active Circuits . . . . . Analyze/Circuits/Active 47

Overcrowded flow graphs easily invite error. To maximize a flow graph's efficiency as an analysis tool, it should carry only essential information. Judicious parameter selection and superposition are keys to streamlined flow graphs.

Design Ideas

Shunt Regulator Has Optimized Gain . . . . . Design/Circuits/Linear 53

Optimize transistor gain to get a low cost, small size IC power supply with this shunt-regulator circuit that finds wide application.

"U" Cores Speed ROM Quick-Change . . . . . Design/Systems/Digital 55

Among the many alterable ROM's, the braid transformer type is still the quickest and easiest to change. If you haven't tried it, read this and see how.

Minicomputer Gets Tough! . . . . . Package/Systems/Digital 58

Up to now, off-the-shelf minicomputers have led a pretty soft life within comfortable laboratory environments. Getting the mini out of the lab and into harsh field environments requires a rugged package design; here's how one firm designed package muscle into their minicomputer.

Synchronized Gating Kills ± One-Count Ambiguity . . . . . Design/Systems/Digital 61

Synchronization of internal gating and input pulses provides a counter with half the ambiguity usually expected. Instead of ± one count, the ambiguity is −1 count max.

Customer Engineering Clinic . . . . . Design/Systems/Linear 63

Addition of a zener diode prevents premature regulator shutdown in an op amp power supply designed with one dc-to-dc converter.

Design Predictions

Electronics and Astrology 32

EDN regional editor Tom Rigoli envisions that electronic technology may someday provide a scientific basis for astrology.

Design Interface

Data Base Profiles Sounding Board/70 65

Better than 2000 engineers replied with personal data for Sounding Board/70. Here are the profiles on age, income, longevity and group membership. Intense interest in their profession is the common denominator.

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If it's happening in connectors, it probably started at Hughes.

Editorial

Sounds from Sounding Board/70

In past issues of EDN, readers were invited to join "Sounding Board/70". This group was established to provide a meaningful base for reader opinion about the professional status of design engineers in electronics.

Our first questionnaire to Sounding Board/70 members has made its round trip through the mails and has been tabulated and interpreted in this issue's Interface article beginning on p. 65.

Perhaps more significant than the statistical tabulations themselves are the hundreds of write-in suggestions for topics pertinent to engineering careers. Many of these suggestions extended into opinions and several general trends are clear.

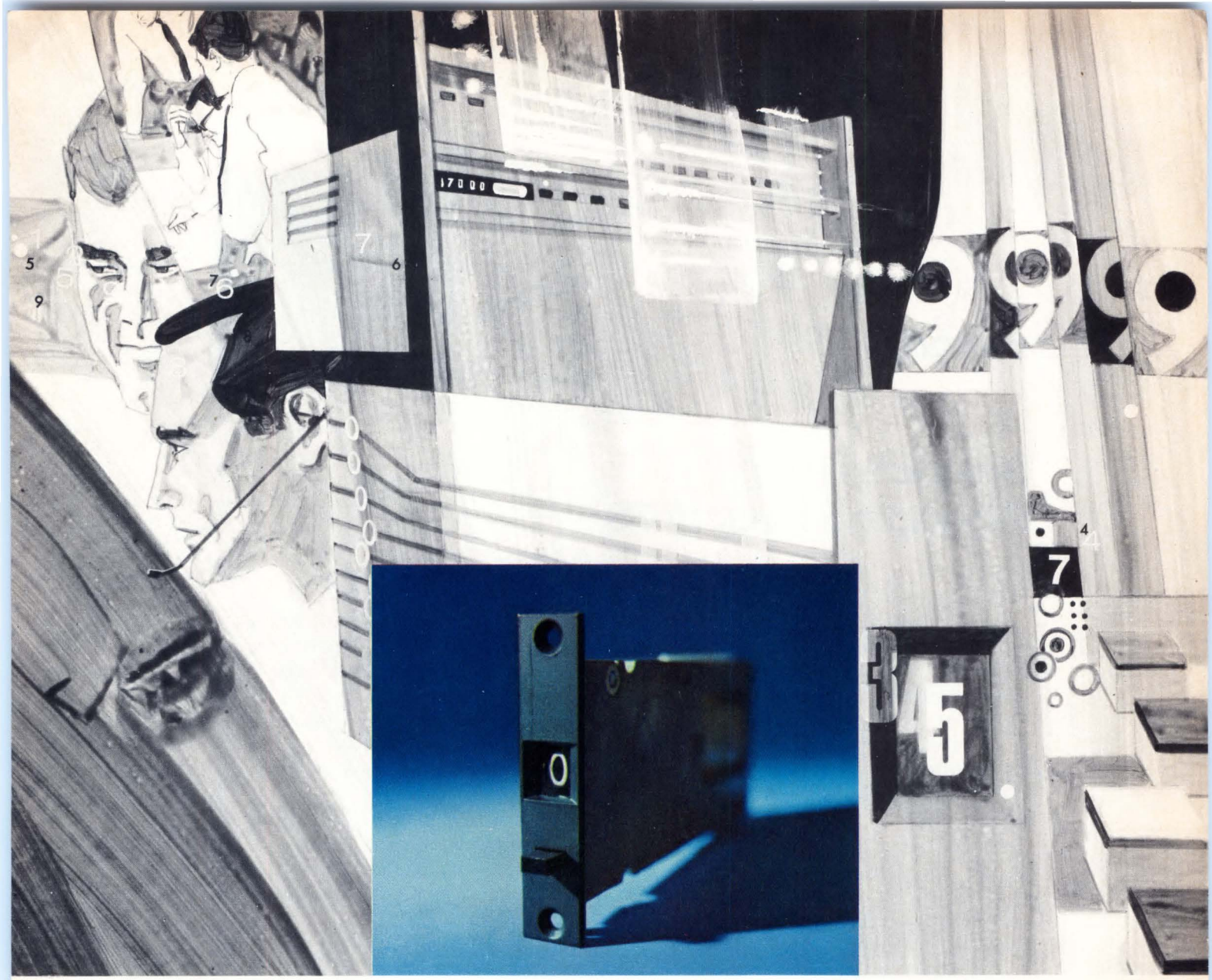
Two problems emerge as uppermost in the minds of Sounding Board members. First, they think that pension plans should be portable. Because engineers (particularly aerospace) must change jobs frequently, they take a beating in terms of pension fund investment. Second, they would like to find a way to maintain their position on the economic scale. With labor unions going after the largest wage and benefit package increases in history, engineers feel that labor is rapidly closing the gap and even may outdistance engineers before long.

Though aired repeatedly, a third problem—professionalism—displayed no unanimity of opinion. Rather, respondents were polarized, with many wanting to make engineers more "professional" and almost as many saying that the term "professionalism" is meaningless when applied to engineers working for a salary.

Finally, the term "union" is not popular. Most readers feel that some kind of an association is necessary to protect the engineer's economic interests but, please, don't call it a union.

Several topics pointed out by our first survey now are under study at EDN. We will be reporting on them in Interface articles as they are developed. Meanwhile, we'd like to thank you for your interest in Sounding Board/70. We'll be "telling it like it is", pointing out the pros and cons of many questions crucial to engineering careers in future issues of EDN. As a publication vitally concerned with the well-being of our entire industry, our position will be to faithfully reflect, and identify as such, both opinion and fact surrounding questions vital to you and your career.

Editor



the decade and its capability

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

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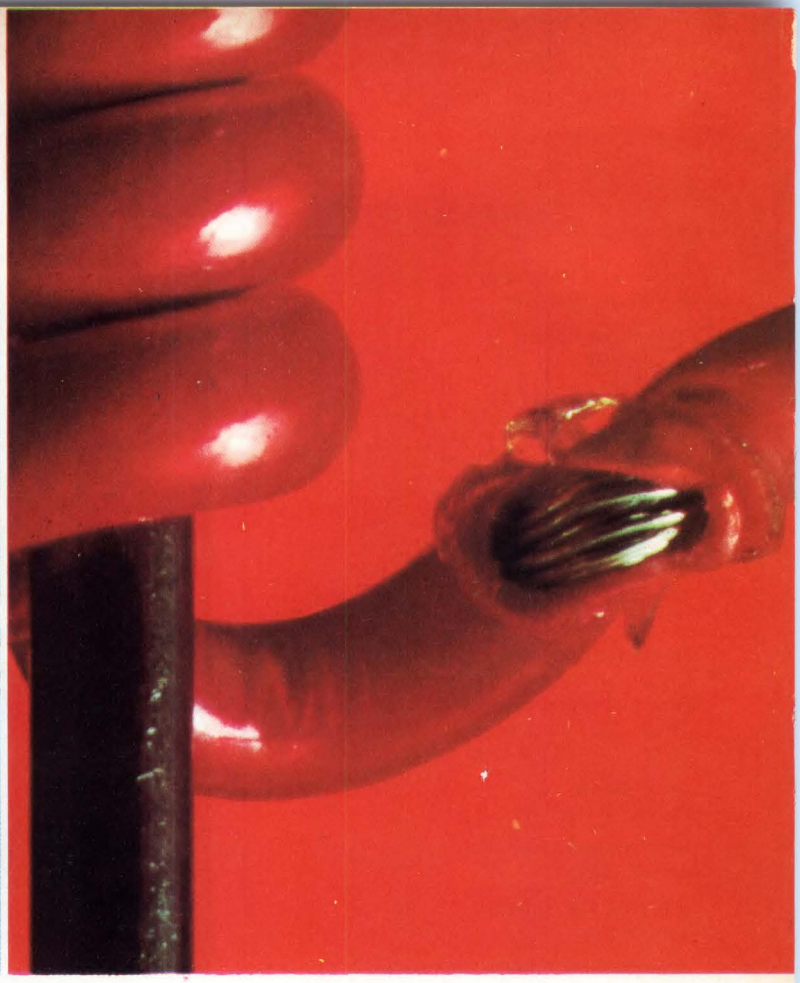
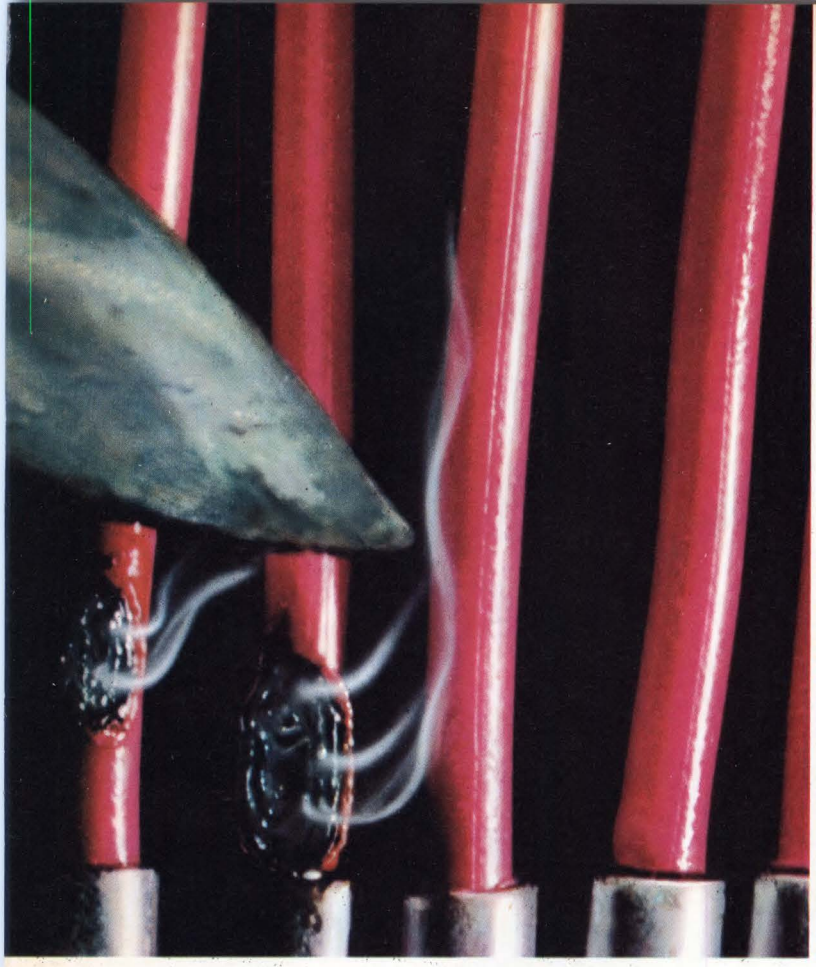
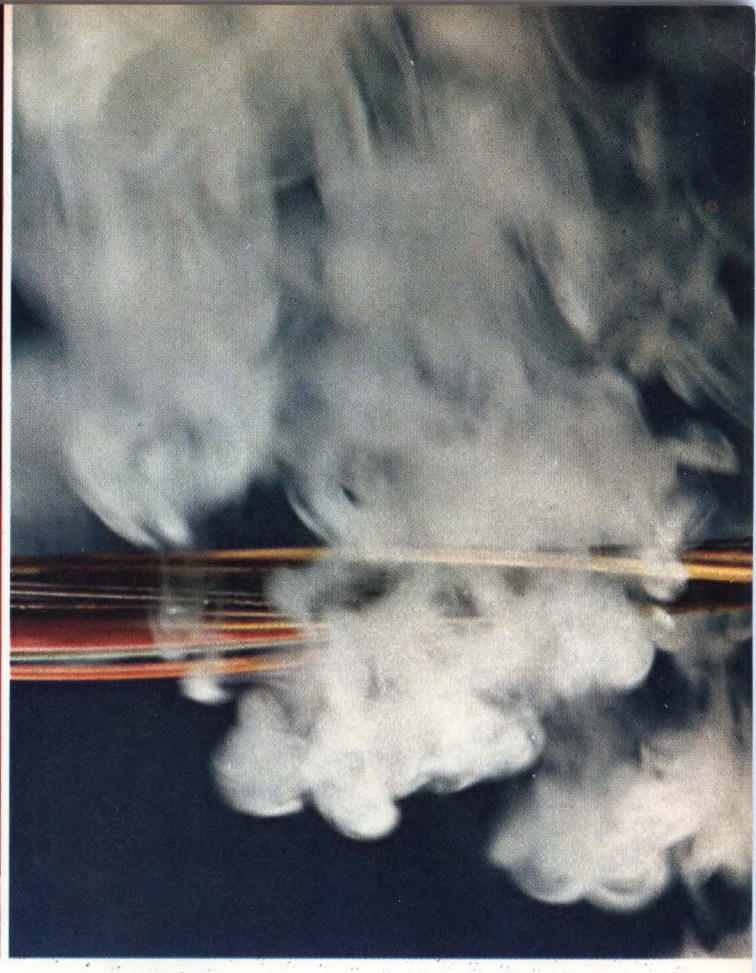


In a world where things





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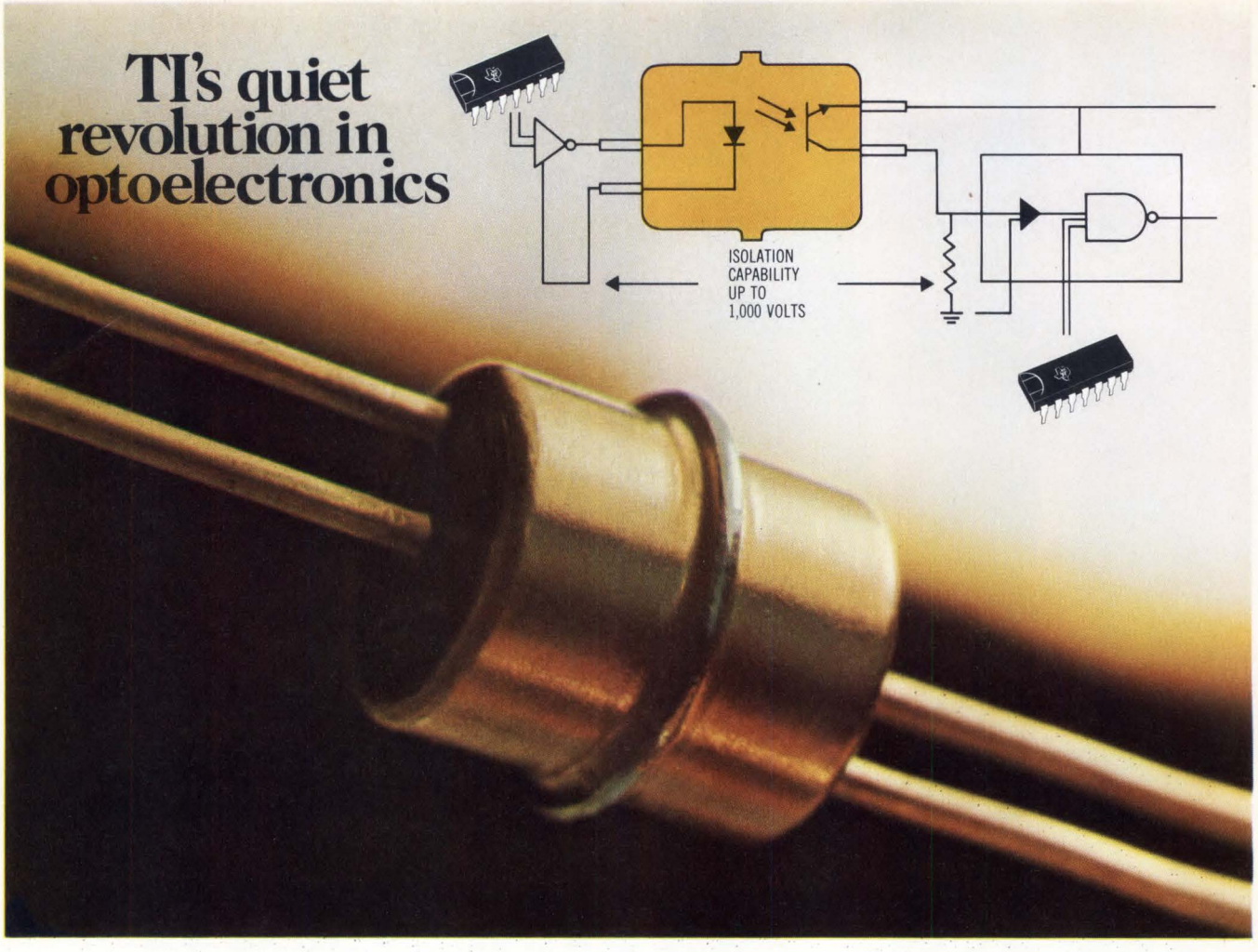

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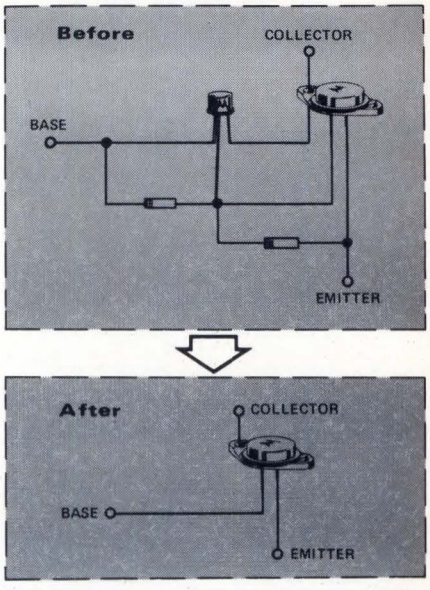
CIRCLE NO. 15

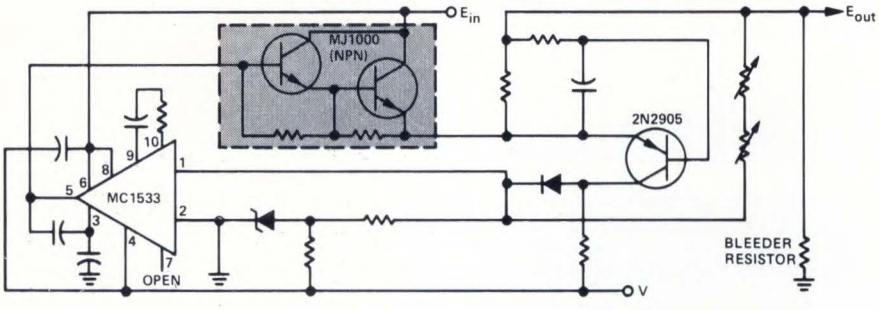
Compress Your Costs. Cut space and heat sinking needs, assembly time and components because the driver device is now on the same heat sink as the output unit. Reliability rises, too.

DARLINGTONS SIMPLIFY!



Up Op Amp Power. No separate, discrete driver transistor needed now — it's all there on one monolithic, EpiBase* power chip: driver transistor, output device and base-emitter resistors.

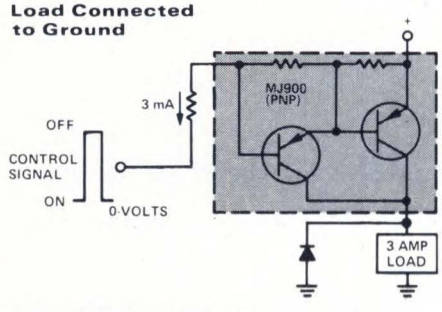
VOLTAGE REGULATOR



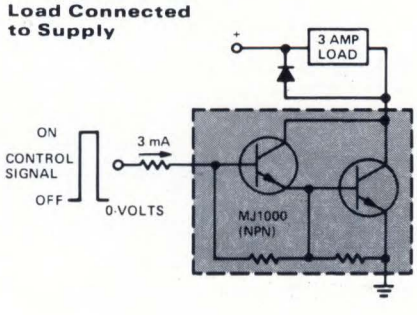
Power Darlingtons

DC STATIC SWITCHES

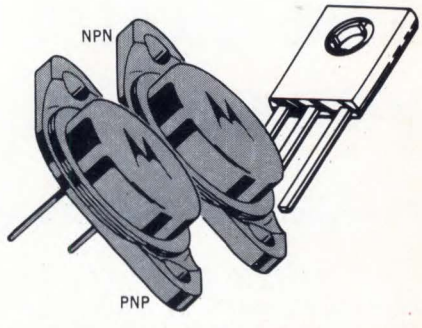
Load Connected to Ground



Load Connected to Supply



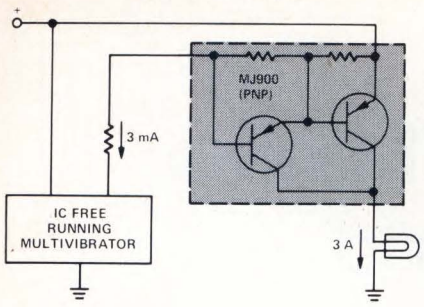
Put In Either Polarity. Positive or negative-based systems are possible with your choice of either PNP or NPN devices that can also be used as complements in audio amplifiers.



Perform With Package Variety. Besides the 5 A, TO-3 darlington, you'll soon have your choice of Thermopad plastic packages 77 and 90 — two sizes of case economy that will further reduce design costs.

– where the priceless ingredient is care!

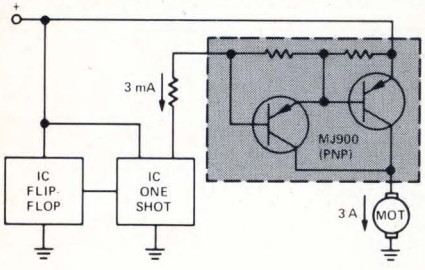
LAMP FLASHER



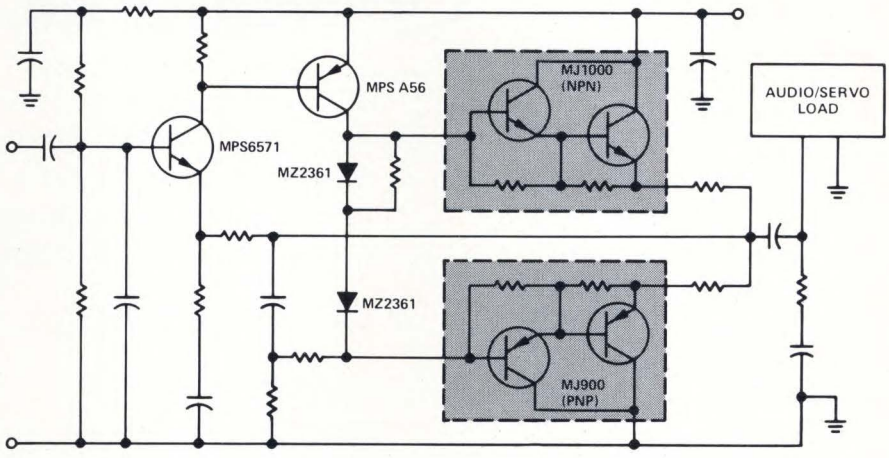
Obtain 1,000 dc gain. Yesterday, 25 minimum beta was great — today, Motorola power darlingtons give you a minimum of 1,000 . . . an unheard-of, commercial/industrial state-of-the-art first!

Innovate With I/C's. Drive the 3 A darlington with power levels derived from integrated circuit logic gates. Go from milliamperes to amperes directly, compatibly, easily.

DC MOTOR SPEED CONTROL



30-W AMPLIFIER USING COMPLEMENTARY SYMMETRY



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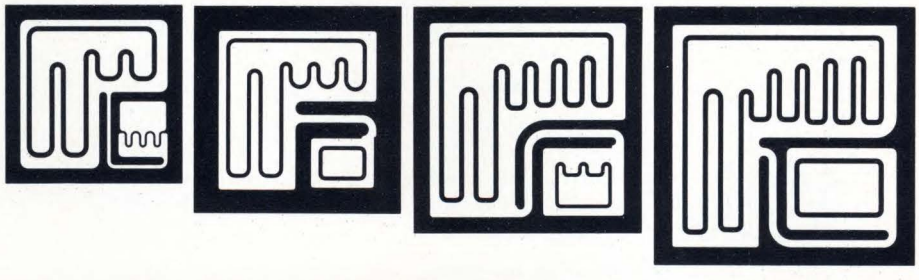

Power Darlington PNP	Power Darlington NPN	I_C A (Cont)	$V_{CEO(sus)}$ V	h_{FE} @ I_C (min)	P_D W	I_{CBO} @ V_{CB} mA	SOA	Price 100 Up PNP	Price 100 Up NPN
MJ900	MJ1000	5	60	1,000 @ 3A	90	0.2 @ 60V	3A @ 30V	$2.90	$2.50
MJ901	MJ1001		80					$3.30	$2.90

*Trademark Motorola Inc.

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MOTOROLA Silicon Power Transistors

CIRCLE NO. 16

Bell & Howell Makes The Best Hybrid Operational Amplifiers

All the physical features, parameters and characteristics that are vital to the packaging and performance of op amps in your circuitry are built into Bell & Howell hybrid op amps. Every model is engineered for optimal balance between performance, size and cost — and offer these major features:

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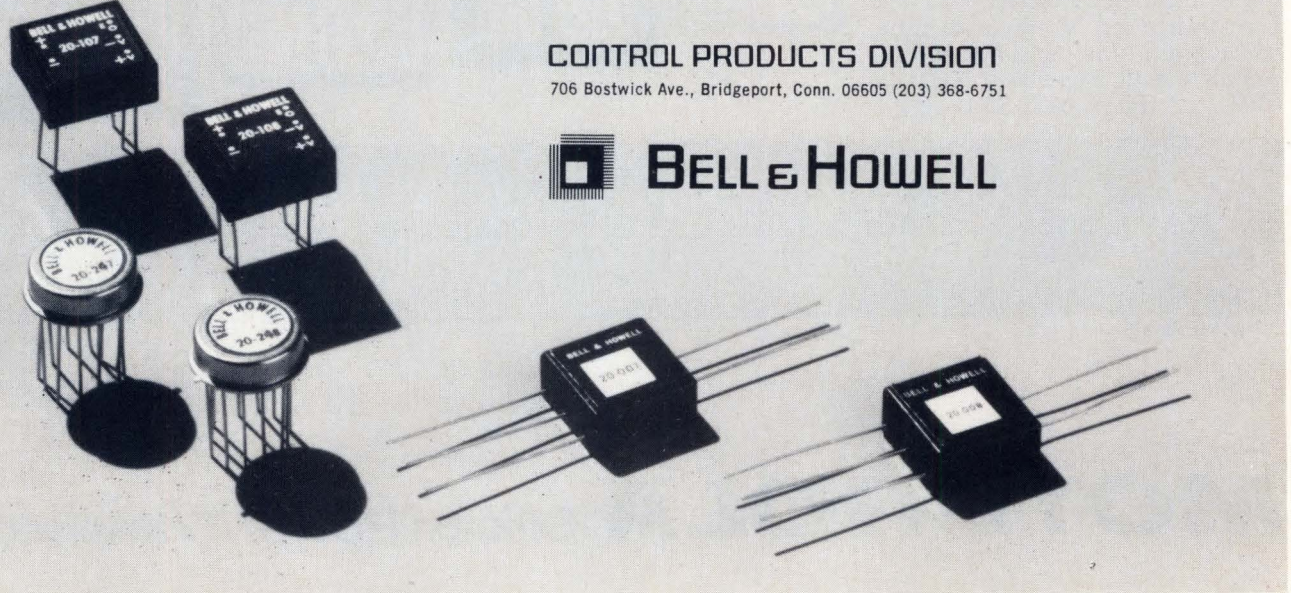
- Small, Compact Size (0.6" x 0.6" x 0.25") Epoxy & TO-8
- Hermetically & Plastic Packaged
- MIL & Commercial Temperature Range
- Input and Output Fully Protected
- Frequency Compensated
- Temperature Cycled for User Stability
- 100% Electrical Test Critical Parameters
- Test Documentation Available

SPECIFICATIONS:		MEDIUM GRADE PRODUCT					
		20-007	20-247	20-107	20-008	20-248	20-108
Voltage offset	max.	.2mv	.2mv	.2mv	1mv	1mv	1mv
Thermal rate	max.	5μv/°C	5μv/°C	5μv/°C	25μv/°C	25μv/°C	25μv/°C
Input bias current	max.	150na	100na	150na	5pa	5pa	5pa
Common mode rejection	typ.	100db	100db	100db	80db	80db	80db
Open Loop Gain (at 10 kHz)	min.	2,000v/v	2,000v/v	2,000v/v	1,500v/v	1,500v/v	1,500v/v
Output current	min.	±5ma	±5ma	±5ma	±5ma	±5ma	±5ma
Price (in quantities of 100)		$16.00	$24.00	$16.00	$29.00	$51.00	$29.00



CONTROL PRODUCTS DIVISION
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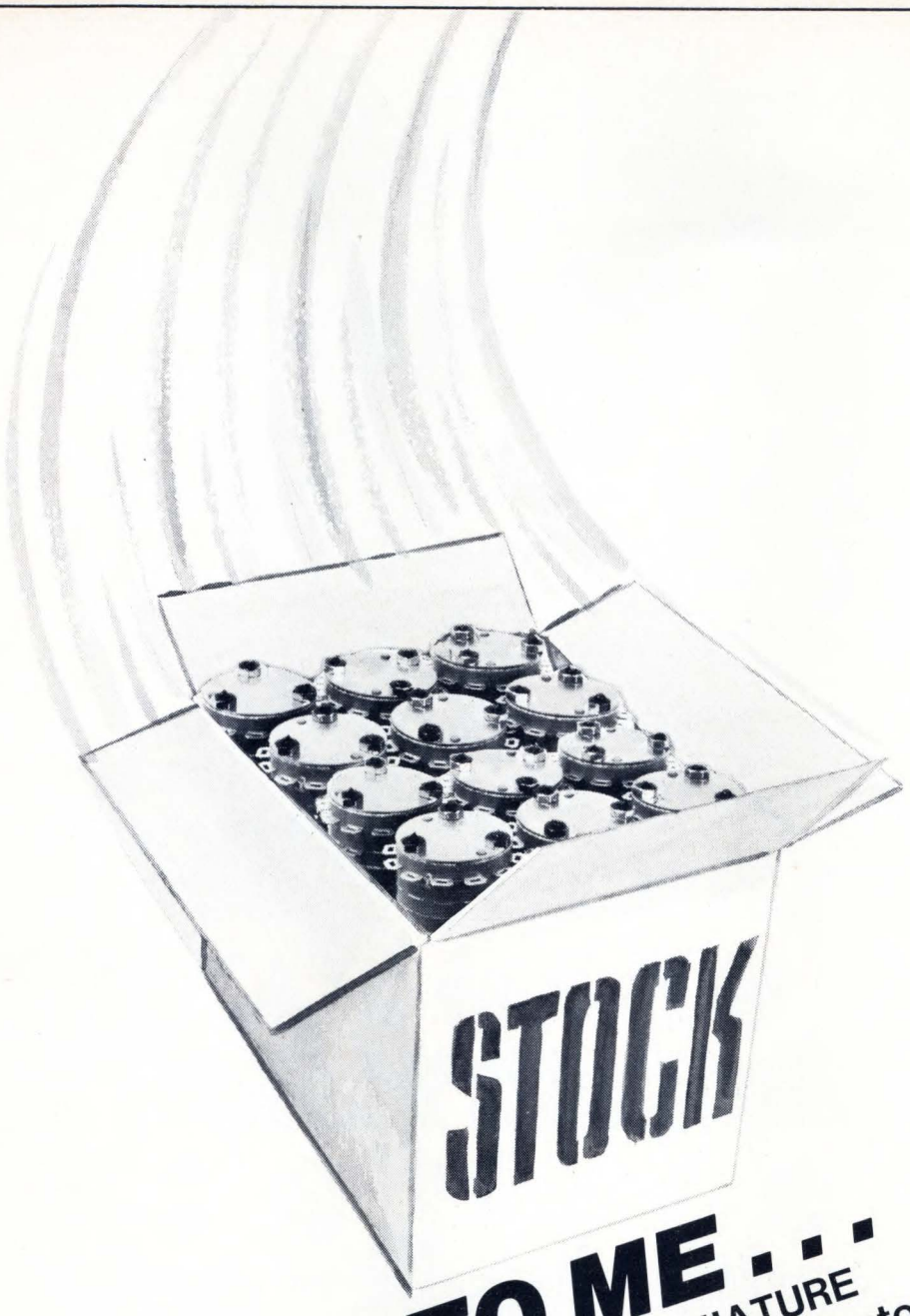
BELL & HOWELL

CIRCLE NO. 29



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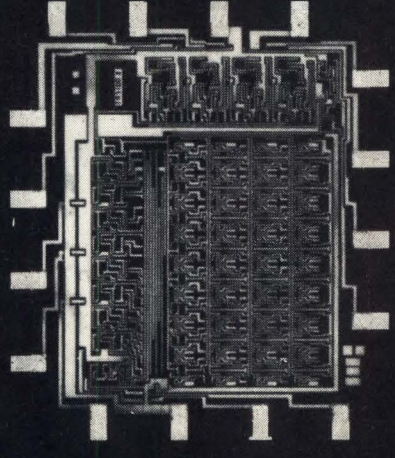
CIRCLE NO. 18

Who says you can't get beam lead?

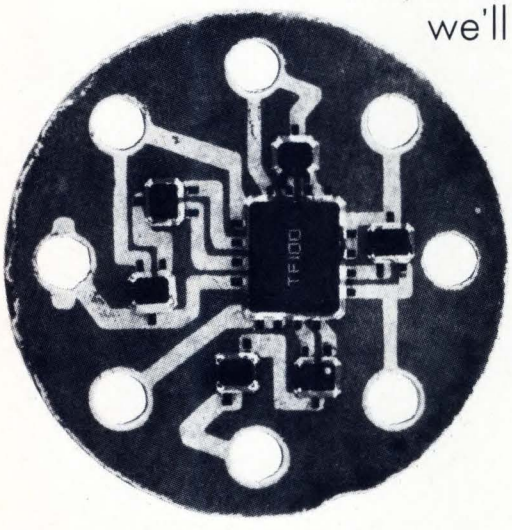
Raytheon beam lead devices
available now in chip form,
in standard or custom packages,
or in hybrid assemblies.



Help! We're up to our ears in beam lead semiconductor devices. All kinds. And more coming every day.

Hybrids, cans, dips or chips

Buy the chips. Take them in TO-18 cans or DIPs. Get them in custom packages. Or take advantage of our capability to design, assemble and completely test them in custom hybrid assemblies. Any way you need them, we'll sell them. Now. So don't just stand there. Send orders. To the company that gets the ideas and delivers the goods. Raytheon Semiconductor, 350 Ellis St. Mountain View, California 94040. Phone (415) 968-9211.



Raytheon custom beam lead hybrid assembly

Come and get them

Beam lead T²L RAY I & II series

RG130, 1, 2, 3: Dual 4 input line driver	Now
RG200, 1, 2, 3: Expandable single 8 NAND gate	Now
RG220, 1, 2, 3: Quad 2 input NAND gate	Now
RG230, 1, 2, 3: Quad 2 input AOI expander	Now
RG240, 1, 2, 3: Dual 4 input NAND gate	Now
RG250, 1, 2, 3: Expandable quad 2 AOI gate	Now
RG310, 1, 2, 3: Exp. dual output, dual 2 input AOI gate	Now
RG320, 1, 2, 3: Triple 3 input NAND gate	Now
RG380, 1, 2, 3: Hex inverter	Now
RF100, 1, 2, 3: Dual J-K flip-flop (separate clocks)	Now
RF110, 1, 2, 3: Dual J-K flip-flop (common clock)	Now
RF200, 1, 2, 3: J-K flip-flop (AND inputs)	Now
RF210, 1, 2, 3: J-K flip-flop (OR inputs)	Now
RF9601/8601: Retriggerable monostable multivibrator	Now
RL10, 1, 2, 3: Fast full adder	Now
RL20, 1, 2, 3: Dependent carry fast adder	Now
RL30, 1, 2, 3: Independent carry fast adder	Now
RL40, 1, 2, 3: Carry decoder	Now
RL60, 1, 2, 3: Four bit storage register	Now
RL70, 1, 2, 3: Four bit storage register	Now

Beam lead T²L RAY III series

RG3380, 2: Hex inverter	Now
RG3390, 2: Dual 4 input AND gate (split outputs)	Now
RG3410, 2: Quad 2 input NOR gate	Now
RF3200, 2: J-K flip-flop (AND inputs)	Now

Beam lead linear circuits

RM709: Operational amplifier	Now
RM741: Operational amplifier	Now

Beam lead transistors

BL1000: 2N930 equivalent. TO-18 cans 6/15. Chips	Now
BL1001: 2N2484 equivalent. TO-18 cans 6/15. Chips	Now
BL1002: 2N918 equivalent. TO-18 cans 6/15. Chips	Now
BL1003: 2N2221 equivalent. TO-18 cans 6/15. Chips	Now
BL1004: 2N2221A equivalent. TO-18 cans 6/15. Chips	Now
BL1005: 2N2222 equivalent. TO-18 cans 6/15. Chips	Now
BL1005QD: Quad DIP 2N2222	Now
BL1006: 2N2222A equivalent. TO-18 cans 6/15. Chips	Now
BL1007: 2N2906 equivalent. TO-18 cans 6/15. Chips	Now
BL1008: 2N2906A equivalent. TO-18 cans 6/15. Chips	Now
BL1009: 2N2907 equivalent. TO-18 cans 6/15. Chips	Now
BL1010: 2N2907A equivalent. TO-18 cans 6/15. Chips	Now
2N929: Available in chips only	Now
2N2369: Available in chips only	Now
2N2483: Available in chips only	Now
2N2604: Available in chips only	Now
2N2605: Available in chips only	Now
2N2894: Available in chips only	Now
2N2945: Available in chips only	Now

Beam lead diodes

IN914: Available in chips only	Now
IN3600: Available in chips only	Now

Beam lead memories

RR6100: 64 bit bipolar RAM (0° to 75°C)	6/15
RR5100: 64 bit bipolar RAM (−55° to 125°C)	6/15
RR6110: 256 bit bipolar RAM multi-chip array	6/15

RAYTHEON

CIRCLE NO. 19

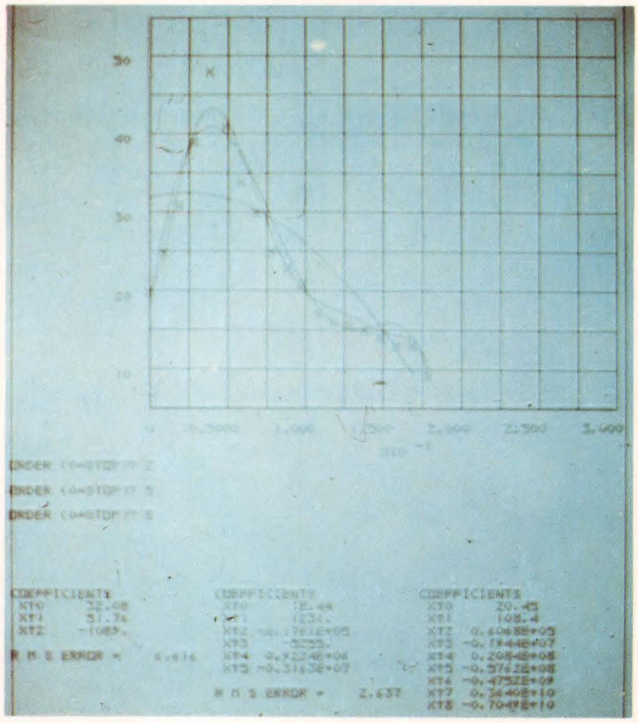
Terminal Uses Chemistry To Conserve Electronics

NEW YORK – Electronics isn't everything. Believe it or not there are other ways of doing things. Corning says the chemistry of a novel glass can be used to save as much as $100,000 worth of electronics in a graphic-display, time-share terminal for computers. This time the glass is not used for ovonic switches but for carrying many millions of tiny silver-halide particles that can be "switched" to dark states, will stay in these dark states for a while, and then can be switched back to transparent states. The optical memory in the glass plate eliminates the usual large amount of electronic memory needed to keep a CRT refreshed.

Corning has built a graphic computer terminal around a 2- by 3-in plate of this "photocromic" glass from which

Image projected on viewing screen is green because this is the wavelength that least disturbs the image in the special glass. The image tends to be a bit faint on present models and shows progressive fading after the first few minutes which permits the refresh sequence to be followed easily.

Corning terminal (below) projects a "frozen-in" picture from a 2- by 3-inch rectangular plate of special glass onto a rear-projection screen. Most of the cabinet space under the screen is taken up by various light paths directed back and forth between mirrors. The image can be deflected by one mirror to an electrostatic copier that normally is located at the right side of the console.



they project 8-1/2 by 11 in displays. The company is offering the terminal for about $20,000. They say it does the work of all-electronic CRT terminals costing from $60,000 to $150,000.

Writing in the Corning 904 terminal is by a two-step process (see sketch). First an electron beam in a more or less conventional CRT excites an ultra-violet phosphor plate behind the Corning glass plate. The UV is of the right wavelength to break down the silver-halide particles and they darken. The Corning plate is divided into many small "light pipe" segments so the UV darkening will be kept localized to prevent fuzzy lines in the display.

To make the memorized picture visible (the glass does not generate light like a CRT) and to enlarge it for easier viewing, Corning bounces a green light off it, magnifies the image, and rear-projects the image on a relatively large viewing screen. This resembles a viewgraph projection. A green projection lamp is used as the green wavelength falls neutrally between the UV that writes on the glass and the IR that erases it.

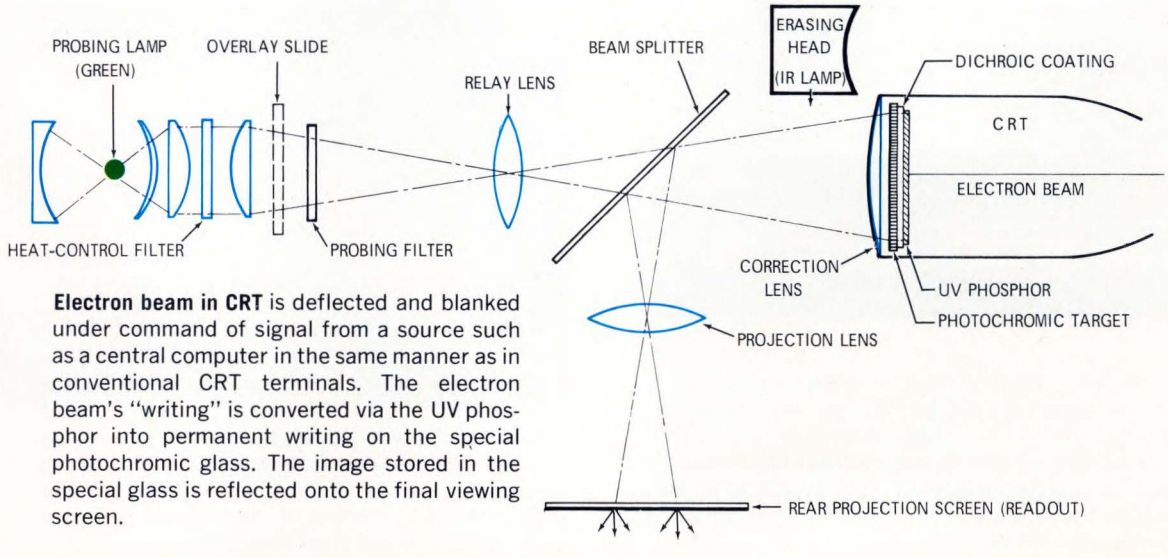
The projected image of Corning's first three units that EDN examined did not appear especially bright or sharp to EDN. There was also a noticeable fading over the fifteen minute period we took while interactively asking the computer to go through various curve fitting refinements as shown in the illustration. The first curves would have faded slightly by the time the computer drew our last request.

However, there was absolutely no flicker as in CRT displays and we found we quickly got used to the way the display wrote what the remote central computer told it to. (Incidentally, it was interesting in this demonstration to see the line being drawn pause while we lost priority to some other time-share customer.)

An advantage of the liberal use of projection in this terminal is that it is relatively easy to "play around" with the image. For example, Corning inserts slides into the light path to throw graph grid lines on the screen. This is a lot cheaper than having these graphs "piped" in from a central time share computer and, according to Corning, can significantly cut down the on-line time charges in time sharing.

Another use Corning makes of the optical flexibility is to rotate a mirror into the light path to deflect the image from the screen to the electostatic copier. Making a copy is as simple as hitting the "copy" button and takes no more time than with an office copier.

The terminal can only store one image at a time (unless one doesn't mind writing one on top of another) so must be erased between "pages". To erase, Corning floods the glass plate with an infrared lamp. This causes the silver-halide particles to recombine and become transparent again, ready for another use. Unfortunately, the erasing is not selective so one cannot do neat editing. Instead one must either blanket erase and start all over again or cross out mistakes and write over. Also, Corning warned us not to erase too frequently as there is danger that the IR heat build up would damage the system.



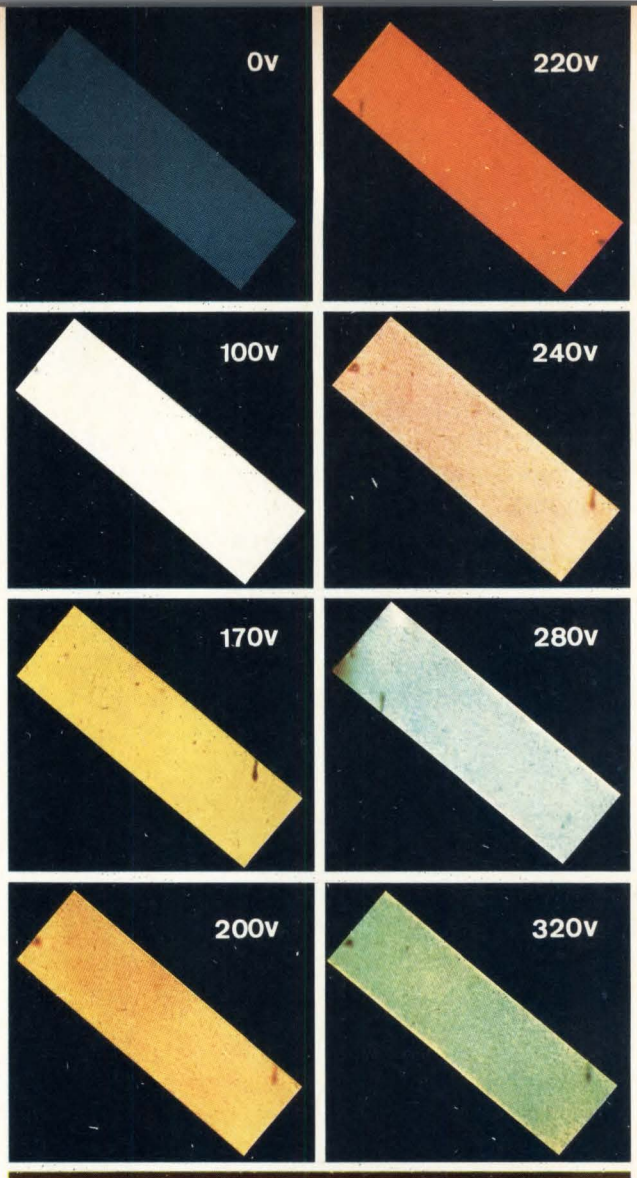
Electron beam in CRT is deflected and blanked under command of signal from a source such as a central computer in the same manner as in conventional CRT terminals. The electron beam's "writing" is converted via the UV phosphor into permanent writing on the special photochromic glass. The image stored in the special glass is reflected onto the final viewing screen.

Better Colors with Ferroelectric Ceramic

ALBUQUERQUE, N.M.—Engineers at Sandia Labs have come up with ferroelectric ceramic material that is vastly improved over earlier versions. With the new materials, colors are much sharper than was possible when these ceramics first were reported (see EDN, December '68, p. 26).

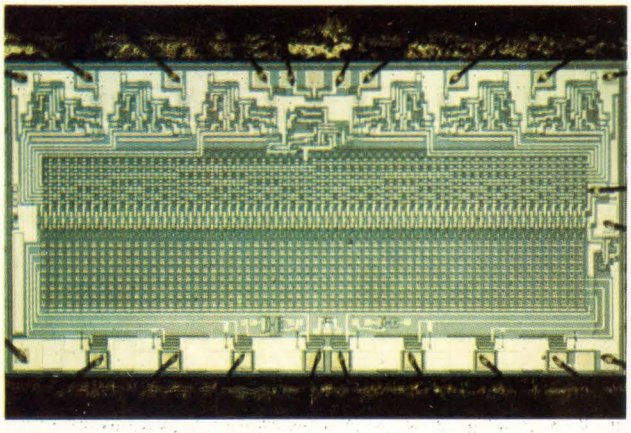
The improved ceramic is a type that exhibits no remanence, but does offer very distinct colors for display applications. While the earlier versions also displayed multicolors, they were not as sharply contrasting as can be obtained with the new. In the photos shown, the sample used has a 1-mm gap between aluminum electrodes that have been evaporated onto the ceramic.

In the work being done at Sandia, two other types of ferroelectric ceramic structures are in use. They are termed linear and tetragonal and exhibit a remanence characteristic when a sufficient electric field is applied then removed. Both optical memory and display applications have been cited for these.

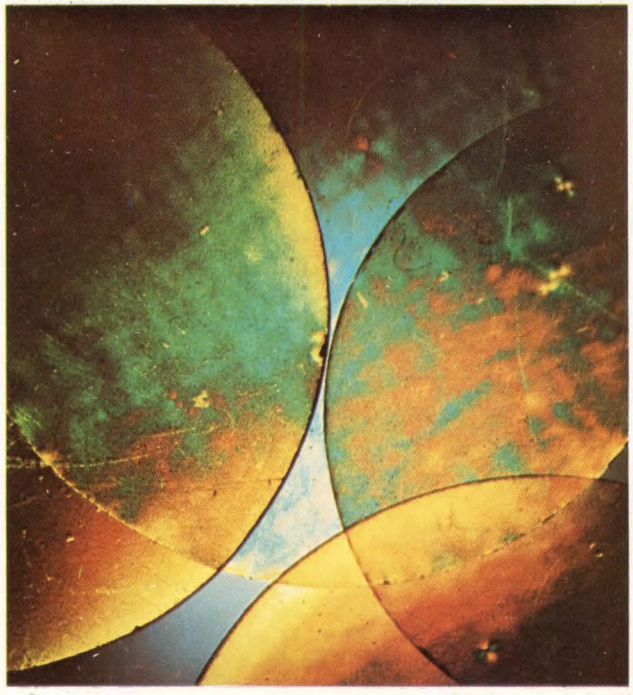


Multicolors are obtained in ceramic material by applying electric field across the 1-mm gap, 8.5-mil-thick sample. Colors relate to applied field as indicated on these photomicrographs.

Programmable ROM Debuts



MELBOURNE, FL.—Bipolar programmable ROM has "nichrome" fuse links on a 88- by 155-mil chip. Addressing any one bit of the 512-bit ROM while applying a 30-mA current to the corresponding output lead blows that fuse link. Result is a programmed "1" for that bit. Fuse links are shown on lower portion of Radiation Inc. photo. For complete details see article on page 71.



Ferroelectric ceramic samples are viewed through crossed polarizers and a full-wave (first order blue) plate. Variety of colors produced in the lead-lanthanum-zirconate-titanate 20-mil-thick samples is caused by variations in thickness and by strains present in the unannealed plates.

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4SC-9153R2

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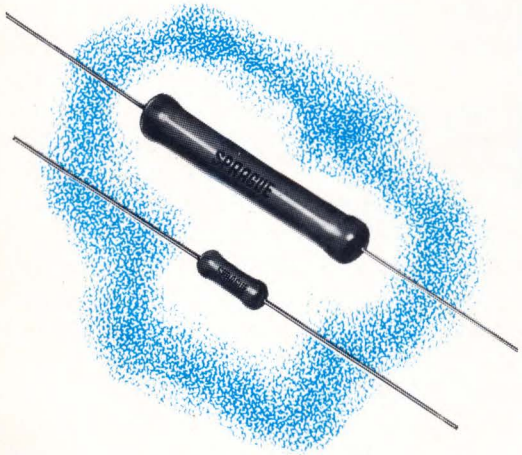

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4SR-9145R2

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MOS/LSI + Electronic Printout = 1.8 lb Calculator

NEW YORK—Canon Inc. has teamed Japanese production/assembly skills with advanced U.S. semiconductor technology at Texas Instruments Incorporated to develop the first all-electronic printout calculator expected to sell for $400 when available in the early part of 1971.

The new battery-powered calculator, called the "Pocketronic" is the first to eliminate both failure-prone mechanical printers and glass number tubes. The calculator evolved from a joint development program between Canon and Texas Instruments.

Large-scale integration from TI helped Canon achieve the small size—4 by 8-3/16 by 1-15/16—and light weight—1.8 lb.—that make it the world's first truly personal calculator.

Despite its compactness, the "Pocketronic" performs a full range of addition, subtraction, multiplication, division, credit balance and other manipulations of numbers as large as 12 digits, to four decimal places.

All "Pocketronic" calculations are performed by three MOS/LSI arrays built by TI at its new Houston facilities. The logic in the calculator is partitioned as follows:

Chip No. 1—127 by 146 mils, containing all circuitry for character generator and timing counters;

Chip No. 2—160 by 162 mils, containing key encoder, buffer register, input register, adder and accumulator;

Chip No. 3—135 by 167 mils, containing all control logic circuitry.

The control logic chip is built using TI's programmable logic array (PLA) concept, first announced at the 1970 IEEE Show in March. This logic is a unique combination of master/slave J-K flip-flops and static read-only memories, all on a single MOS/LSI chip.

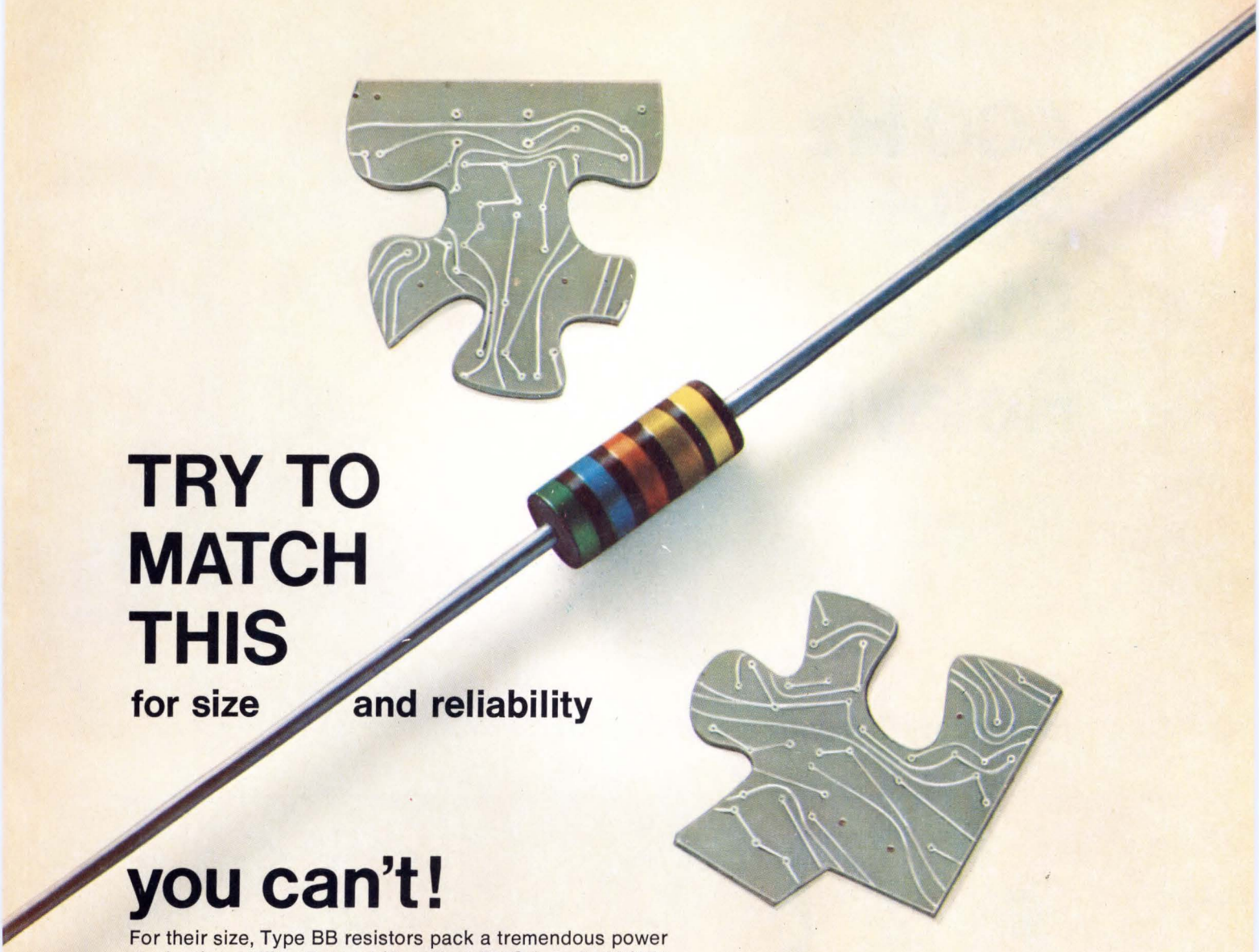
TI's PLA approach involves programming the final gate oxide-removal photomask used during the manufacturing process, so that a custom array can be produced at costs usually associated with standard devices. Computer-aided design and software routines convert Boolean equations into commands which control the extent of oxide removal, and thus the logic configuration.

Jointly developed by Canon and Texas Instruments, the "Pocketronic" is the world's smallest electronic calculator. It uses complex TI MOS (metal oxide semiconductor), LSI (large scale integration) circuits, and TI's recently patented electrothermal printer for number display and hard copy printout. Canon expects to begin marketing its calculator in the U.S. during early 1971, at under $400.

Heart of the "Pocketronic's" all-electronic, low-cost printer is a special semiconductor thermal printhead which is part of a new thermal printing system for which a patent was issued to TI this past February. Signals from the LSI circuits cause selected segments of a 20-square mosaic (4×5) on the surface of the IC printhead to reach about 400°F within a hundredth of a second, forming sharp, clear numbers on a 1/4-in-wide strip of heat-sensitive paper magnified through a special window for easy visibility.

Schematically, each mesa is an electrically/thermally isolated area of the printhead. Diffused into each mesa is a transistor. When the transistor is saturated, dissipated in the collector resistance heats the mesa.

The only discrete devices in the Pocketronic are mounted on a single 2-3/4-in-square printed circuit board, and are associated with paper advance and system clock generator.



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And miniaturization has not reduced reliability. Tests prove it. They satisfy the highest level—the S level—of the latest MIL-R-39008 Established Reliability Specifications in all resistance values.

The key is hot molding—the Allen-Bradley way. A-B developed and built the machines. Only A-B uses them. They're fully automatic. Built-in precision control. A high degree of uniformity. Predictable performance from resistor to resistor—year after year.

For immediate delivery at factory prices call your authorized A-B industrial electronics distributor. Or write Marketing Dept., Electronics Division, Allen-Bradley Co., 1201 South Second St., Milwaukee, Wis. 53204. Export Office: 1293 Broad St., Bloomfield, N.J., U.S.A. 07003. In Canada: Allen-Bradley Canada Limited.

Exclusive
Only A-B Type BB RCR05 meets MIL-R-39008 ER (established reliability) for 1/8-watt resistors at the S level.
Shown actual size.

A-B QUALITY

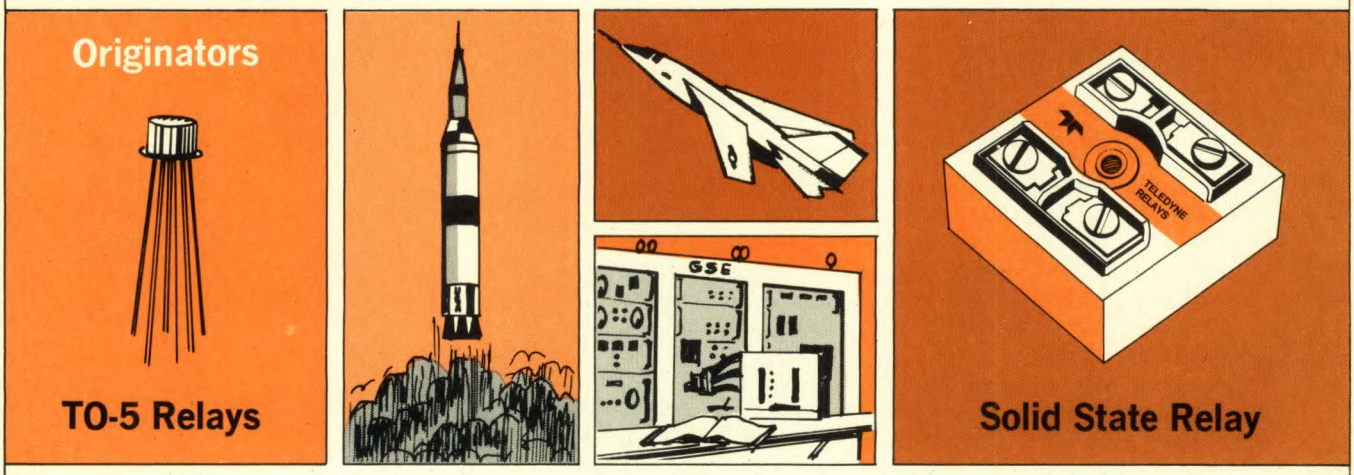
ALLEN-BRADLEY
QUALITY ELECTRONIC COMPONENTS

EC69-80

CIRCLE NO. 33

400 Hz Solid State Relays

for military & commercial aircraft



The originators of TO-5 relays announce another first! Solid state relays that meet or exceed all categories of MIL-STD 704A. Transient protected on input and output. Features include an ultra-sensitive "coil" (compatible with 5 volt logic systems, such as TTL), and a zero-voltage switching option to minimize RFI. They can switch over 5 KW, resistive or inductive loads (50-500 Hz). Extremely high reliability and maintenance-free operation make them ideal for aircraft control and power system applications. Three input "coil" ranges are available, 3-8 VDC, 7-85 VDC and 90-230 VAC. Features include low contact resistance (50 milliohms typical) and contacts capable of withstanding overloads 1000% above ratings. Lack of moving contacts prevents arcing, permitting switching in explosive atmospheres, controlling motors, solenoid valves, actuators, transformers, etc.

The high contact surge rating is ideal for lighting control systems (5000 watts of tungsten lamps can be switched). For complete technical data on our 400 Hz Series 6 Solid State Relays and solutions to your 400 Hz power switching problems, contact

TELEDYNE RELAYS

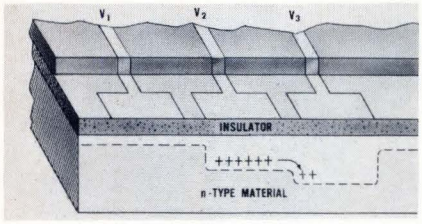
3155 West El Segundo Blvd. Hawthorne, Calif. 90250
Telephone (213) 679-2205

CIRCLE NO. 23

New Class of Semiconductor Devices Reported

MURRAY HILL, N. J. – Employing principles that haven't been used in semiconductor technology before, scientists at Bell Laboratories have created a new class of low cost and reliable electronic devices for imaging, logic and memory functions.

Their new devices are called Charge Coupled Devices (CCDs). Performing many of the functions of more highly complex ICs, CCDs are simple, easily fabricated, three-layer structures.



Charge Coupled Device (CCD) creates and stores minority carriers, or their absence, in potential wells near the surface of the semiconductor. The minority carriers may be moved from under one electrode to a closely adjacent electrode on the same substrate by applying a more negative voltage to the adjacent electrode.

In experiments, Bell Labs scientists used CCD structures consisting of metal conductors, a layer of silicon dioxide and a base of homogeneous silicon semiconductor. The devices are expected to be produced at lower cost and have potentially higher reliability than complex ICs now used for the same functions.

A number of applications have been suggested for this simple device.

Shift Register – Minority carriers may be stored and moved in precise patterns, in two dimensions, and can be detected and measured at some location. The basic shift register may be used to construct a recirculating memory or used as a delay line.

Imaging Device – Such a device may be made by shining a light image on the bottom of the semiconductor part of the device, creating electron-hole pairs. The holes will diffuse to the electrode side where they can be stored in the potential wells created by the negatively charged electrodes. Later, the image may be read out via shift register action.

Semiconductor Processing Automated by Ion Implanter

TOKYO, JAPAN – Fully automated manufacturing of diodes, transistors and MOS has been successfully achieved in trial runs by Hitachi, Ltd.

With a specially designed ion implanter, reported to be the first of its kind in the world, the process is expected to pave the way for completely automated production of semiconductor devices.

In the Hitachi process, impurities such as boron and phosphorus are ionized, accelerated at 200 kV and implanted into the silicon substrates.

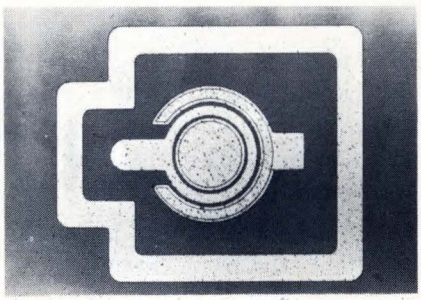
Advantages over the conventional thermal diffusion process according to Hitachi are:

– Ions can be implanted simultaneously into a maximum of nine silicon wafers, therefore processing of a large number of semiconductor devices with uniform characteristics is possible. About 40 wafers can be handled per hour with this machine.

– Computer-controlled automatic production is possible. Adjustment of the ion source and acceleration voltage can be handled easily and safely at ground potential.

– The amount of impurities can be monitored during the processing, because direct measurement and control of ion beam current are possible.

– Processing can be done at relatively low temperatures, ranging between 400 and 900°C., while the thermal diffusion process requires 1000 to 1200°C.



MOS field effect transistor test-manufactured by new ion-implanter.

Smile! You're on

World's first color-screen telephone will be demonstrated at Expo '70 in Osaka, Japan. New system uses the same circuit techniques developed last year for Toshiba microcolor TV camera. Telephone user sees the face of the other party on a 12-in color receiver tube set in an oval console. Above it is a 3-in image of his own face, and by pushing a button he can see his own face on the larger color screen.

Clearing Channels

A new communications system reduces police radio channel overcrowding by replacing some voice messages with digital data transmissions. Readily added to present systems, the equipment relays certain messages as quick bursts of tones. It was developed by Sylvania Electronic Systems, Mountain View, Calif.

The system comprises patrol car equipment to send and display messages and a base station display and console linked to a computer. By pushing a button, a patrol officer can send such messages as "need assistance", "out of service", or "send ambulance", and do it faster and less obtrusively than he could by voice transmission. The station computer times an officer who must leave his car during an investigation and sounds an alarm if he does not report within several minutes. The equipment also enables patrol cars to get an immediate and direct record check on a car license number from state motor vehicle department computers.

To Speed Mail

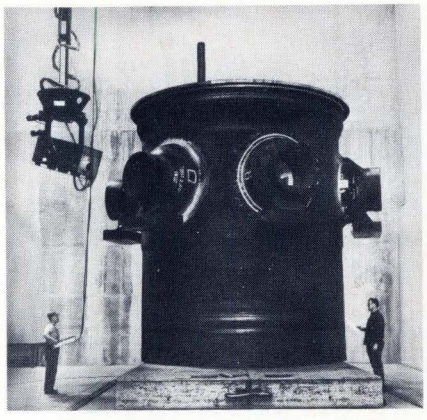
PROMPT (Program to Record Official Main Point-to-Point Times), designed to monitor the flow of mails has begun preliminary testing at San Diego's main post office. Conducted jointly by the Bureau of Planning and Marketing, Post Office Department, and General Dynamics, PROMPT uses "electronic letters", each containing a printed circuit card, mailed in various mail classes in all types of containers, mixed with regular mail, and addressed to known destinations.

Electronic tracking equipment records the time it takes for test letters to be moved from deposit locations, sorted and processed, identifying potential bottlenecks to keep the mail flowing.

X-Rays Huge Vessel

A new, highly maneuverable radiographic linear accelerator is capable of penetrating up to 20 in of steel. Combustion Engineering, Inc., (C-E) supplies nuclear power generating components and hardware including welded reactor vessels weighing up to 655 tons and up to 12-in thick with seams that must be X-rayed for defects.

The Linatron 1500, a linear accelerator manufactured by the Radiation Div. of Varian Assoc., performs fast and accurate X-ray functions on all C-E's pressure vessels. The 7-1/2 MeV, 1500 rad/min device is much smaller than conventional extra-depth X-ray apparatus, weighs only 2000 lb and is only 66 in long. Key to the compact size of the X-ray head is Varian's new vacuum-sealed standing wave accelerator with integral gun and target – the first commercial product to utilize this recent AEC development. When C-E tested the Varian Linatron 1500, they found it could effectively penetrate up to 20 in of steel.



Form Computer Co-op

A group of engineering firms in Boston has recently organized its own library of engineering applications programs and filed it on the AL/COM Computer Time Sharing Network for mutual use. The library comprises the most widely used engineering programs developed by member firms in the cooperative.

The first 15 programs are currently in use on the AL/COM system, which is operated by Applied Logic Corp. from its computer complex in Princeton, N. J. Additional applications programs are now being readied for the library. Ultimately, the library will contain hundreds of applications programs. Coordinating the project is Computer Dynamics, Inc., of Boston, an AL/COM Associate and a specialist in computer applications related to civil engineering. The Boston users group will make its library accessible to engineering firms across the country in the near future.

Guess the price of HP's new counter

Clues:

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

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

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

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

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

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

HEWLETT hp PACKARD

ELECTRONIC COUNTERS

CIRCLE NO. 25

02003

ELECTRONICS AND ASTROLOGY

Will electronics furnish a rational basis for astrology? EDN Regional Editor Thomas P. Rigoli thinks so, if certain conditions are met. One of these is confirmation of the "unified field" theory.

Man is a complex electronic structure. This view has emerged over the past decade, and current advances in aerospace research, biophysics and medical electronics only serve to confirm this concept. From electroshock therapy, through the development of medical electronic equipment, to such experimental work as electronically-induced sleep and electroanasthesia, we have become increasingly aware of Man's electronic nature.

Since the very early days of electricity, we have been familiar with the manner in which simple electronic structures are influenced by external fields in the electromagnetic spectrum. Surely it is not too much to suspect that more complex structures are similarly influenced.

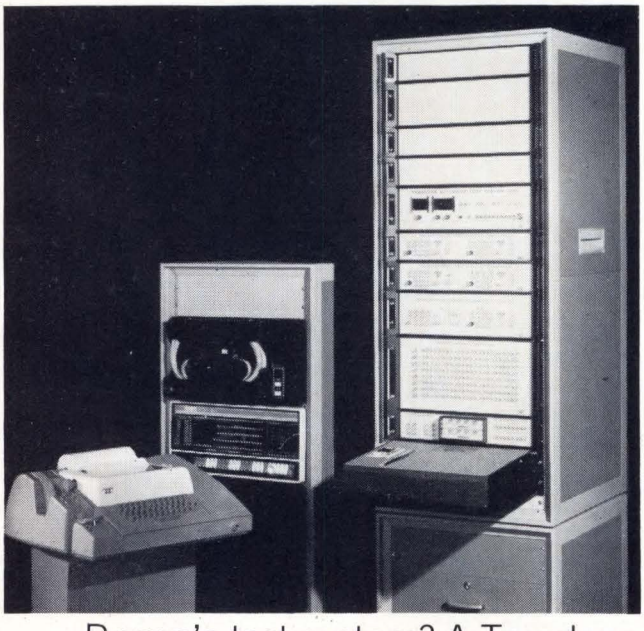
Astrologers have, for millenia, postulated that part of Man's environment was made up of mysterious "emanations" from the planets of the solar system, and that these "planetary influences" were particularly strong when certain planets were in "conjunction" or in "opposition" to each other. Now astrology may be classified, at best, as an empirical science—a host of conclusions based upon an observed experiment. The stumbling block has always been that the observer was always, necessarily, a participant in the experiment. But could it be that the ancient and arcane practice of astrology unwittingly stumbled upon a fundamental truth?

When Man can at last separate his roles as participant and observer, I predict that we will find that astrology is nothing but electronic interaction on a cosmic scale. Presupposing a unified field theory of gravity and magnetism, we will find that Man's geomagnetic environment truly is subject to forces of a cosmic magnitude, that the planets of the solar system truly do have an influence on these forces, just as the sun and moon influence the tides of the oceans. Because he could see and observe them, Man has learned to predict the tides accurately and even to harness them to work for him, as well as he with them. Just because they are not visually perceptible does not mean that Man cannot accurately predict, harness, and even adapt to the geomagnetic tides of his invisible environment.

Such a hypothesis, if true, could be the missing link that could explain many of the empirical observations of astrologers over the centuries. There's much we don't know about our relationship to the ever-changing universe. But with knowledge increasing at a nearly-exponential rate, we may be on the threshold of innovative electronic design that will tell us more about Man's true nature than we ever dreamed possible. We must take care not to stumble over that threshold through blind skepticism of an empirical body of knowledge acquired painfully over the centuries. Electronics may be the key that unlocks astrology.

Why Ragen Semiconductor tests C/MOS with a Teradyne J259

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

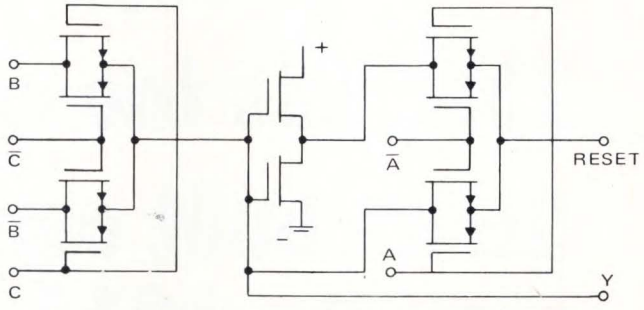


Ragen's test system? A Teradyne J259.

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

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

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



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

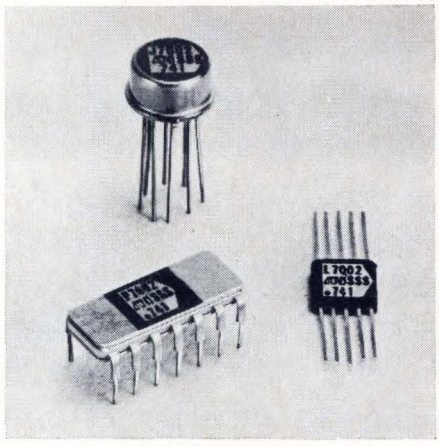
It doesn't leave you high and dry when your test load changes. When you expand, it expands, through the easy addition of multiplexers, magnetic-tape units, line printers, and all the software you need to go with them.

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

Teradyne makes sense.

CIRCLE NO. 26

We started out To make a better 741 Op Amp.



That was too easy.

So we built ours even better than the 101A.

	OURS	THEIRS	
	SSS 741	OTHER 741	101A
Offset Voltage V_{OS} (max.)	**2 mV**	5 mV	2 mV
Input Offset Current I_O (max.)	**5 nA**	200 nA	10 nA
Input Bias Current I_B (max.)	**50 nA**	500 nA	75 nA
Input Resistance R_{IN} (min.)	**2 MΩ**	0.3 MΩ	1.5 MΩ
Voltage Gain A_{VO} (min.)	**100,000**	50,000	50,000

Impressed?

Wait 'til you see our 741A!!!

PRECISION MONOLITHICS INCORPORATED

1500 SPACE PARK DRIVE • SANTA CLARA, CALIFORNIA 95050 • PHONE: 408-246-9225

makes it!

CIRCLE NO. 27

PROGRAMMABLE CALCULATORS—

THE ENGINEER'S PERSONALIZED COMPUTER

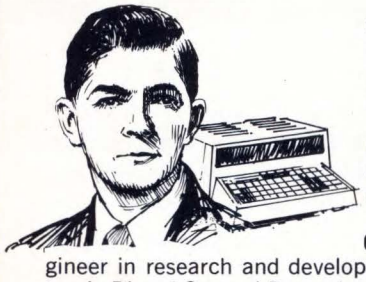
HARRY T. HOWARD, Technical Editor

Programmable calculators provide greater problem solving capacity at lower cost—amply demonstrated by the participants in EDN's "Calculator for a Month" program.

The conventional calculator is a versatile tool, but it is not sophisticated enough to handle many engineering needs. On the other hand, a full-scale computer can be expensive and sometimes inconvenient. Programmable calculators appear to be the middle ground between the two extremes—conventional calculators and huge computers.

The five respondents to the editorial, "Did You Say A Desk-Top Calculator for a Month?" (EDN, July 15, 1969), more than demonstrated the power of these desk-top machines with the following problems that they actually solved. Here is part two of this article; the first part appeared in the April 1 issue.

(Continued)



Carl David Todd is a registered professional engineer with his own consulting firm in Costa Mesa, Calif. His area of activity includes general solid-state circuit design, instrumentation, computer interfacing and process control. He holds five patents and has written two books in addition to writing sections for many texts.

Wang 370 system is comprised of subsystems that include a 370 programming keyboard, four Type 371 program card readers, a 373 auxiliary memory, a 370-12 trig pack and a 379 five- and seven-output printer. Like the 370, Model 700 has capabilities for search and return and branching, but at higher speeds.

Carl M. Smolka has had several years experience as an engineer in research and development of special purpose tactical antennas for the Electronic Div. of General Dynamics, Rochester, N.Y. He holds a Master's degree in electrical engineering and currently has a patent pending on an automatic antenna coupler.

Subroutines for the Hewlett-Packard 9100A keyboard functions are stored in a ROM. A magnetic core memory contains 19 accessible registers: three for display, two for data storage, and 14 for program storage or additional storage. The 14 program registers accommodate 70 to 196 program steps. A cathode ray tube displays three registers—x (keyboard), y (accumulator) and z (temporary).

Experience of **Stanley R. Brown,** principal engineer for Philco-Ford Corp., Newport Beach, Calif., includes computers, industrial relations and statistical communication. He holds two patents and has presented papers at national conferences.

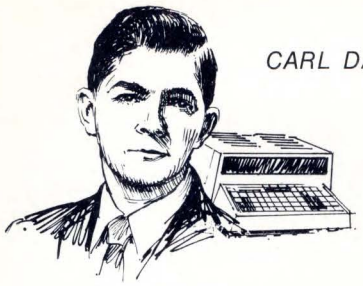
Fundamentally, the PDP-8/L comprises a memory-logic console and an ASR-33 Teletype input/output. Specific language, FOCAL, in memory provides 700 memory locations for operator's needs. In this mode, diagnostic messages are read out; editing is performed; special program trace features are available, and output formatting can be varied.

Darold Rorabacher, a graduate in mathematics from MIT, is manager of the systems analysis department at Sanders Associates, Inc., Nashua, N.H. His fields of interest are real-time computer processing and digital-filter design.

Mathatron III operates in accordance with standard algebraic notation, servicing 16 calculator terminals (keyboards) or other ASCII terminals such as teletypewriters. The system used was comprised of five keyboards, a Teletype and a phone-link keyboard. Each station had up to 128 program steps and eight storage registers.

George Hectus is director of engineering for Conolog Corp., Somerville, N.J. He received a B.S.E.E. from the Newark College of Engineering. He is studying network analysis at Newark and has taken courses in data processing at Rutgers University.

Olivetti Programma 101 has a total of ten registers—eight for storage and two for instructions. Storage register capacity is 22 digits plus decimal point and sign. Five storage registers can be split into two registers, each with an 11-digit capacity plus decimal point and sign. The machine performs normal arithmetic and square root. For scientific functions, a book of mathematical subroutines is provided.



CARL DAVID TODD, Consulting Engineer

Although it might seem foolish at first to be using a powerful personal computer system for simple calculator problems, it most definitely is not!

Little dinky problems do arise—and very often. While we may take pride in some of the complicated problems we solve, it is the simple ones which occur time and time again. The main justification for purchasing a personal computer is to save time and provide more accurate results—whether the problem be simple or complex.

In a consulting engineering office such as ours, there is a great variety of problems that range from simple addition of a list of material costs to network analysis involving the solution of simultaneous equations.

In addition to simple arithmetic operations, I frequently use the programmable calculator to convert periods into frequency rate by using the single key reciprocal. It becomes a simple matter to calculate the parallel equivalent of 10 resistors in about 15s—including the time it takes to reach up and turn the keyboard on!

In one network analysis problem, I had eight loop equations with eight unknown currents. Without a programmable calculator, I would have had to fight through the drudgery of manipulation back and forth until all unknowns were solved. With the Wang 370, it took a few minutes for the first solution, compared to hours for manual computation (assuming no mistakes were made). The same type of problem was solved on the Model 700 in a matter of seconds—first root was obtained in <5s.

The programmable calculator is quite useful for RMS error calculation or for simple vector magnitude calculation—again without the necessity of a program. When working with simple RC circuits, the logarithmic and exponential capability permits simple calculations with very little effort. After a short time, manipulations become second nature and are so much easier than even using a slide rule. The exponential capability is also very useful in simple calculations involving thermistors—or in computing the compound interest on your savings.

A second general grouping of problems that I see day in and day out are those where the calculations are not really complex, but they must be done over and over and over again. It really doesn't take very long before you get so bored that your mind begins to wander—and you begin to make mistakes. Now, you must do the calculations over again or accept the consequences of an error.

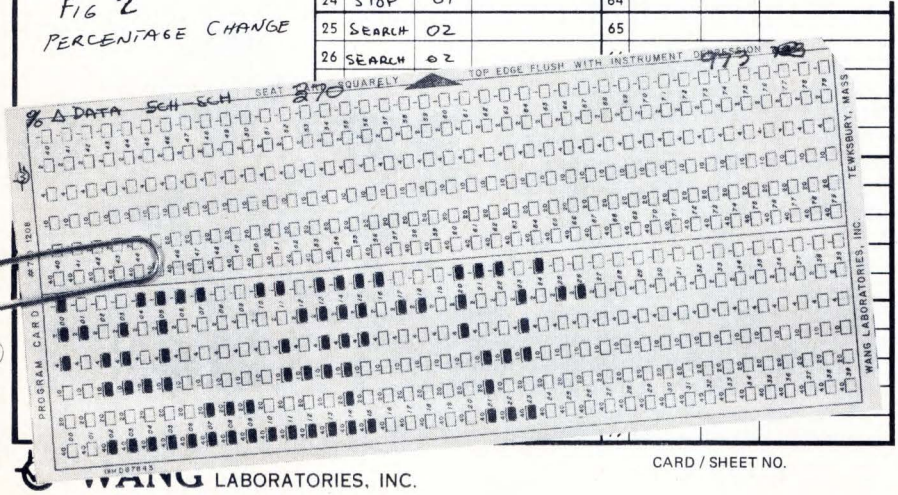
MODEL PROGRAM TITLE: % Δ DATA

(THIS SPACE FOR INSTRUCTIONS AND NOTES)

1. PRIME
2. KEY 1ST DATA
3. +RA
4. KEY NEW DATA
5. SEARCH -SEARCH
6. READ % ~~INCREASE~~ CHANGE
7. KEY IN NEW DATA
8. CONTINUE
9. READ NEW % CHANGE

IF WANT TO KNOW Δ DATA = NEW - OLD PRESS SEARCH - 9

No.	Cmd	Code	Comment	No.	Cmd
00	MK	07		40	
01	SRCH	02		41	
02	CL LA	54		42	
03	+ LA	56	NEW	43	
04	RECRA	51	OLD	44	
05	-LA	57	NEW-OLD	45	
06	ENT	41		46	
07	1	61		47	
08	0	60		48	
09	0	60		49	
10	ENT	41		50	
11	RECLA	55	NEW-OLD	51	
12	+RA	52	NEW	52	
13	-LA	57	-OLD	53	
14	CHS	77	OLD	54	
15	÷=	47	NEW-OLD / OLD x 100%	55	
16	STOP	01		56	
17	SCH	02		57	
18		02		58	
19				59	
20	MK	07		60	
21	9	71		61	
22	RECRA	51	NEW	62	
23	+LA	56	NEW-OLD	63	
24	STOP	01		64	
25	SEARCH	02		65	
26	SEARCH	02			



WANG LABORATORIES, INC. CARD / SHEET NO.

Fig. 2 PERCENTAGE CHANGE

Fig. 1—**Program and input card** provide percentage change from one data input to the next without disturbing any of the memories. First two steps merely give an address so the program may be found. Steps 02 through 15 command the same operation that would be done with keyboard strokes if the same problem were done manually. Step 16 tells the program to stop. Whenever "continue" key is pressed, steps 17 and 18 tell the reader to return to step 02—beginning of the program.

Additional tagalong program, steps 20 through 25, provides a readout of actual change between old and new data inputs by pressing SEARCH −9 after the first program has been run.

Sure, you might be able to get your secretary to do the simple repetitious calculations, but she is busy typing that important letter or overdue report. Even if she were free, the chances are that she would make errors, and the overall calculations would be time consuming.

By preparing a simple program, you can tell the computer what to do in about as much time as it takes to tell your secretary. This is done with prescored IBM cards and a porta-punch. First you write down each functional step and look up its command code, but it isn't long before you have most of the codes committed to memory and you can punch a simple program directly. After a while, you find that you build up a program library of those problem solutions that appear frequently, and you just retrieve the card from your file, insert it in the card reader, and off you go. One example of a very simple but helpful program is discussed in **Fig. 1**.

Numerical integration of rather wild functions becomes easy on the 370, once the function is programmed. Because the computation is relatively effortless, the increments may be made quite small. With logical branching, truncated and noncontinuous functions may be handled with ease.

A program may be written to solve a given function for various values of a given variable that may be automatically incremented in either an arithmetic or algebraic fashion. By using the logic branching capability, it is easy to program the calculations to cover a specific range from a minimum to a maximum amount with fine increments over a portion of the range and larger increments over the rest. Such an example is discussed in **Fig. 2**.

It was desired to calculate the normalized meter current as a function of the normalized input voltage for several constant values of the ratio R_1/R_2. The amount of time required for one entire pass—tabulated results—was about 5 min. As I recall, my original calculations using a rotary calculator with arcsin tables took a few hours for much fewer data points.

System limits are governed by the amount of data storage, the number of program steps available and the programming capability of the user. While no extreme skill is required to program rather sophisticated functions, a slight twist here or there can greatly simplify the program and economize on the amount of storage required for a given problem.

(Continued)

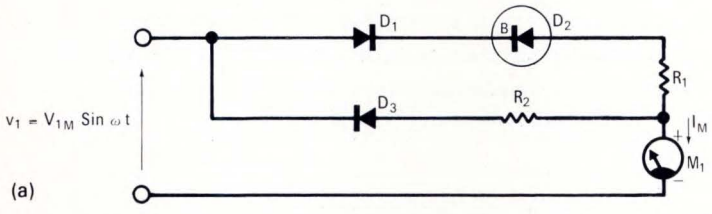


Fig. 2—**Circuit (a)** is an expanded scale ac voltmeter. Transfer equation in normalized fashion is given as:

$$\frac{I_M}{V_B/R_1} = \frac{\sqrt{(V_{lm}/V_B)^2 - 1}}{\pi} - 0.5 + \frac{\sin^{-1}(V_B/V_{lm})}{\pi} - \frac{V_{lm}R_1}{\pi V_B R_2} \qquad (1)$$

(Equation (1) is from a book to be published in 1970 entitled, "Zener and Avalanche Diodes", by Carl David Todd; John Wiley & Sons, Inc.)

It was desired to calculate the normalized meter current $I_M/(V_B/R_1)$ as a function of normalized input voltage V_{lm}/V_B for several constant values of the ratio R_1/R_2. Terms that were relabeled for simplicity are:

$$Y = \frac{I_M}{V_{B/R_1}} \qquad X = \frac{V_{lm}}{V_B} \qquad K = \frac{R_1}{R_2}$$

and modifying the arcsin function to be given in degrees:

$$\therefore Y = \frac{\sqrt{X^2 - 1}}{\pi} - 0.5 + \frac{\sin^{-1}\left(\frac{1}{X}\right)}{180} - \frac{KX}{\pi}$$

$$Y = y_1 - y_2 + y_3 - y_4$$

Now the equation for Y is in terms of variable X and constant K. When making the calculations, it was decided to see how each term of the equation varied. Program is shown in (**b**) and tabulated results for one set of conditions is listed in (**c**).

By incorporating a little flexiblity into the program, initial and final values of X aswell as determining the increment of X was set up.

(b)

MODEL PROGRAM TITLE NO. 2857

(THIS SPACE FOR INSTRUCTIONS AND NOTES)

1. KEY X_0 = INITIAL X
2. STORE FULL 1
3. KEY ΔX
4. SF 2
5. KEY X_F = FINAL X
6. SF 4
7. KEY R_1/R_2
8. SF 5
9. SEARCH-SEARCH

(SEE OTHER SIDE FOR PROGRAM CODES)

No.	Cmd	Code	Comment
00	MK	07	
01		02	
02	CLR RA	50	
03	REC F	17	X
04	1	61	
05	-RA	53	
06	REC F	17	X_F
07	4	64	
08	+RA	52	$X_F - X$
09	SKIP if +	05	IF $X_F - X$ IS + GO TO STEP 12
10	SCH	02	GO TO STEP 75
11		37	
12	CLR A	50	
13	REC F	17	X
14	1	61	
15	WRT!	24	PRINT ON
16		72	
17	WRT!	24	CARRIAGE RETURN
18		71	
19	WRT!	24	PRINT
20		22	X
21	X^2	45	
22	+RA	52	
23	1	61	
24	-RA	53	
25	$\sqrt{X}$	44	
26	ENT	41	
27	CONTROL	21	π
28		15	
29	÷=	47	
30	SF	13	
31	3	63	
32	WRT!	24	PRINT
33		35	y_1
34	(-)	75	
35	5	65	
36	-F	16	
37	3	63	
38	REC F	17	X
39	1	61	
40	÷=	47	V_X
41	CONTROL	21	ARC SIN
42		13	
43	ENT	41	
44	1	61	
45	8	71	
46	0	60	
47	÷=	47	
48	WRT!	24	PRINT
49		35	y_3
50	+F	12	
51	3	63	
52	REC F	17	X
53	1	61	
54	ENT	41	
55	REC F	17	R_1/R_2
56	5	65	
57	ENT	41	
58	CONTROL	21	π
59	15	15	
60	÷=	47	
61	WRT!	24	PRINT y_4
62		35	
63	-F	16	
64	3	63	
65	WRT!	24	PRINT Y
66		35	
67	REC F	17	
68	2	62	
69	+F	12	
70	1	61	
71	SCH	02	GO TO STEP 02
72		02	
73	MK	07	
74		37	
75	WRT!	24	PRINT OFF
76		73	
77	STOP	01	
78			
79			

CARD / SHEET NO.

$\frac{R_1}{R_2} = 0.2$

$R_2 = 5\ R_1$

(c)

$X = \frac{V_{lm}}{V_B}$	$y_1 = \frac{\sqrt{(V_{lm}/V_B)^2 - 1}}{\pi}$	$y_2 = \frac{\sin^{-1}[V_B/V_{lm}]}{\pi}$	$y_3 = \frac{V_{lm}R_1}{\pi V_B R_2}$	$Y = \frac{I_M}{V_B/R_1}$
1.0000	.0000000000	.4999999939	.0636619772	.0636619833-
1.2000	.2111428919	.3135705012	.0763943727	.0516809786-
1.4000	.3118787204	.2533482856	.0891267681	.0239997621-
1.6000	.3975689205	.2149010414	.1018591636	.0106107983
1.8000	.4764026148	.1874943812	.1145915590	.0493054370
2.0000	.5513288955	.1666666666	.1273239545	.0906716076
2.2000	.6237574408	.1501982878	.1400563499	.1338993787
2.4000	.6944701823	.1368017687	.1527887453	.1786832057
2.6000	.7638437267	.1256659164	.1655211408	.2240885023
2.8000	.8324883758	.1162490693	.1782535362	.2704839049
3.0000	.9003163161	.1081734485	.1909859317	.3175038329
3.2000	.9675782866	.1011644279	.2037183271	.3650263854
3.4000	1.0343866960	.0951253525	.2164507226	.4129597259
3.6000	1.1008184940	.0895978924	.2291831180	.4612332684
3.8000	1.1669433180	.0847640216	.2419155135	.5097918261
4.0000	1.2328088880	.0804306277	.2546479089	.5585916068
4.2000	1.2984546570	.0765230447	.2673803044	.6075973973
4.4000	1.3639173920	.0729808896	.2801126998	.6567805518
4.6000	1.4292078640	.0697547747	.2928450953	.7061175234
4.8000	1.4943633680	.0668038954	.3055774907	.7555887727
5.0000	1.5593936020	.0640942300	.3183098861	.8051774459
5.2000	1.6243163550	.0615971774	.3310422816	.8548712510
5.4000	1.6891431350	.0592885136	.3437746770	.9046569716
5.6000	1.7538865840	.0571475788	.3565070725	.9545250903
5.8000	1.8185498160	.0551566436	.3692394679	1.0044669910
6.0000	1.8831466820	.0533004037	.3819718634	1.0544752220

CARL SMOLKA, General Dynamics

Within a month, we designed over 130 antenna arrays using the programmable calculator—an accomplishment unattainable by either the classical approach or through use of a computer.

For antenna design, programmable calculators are invaluable. In a short time, an engineer can plot a number of broadside patterns by merely changing the variables that represent the element number and spacing in the equation for a linear multi-element array. To further demonstrate the calculator's ability, pattern plots for an axial mode helical antenna are attained with an HP 9100 system (see **Fig. 3**).

In RF work, impedance measurement often necessitates the use of a finite length of transmission line between the device to be measured and the measuring instrument. In order to determine the actual load impedance correctly, it is necessary to compensate for both the attenuation and phase shift introduced by this finite length of transmission line. This type of problem is very common in the antenna work done at General Dynamics in the design of broadband matching networks and tuned antenna couplers for the VLF through UHF frequency ranges.

An HP 9100 calculator system was used during the design of the broadband matching networks for the communications antennas on a naval ship. With large shipboard fan antennas, the feedpoint normally is located at a considerable height above the deck, adjacent to the yardarm from which it is strung. In order to design a broadband matching network, the feedpoint input impedance must be accurately measured, necessitating remote measurement via a length of transmission line. This remote measurement is required not only for the single logistic problem of locating the measurement equipment at the feedpoint, but also because the entire mast is a physical part of the radiating system and the location of an operator or extraneous equipment in the near field will lead to erroneous data.

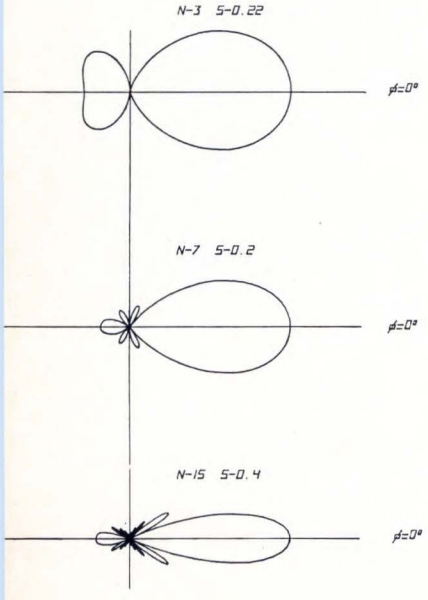
The practiced method of attaining this data is with a length of coaxial cable that in the normal operating mode is the actual feedline for the antenna. The antenna impedance data points are measured with the line located between the actual load and the measuring instrument. To compensate for cable phase shift and attenuation, the measurement is repeated with a short-circuit load. Actual load impedance is determined by manually plotting, rotating and adjusting the data point on a Smith Chart.

This manual process is subject to human error and can be extremely time-consuming even with a modest set of data such as twenty points within the 2- to 6-MHz frequency range for a broadband antenna. For experienced personnel, a data set of this size requires at least an hour for reduction to accurate input impedance values and resultant VSWR values.

To assist in this data reduction, a program was writ-

Fig. 3—**Axial mode helical antenna** pattern plots were obtained by using the following equation:

$$E(\phi) = \left[\sin\frac{90°}{N}\right] \frac{\sin N/2\ \{360°\ (S_\lambda\ [1 - \cos\phi] + 1/2N)\}}{\sin 1/2\ \{360°\ (S_\lambda\ [1 - \cos\phi] + 1/2N)\}}\ [\cos\phi]$$



(This equation is from "Antennas" by John D. Kraus; McGraw-Hill; 1950; page 213, table 7-2.)

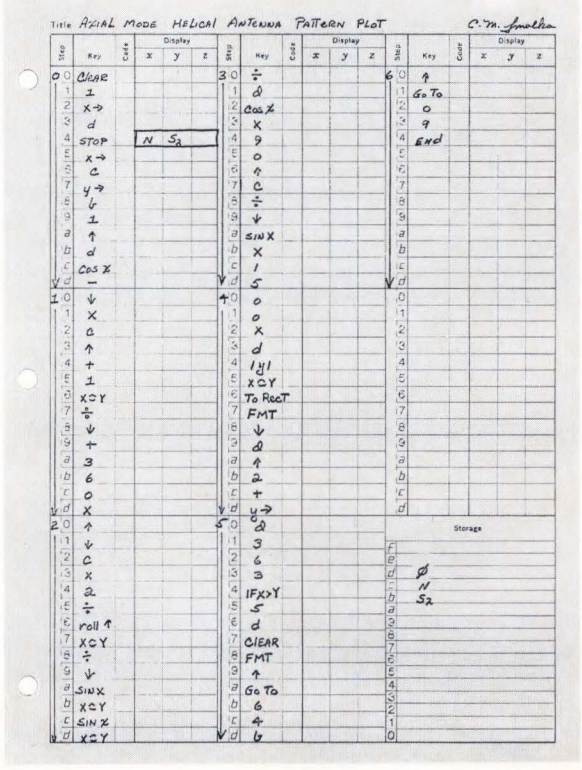
Where: N = number of turns
S_λ = spacing between turns in free space wavelengths.
ϕ = angle with respect to the helix axis.

Equation (1) is valid for the following conditions:

$12° < \alpha < 15°$
$3/4 < C_\lambda < 4/3$
$N > 3$

Where: α = helix pitch
C_λ = circumference of the helix in free space wavelengths.

After entering the program into the HP 9100 system and entering the required data ($S_\lambda \rightarrow y$, $N \rightarrow x$) at the proper halt commands, the plots were obtained.



ten for the HP 9100A system that determines and plots the compensated data points directly on a Smith Chart using the X-Y recorder (HP 9125A).

To use the program, the measured short-circuit impedance and measured input impedance are keyed into the calculator. The calculator first displays the cable attenuation in dB, then plots the compensated point directly on the Smith Chart. Finally, the resultant VSWR of the compensated point is displayed. The entire process is performed automatically and it takes approxiamtely 15s/data set.

With a data set of twenty input impedance values and twenty associated short circuit impedance values, the calculator system consumes 5 min compared to an hour of manual calculation. A further advantage that is the resultant chart is in a final form for project reports.

To illustrate the system operation, the following data set was run.

FREQUENCY (MHz)	SHORT-CIRCUIT IMPEDANCE (Z_{sc})	INPUT IMPEDANCE (Z_{in})
2.0	2 + j30	15 − j20
2.5	3 + j42	29 + j1
3.0	5 + j58	55 + j5
3.5	8 + j77	45 − j10
4.0	15 + j115	38 + j8
4.5	50 + j190	75 + j15
5.0	450 + j450	60 − j45
5.5	100 − j320	30 − j28
6.0	35 − j135	11.5 − j5

A plot of the input data without correction is shown in **Fig. 4**, with the printer listing of the entered data points and the resultant VSWR of each data point. Plot of the compensated points or the actual load values is shown in **Fig. 5**, with the printer listing of the short circuit input values ($Z_{sc} = R_{sc} \pm j\, X_{sc}$). Also shown are the cable attenuation (α) in dB, input values for $Z_{in} = R_{in} \pm jX_{in}$ and the actual VSWR of the load impedance.

The VSWR information, tabulated below, points out why the cable must be accounted for. The difference in VSWR is attributed to cable attenuation which makes the load appear more closely matched than it actually is. This is extremely important since actual mismatch determines the amount of power transfer to the load.

FREQUENCY (MHz)	INPUT VSWR	LOAD VSWR
2.0	3.9110	4.3859
2.5	1.7252	1.7991
3.0	1.1442	1.1552
3.5	1.2651	1.2953
4.0	1.3901	1.4371
4.5	1.6027	1.7089
5.0	2.2673	2.5295
5.5	2.3668	2.5905
6.0	4.3937	6.6622

Electrical engineering laboratories of this decade will find the programmable calculator as necessary as the oscilloscope. This machine not only frees the engineer for more creative work, but also provides him with an instrument for optimizing designs in a timely fashion (using his own language) right at his own desk.

(Continued)

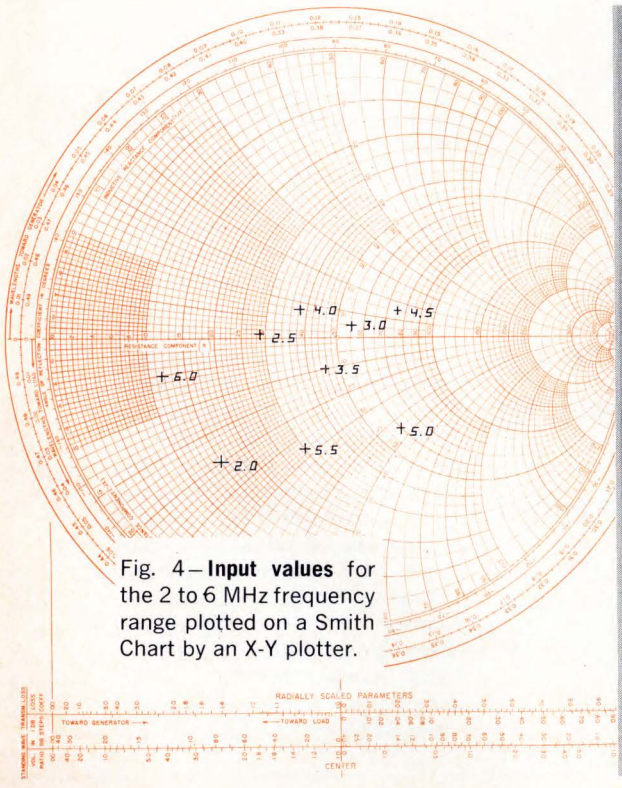
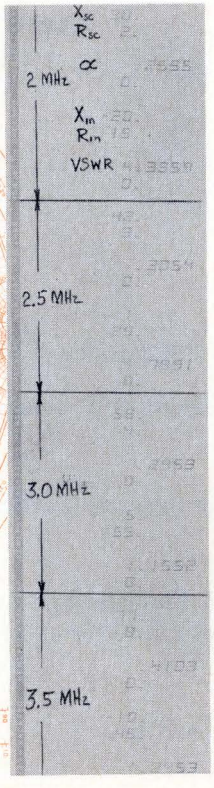


Fig. 4 – **Input values** for the 2 to 6 MHz frequency range plotted on a Smith Chart by an X-Y plotter.



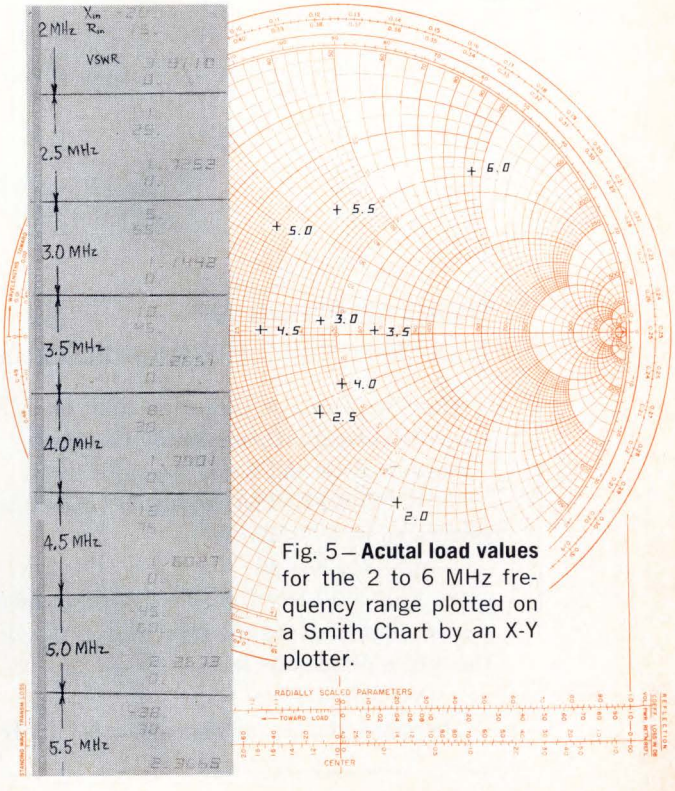


Fig. 5 – **Acutal load values** for the 2 to 6 MHz frequency range plotted on a Smith Chart by an X-Y plotter.

STANLEY BROWN, Philco-Ford

As one gains experience, one automatically plans his work so that problems are formulated to take advantage of the machine's capability.

I am of the opinion that engineering management should be able to expect a high order of detailed analysis of problems in their various engineering staffs. This expectation must, however, be preceded by making appropriate equipment available as well as the time required to fairly understand the equipment. This latter requirement is particularly important inasmuch as it requires far less effort to acclimate an engineer to the use of a computer and computer languages than it does to give a computer programmer an engineering background. I do not want to start a holy war between programmers and engineers, because the programmers have done an excellent job in providing excellent software for engineering applications, and it makes no sense at all that engineers do not make maximum use of it.

Actually the PDP-8/L is a small computer with capability for process and inventory control, accounting, etc. In this evaluation, engineering computation will be emphasized. Basic input/output device was a ASR33 teletypewriter.

Software used was FOCAL (FOrmula CALculator) —a compiler that allows one to converse with the machine in a language that combines some of the best features of BASIC, EDIT and FORTRAN. The FOCAL language is very powerful and easy to learn. When the FOCAL compiler is loaded into memory, about 680 words of storage remain for additional programming and execution. Each additional defined symbol requires about five of these words, while each character in the program written requires about 1/2 a word.

One of the simplest problems handled was to plot the distance along the earth's surface from a point directly underneath an object to the line-of-sight horizon of the object. Formulation of the problem and the subsequent programming was almost trivial, but the requirement existed for a high degree of accuracy in determining the inverse cosine of angles very close to 90°. This sort

```
@PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
                                                                    W
C-FOCAL,1969

01.01 TYPE "  A",#;FOR B=2,2,6;T %1,"          B =",B
01.98 F A=1,2,5;DO 2
01.99 T !,!,"HOW ABOUT THAT FOLKS!";Q

02.01 T !,%2.1,A
02.77 F B=2,2,6;D 3

03.05 SET X=A↑B
03.10 IF (X-(B*FITR(FEXP(A))-FSGN(FLOG(1/A))*FSQT(B)/2))3.2,31.99,3.2
03.20 T %," ",X

31.99 T "   HELLO  THERE";R
*G
  A       B = 2          B = 4          B = 6
 1.0   0.100000E+01   0.100000E+01   0.100000E+01
 3.0   0.900000E+01   HELLO  THERE   0.729000E+03
 5.0   0.250000E+02   0.625000E+03   0.156250E+05

HOW ABOUT THAT FOLKS!*
```

Fig. 6—**Program computes** and tabulates A^B for specific values of A and B. Step 03.05 determines the specific function to be tabulated. Step 02.77 selects values for B and Step 01.98 selects values for A.

Line 01.01 shows FOCAL's capability to type literal statements, to establish numerical format, to define number of program steps on a given line, and to automatically sequence a given value from an initial value through given increments to a final value. During initiation of this step, Teletype prints two spaces and then A—indicated by quotation marks. Comma indicates continuation of type command, and in this case, symbol # causes a carriage to return without line feed. Semicolon indicates completion of command and start a new command. Next command, between the two semicolons, increases B from 2 to 4 to 6, last value B will assume. With each value of B, next command following the semicolon is carried out—a "type" command. Percent sign followed by 1 indicates total number of digits to be printed out (when written as in step 02.01 (%2.1), the output is

REAL MEANING OF

IF (X- (B*FITR(FEXP(A))-FSGN(FLOG(1/A))*FSQT(B)/2))3.2,31.99,3.2

This function was chosen so that when X equalled 81, quantity within the outmost parentheses would become 0.

Assume B=4 and A=3, therefore X=81

(1) B*FITR(FEXP(A) means B times integer (ignoring fraction portion) generated by 2.71828^4 (e^4).

$\therefore 4e^3=(4)\ (20)=80$

(2) FSIGN(FLOG(1/A))*FSQT(B)/2)) means evaluate sign-only of the result of multiplying the logarithm of 1/A only by the square root of B only, the whole divided by 2.

$\therefore (\log_e 1/3)\ (4/2)=-1$

Therefore, the overall expression is 0 for B=4 and A=3.

of routine calculation was handled easily. Here one appreciates the convenience of the hardcopy output for plotting and tabular printout. As a matter of fact, one should have printout capability of some form whenever he uses equipment of this sort.

If one is to fully appreciate the capabilities of a machine such as the PDP-8/L, he must be aware of its program procedures. The simple program in **Fig. 6** requires loop and branch operations. If one views a program such as this by itself, one may feel that it is merely a "toy" type program. However, do not forget that basic routines such as this form the skeleton for the most complex problem. This fact and the machine's power can only be appreciated by comparing actual calculations to the FOCAL programs used to accomplish them (**Fig. 7**). These exemplify only one of several very complex problems solved with the PDP-8/L during the month.

In conclusion, I can only say that my own imagination was highly stimulated by a number of possibilities which one could consider if he were a personal owner of this machine.

(Continued)

two digits with one digit appearing to the right of decimal point). Second part of "type" command Step 01.01 indicates a literal typeout of a number of spaces followed by B, another space and an equal sign. Comma indicates another type command which in this case is B's numerical value.

Step 01.98 also has multiple commands. First group between semicolons increases value of A from 1 to 3 to 5. At each value, the next command after semicolon is performed. This next command DO 2 indicates a branch all starting with 2, i.e., to steps 02.01 (print out values of A) and 02.77.

Step 02.77 increments B from 2 to final value 6 again. Following the setting of each value, command DO 3 branches the program to all group 3 Steps 03.05, 03.10 and 03.20.

Step 03.05 performs an exponential operation (X = A ↑ B means A^B). Step 03.10 represents other branching capabilities of FOCAL. Also, it partially indicates functional notations other than trigonometric that FOCAL can handle. Basically, this line means, if computed value within outermost parentheses is not equal to zero, branch to step 03.20 and if it equals zero go to Step 31.99. For example, when A=3 and B=4, value of X was not typed out but the message of Step 31.99 was and program's normal sequence resumed. With this exception, all steps are performed following through steps 03.10 and 03.20. Step 03.20 first commands floating point notation by % only, then two literal spaces followed numerical value of X in floating point notation. When A=5 and B=6, program proceeds to Step 01.99 where the final message is typed out and the program is halted with "Q" (for Quit) command (asterisk indicates control is returned to user).

PROGRAM ASKS FOR ARBITRARY INPUTS $\bar{X}_1, \bar{X}_2, \bar{Y}_1, \bar{Y}_2, \tilde{X}_1, \tilde{X}_2, \tilde{Y}_1, \tilde{Y}_2, C_1, \& C_2$

THEN COMPUTES: $A = \frac{1}{2}\tan^{-1}\left[\frac{2C_1}{\tilde{X}_1^2 - \tilde{Y}_1^2}\right]$,

$$Z_1 = \left[(\tilde{X}_1 \cos A)^2 + (\tilde{Y}_1 \sin A)^2 + 2C_1 \cos A \sin A\right]^{1/2},$$

$$W_1 = \left[(\tilde{X}_1 \sin A)^2 + (\tilde{Y}_1 \cos A)^2 - 2C_1 \sin A \cos A\right]^{1/2},$$

$$Z_2 = (\bar{X}_2 - \bar{X}_1)\cos A + (\bar{Y}_2 - \bar{Y}_1)\sin A,$$

$$W_2 = -(\bar{X}_2 - \bar{X}_1)\sin A + (\bar{Y}_2 - \bar{Y}_1)\cos A,$$

$$Z_3 = \left[(\tilde{X}_2 \cos A)^2 + (\tilde{Y}_2 \sin A)^2 + 2C_2 \cos A \sin A\right]^{1/2},$$

$$W_3 = \left[(\tilde{X}_2 \sin A)^2 + (\tilde{Y}_2 \cos A)^2 - 2C_2 \cos A \sin A\right]^{1/2},$$

$$C_3 = (\sin A \cos A)(\tilde{Y}_2^2 - \tilde{X}_2^2) + (\cos^2 A - \sin^2 A)C_2,$$

AND FINALLY

$$\int_{-W_1\left[2\ln\left(\frac{1}{1-\rho}\right)\right]^{1/2}}^{W_1\left[2\ln\left(\frac{1}{1-\rho}\right)\right]^{1/2}} \int_{-Z_1\left[2\ln\left(\frac{1}{1-\rho}\right) - \left(\frac{W}{W_1}\right)^2\right]^{1/2}}^{Z_1\left[2\ln\left(\frac{1}{1-\rho}\right) - \left(\frac{W}{W_1}\right)^2\right]^{1/2}} P_d(Z,W)\, dZ\, dW$$

WHERE ρ IS AN ARBITRARY CONSTANT ≤ 1 AND

$$P_d(Z,W) = \frac{e^{-\left\{\frac{1}{2\left[1-\left(\frac{C_3}{Z_3 W_3}\right)^2\right]}\left[\frac{(Z-Z_2)^2}{Z_3^2} - \frac{2C_3(Z-Z_2)(W-W_2)}{Z_3^2 W_3^2} + \frac{(W-W_2)^2}{W_3^2}\right]\right\}}}{2\pi\left(Z_3^2 W_3^2 - C_3^2\right)^{1/2}}$$

```
C-FOCAL,1969

01.10 A "WHITE SAND " ?X,Y,C?;S I=0

02.01 S A=FATN(2*C/(X↑2-Y↑2))/2;I (-X↑2+Y↑2)2.1,2.1;S A=A+3.14159
02.10 S Z(3+I)=FABS((X*FCOS(A))↑2+(Y*FSIN(A))↑2+2*C*FCOS(A)*FSIN(A))
02.20 S Z(4+I)=FABS((X*FSIN(A))↑2+(Y*FCOS(A))↑2-2*C*FSIN(A)*FCOS(A))
02.30 T %,!,"ANG=",A*57.2957," S1=",FSQT(Z(3)),"  S2=",FSQT(Z(4)),!

03.10 A "BROWN  " ?X,Y,C?;S I=5;D 2.1;D 2.2;T !
03.20 S Z(10)=(FSIN(A)*FCOS(A))*(Y↑2-X↑2)+((FCOS(A))↑2-(FSIN(A))↑2)*C
03.30 A "AVG VAL X&Y,WHITE THEN BROWN "X,Y,C,B
03.40 S Z(6)=(C-X)*FCOS(A)+(B-Y)*FSIN(A)
03.50 S Z(7)=(X-C)*FSIN(A)+(B-Y)*FCOS(A)

04.10 S C=FSQT(Z(4)*5.99271)/12.5;S J=0;T !
04.20 F Y=-12*C,C,12*C; D 5
04.30 T !,"% BROWN SAND",J,"MZB=",Z(6),"MWB=",Z(7)
04.40 S X=FSQT(Z(8));S Y=FSQT(Z(9));S C=Z(10);S I=0;D 2;Q

05.10 S L=-FSQT(Z(3)*(5.99271-((Y↑2)/Z(4)))));S H=-L/25;T "↑ "
05.20 S X=L;D 10;S I=I-A;S X=-L;D 10; S I=I+A
05.30 F X=L+H,2*H,-L-H; D 8
05.40 F X=L,2*H,-L-2*H; D 9
05.50 S I=I*C*H/3;S J=J+I

08.10 D 10
08.20 S I=I+A*4

09.10 D 10
09.20 S I=I+A*2

10.10 S A=((X-Z(6))↑2/Z(8))+(Y-Z(7))↑2/Z(9)
10.20 S A=A-2*(X-Z(6))*(Y-Z(7))*Z(10)/Z(8)*Z(9)
10.30 S A=-A/2*(1-Z(10)↑2/(Z(8))*(Z(9)))
10.35 I (FABS(A)-1414)10.4;T "A=",A;Q
10.40 S A=(FEXP(A))/6.28319*FSQT(Z(8)*Z(9)-Z(10)↑2)
*
```

Fig. 7 – **Try this** on your slide rule.

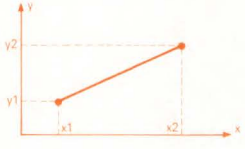
DAROLD W. RORABACHER AND GREG STARADUB, Sanders Associates, Inc.

With a programmable calculator, different algorithms can be proven before ever going to the time-sharing terminal or a big computer. In some cases, the programmable calculator can handle the whole job.

There is a class of trivial problems that can be solved immediately and a class of complicated problems that requires a big computer. But in between, there is a whole area of intermediate problems that either are ignored or someone else is sent off for a couple hours to do. These intermediate problems are the ones that the programmable calculator addresses itself to.

Three algorithms demonstrate the variety of applications for the Mathatronics CS-3. The first problem—linear interpolation—is fairly trivial but still demonstrates the everyday bothersome-problem capability. The next two, a good deal more involved, illustrate how the programmable calculator can be used for toilsome solutions.

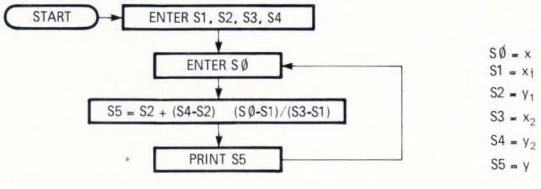
1 LINEAR INTERPOLATION



Interpolation of two points (x_1, y_1) and (x_2, y_2) is defined by the expression:

$$y = y_1 + \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$$

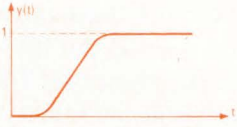
This equation is for a straight line that connects the two points (see graph), and the following flow-diagram illustrates the program used to compute y for a given x.



The reason for the flow-diagram labeling is because the programmable calculator used had only eight readily available storage registers labeled Sϕ, S1,. . ., S7. To run the program after it has been entered into the machine, one merely types in the values for x_1, y_1, x_2 and y_2 and then the value of x. The computed value of y is typed out and the program branches back for a new x input. If new values for x_1, y_1, x_2 and y_2 are desired, the program is restarted.

In the actual program, equation S5 had to be divided into separate operations. Consequently, an additional register S6 was used for temporary storage of the intermediate calculations.

2 RISE-TIME COMPUTATION



In this problem, a system, either circuit or servo, with a step response is defined by

$$y(t) = 1 + \frac{\beta}{\alpha - \beta}e^{-\alpha t} - \frac{\alpha}{\alpha - \beta}e^{-\beta t}$$

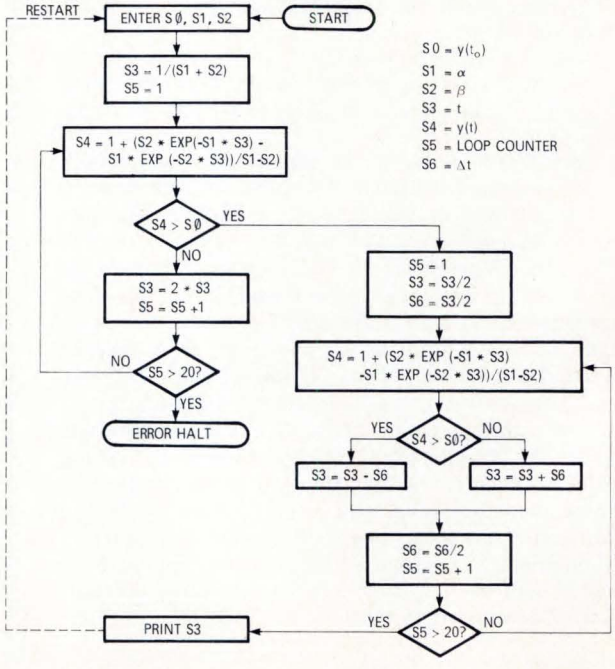
This kind of step response is typical of an underdamped system with the following properties:

$y(0) = y'(0) = 0$

$y(00) = 1$

For a given α and β, it is fairly simple to compute response (y) for a given time (t), but it is not so easy to computer the time (t) required to reach a given response (y). This would be desirable if we wanted to know the percent of rise time. It would be nice to solve for (t) as a function of (y), but, after some handwaving and head-scratching, the usual technique has to be used—plot the function and pick off the proper point.

With a programmable calculator, a program can be written to compute the time for a given response. This is achieved by making a series of guesses for a correct value of (t) and then computing the corresponding y(t). The technique used for guessing is called a binary (or logarithmic) search routine, and it can be used to invert numerically any function that is monotonic.



To run the program, the response value $y(t_0)$ (for 90 percent rise time $y(t_0) = 0.9$), α and β are entered. The program consists of two loops. First loop tries to determine a value of time for a response greater than the desired value. The second loop narrows in on the desired value. This is achieved by going through the loop 20 times and reducing the time increment (Δt) by one half each time. Thus, the accuracy of the final answer is about 2^{-20} or six significant digits. (Try that graphically!)

The following tabluation is the output for some typical values. In order to demonstrate how the program functions, the value of time (t) and response y(t) has been printed each time for both loops. For this particular run, the selected inputs were $\alpha = 100s^{-1}$, $\beta = 300s^{-1}$, and $y(t_0) = 0.9$. Final results show that the 90 percent rise time is 0.0270656 s.

```
S3=  0.2500000E-02 S4=  0.6798210E-01
S3=  0.5000000E-02 S4=  0.2017691E+00
S3=  0.1000000E-01 S4=  0.4730744E+00
S3=  0.2000000E-01 S4=  0.7982365E+00
S3=  0.4000000E-01 S4=  0.9725296E+00
S3=  0.3000000E-01 S4=  0.7982365E+00
S3=  0.3000000E-01 S4=  0.9253811E+00
S3=  0.2500000E-01 S4=  0.8771490E+00
S3=  0.2750000E-01 S4=  0.9042388E+00
S3=  0.2625000E-01 S4=  0.8915304E+00
S3=  0.2687500E-01 S4=  0.8980813E+00
S3=  0.2718750E-01 S4=  0.9012077E+00
S3=  0.2703125E-01 S4=  0.8996566E+00
S3=  0.2710937E-01 S4=  0.9004352E+00
S3=  0.2707031E-01 S4=  0.9000467E+00
S3=  0.2705078E-01 S4=  0.8998518E+00
S3=  0.2706055E-01 S4=  0.8999493E+00
S3=  0.2706543E-01 S4=  0.8999980E+00
S3=  0.2706787E-01 S4=  0.9000223E+00
S3=  0.2706665E-01 S4=  0.9000102E+00
S3=  0.2706604E-01 S4=  0.9000041E+00
S3=  0.2706573E-01 S4=  0.9000010E+00
S3=  0.2706558E-01 S4=  0.8999995E+00
S3=  0.2706565E-01 S4=  0.9000003E+00
S3=  0.2706562E-01 S4=  0.8999999E+00
```

FIRST LOOP

SECOND LOOP

3 FRANCESTOWN TURNPIKE – A PROBLEM IN QUEUING THEORY

This example is well suited for a programmable calculator. To do this by hand is next to impossible, and it is a lot of work on a nonprogrammable calculator, since each summation term must be evaluated separately and the results added. However, with a programmable calculator, all that is required is to key in the values for ρ and N – out pops the value of $\bar{k}$.

This problem in queuing theory can be stated in terms of cars passing through toll booths such as the entrance to the Francestown Turnpike or any other toll road. Consider that there are N booths and the cars are approaching the entrance at a rate of λ cars/s. When a car comes to the entrance, it will pass through a booth if one is available. This will take some time T in seconds for the person to pick up his card or stub and proceed. If the booths are full, the car turns off and takes another route.

The question is:

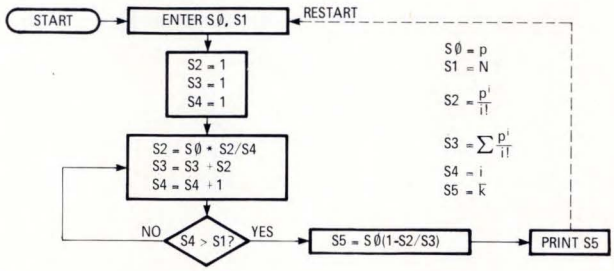
Given N, λ and T, what is the average number of toll booths that are busy?

A little knowledge and dexterity in queuing theory tells us that the following expression defines the probability that k booths will be busy.

$$P(k) = \frac{\rho^k}{k!}\frac{1}{\sum_{i=0}^{N}\frac{\rho^i}{i!}} \qquad \text{where } \rho = \lambda T$$

With some manipulation, the mathematical expression for the average number of busy toll booths is:

$$\bar{k} = \rho\left[1 - \frac{\rho^N}{N!}\frac{1}{\sum_{i=0}^{N}\frac{\rho^i}{i!}}\right]$$



To determine $\bar{k}$, the program illustrated in the flow-diagram was used and the results of some examples are tabulated below.

Sϕ (ρ)	S1 (N)	S5 ($\bar{k}$)
2	1	0.66667
2	2	1.20000
2	3	1.57895
2	4	1.80952
2	5	1.92661

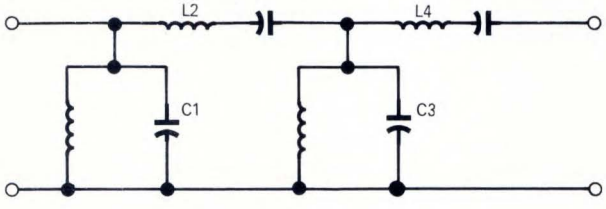
For these runs, $\rho = 2$ means the average rate of approaching cars is twice the rate at which a booth can process them. If there is one booth, it is busy 2/3 (0.66667) of the time. With cars coming at such a high rate, one would think that it would be busier, but because of cars refusing to line up, there is not always one requiring service at the time the booth becomes empty. As the number of booths increases, the average number of busy booths approaches two. In fact, if there were an infinite number of booths, all cars could be processed and, on the average, two booths will be busy.

Many applications such as statistical data and simple iterative routines call for short, simple programs that are easier and more convenient to do on the programmable calculator than on a time-sharing terminal. The programmable calculator's biggest advantage is convenience – there it sits on the desk, always at hand, ready to use.

GEORGE V. HECTUS,

One important factor is the print out. With it, you have a permanent record of all calculations which may be used immediately or held for future evaluation.

In filter design, there are certain equations that are used repetitively until an entire series of filters has been developed. With the aid of the Olivetti Programma 101, a technician can run off a complete series of paper tapes containing all the data necessary to complete a set of master forms used in the manufacturing process. As an illustration, consider the following hypothetical filter problem that was solved with the calculator. In many cases, even though the filter will be more complex, the methods employed are the same.



The problem is to design a series of five filters having center frequencies spaced 200 Hz apart starting at 800 Hz and ending at 1600 Hz. They are to have a 3-dB bandwidth of 80 Hz and a 35-dB bandwidth of 280 Hz. Source and load impedances are 600Ω and no ripple is allowed in the passband.

From published curves, a 4-pole Butterworth filter meets these requirements. Normalized constants for this filter are:

C1 = 0.7654, L2 = 1.848, C3 = 1.848, and L4 = 0.7654.

In order to unnormalize these constants, it is necessary to determine values for L_0 and C_0 that will fit the above requirements. This is achieved with the following expressions:

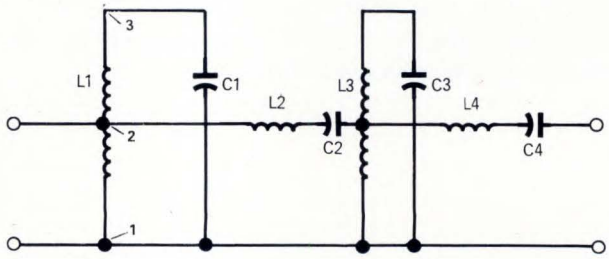
$$L_0 = Z/2\pi(\text{BW3})$$

$$C_0 = \frac{1}{2\pi(\text{BW3})\,(Z)}$$

By programming the Olivetti to solve these functions, values for L_0 and C_0 are 1.193H and 3.315 μF respectively. Using these values, the following table of unnormalized constants was generated by machine:

C1 = (0.7654) (3.315) = 2.537 μF
L2 = (1.848) (1.193) = 2.204H
C3 = (1.848) (3.315) = 6.126 μF
L4 = (0.7654) (1.193) = 0.9131H

These values are used to determine the respective inductance and capacitance that each constant will resonate for every frequency of interest between 800 and 1600 Hz. After programming the calculator, the lowest frequency of interest (800 Hz) is entered first, then the frequency spacing (200 Hz) and finally the highest frequency (1600 Hz). Now the unnormalized constants are entered and the machine proceeds to print the frequency and value of inductance or capacitance required to resonate at that frequency. This procedure is repeated for all frequencies of interest. When another constant is needed, the constant is entered with a touch of the reference key and the machine repeats the previous sequence. Obtained values may now be transferred to a master inductance sheet. Also note that the capacitance values are quite large and therefore expensive. In order to use capacitors of reasonable value and price, a value must be selected that will resonate with an inductance of less than 1 H. One convenient capacitance value is 0.05 μF. Using the same program, another paper tape is generated that gives the total inductance value required to resonate with the 0.05 μF capacitor. It must be remembered that the previously determined inductance values now will be the tap inductances of the coil and the filter circuit will become:



All determined values are now entered on the master inductance sheet (**Fig 7**). Once the master sheet is completed and the proper core has been selected for the coils to be wound on, then the calculator is used to determine the number of turns and the length of wire required for each coil. Wire size was determined with another handy aid. Negative numbers will appear for the turns and length because the program is written for coils with two taps and since there is only one tap, a zero is entered into the machine for the last winding in order to complete the program. In this problem, the negative values are discarded. From the information on these tapes, a master winding sheet can be generated (**Fig 8**).

Should an error arise, it is very easy to review the generated paper tapes and master sheets to determine the source. Obviously, a great amount of time is saved using the programmable calculator instead of computing everything by slide rule or interpreting graphs to obtain the answers. □

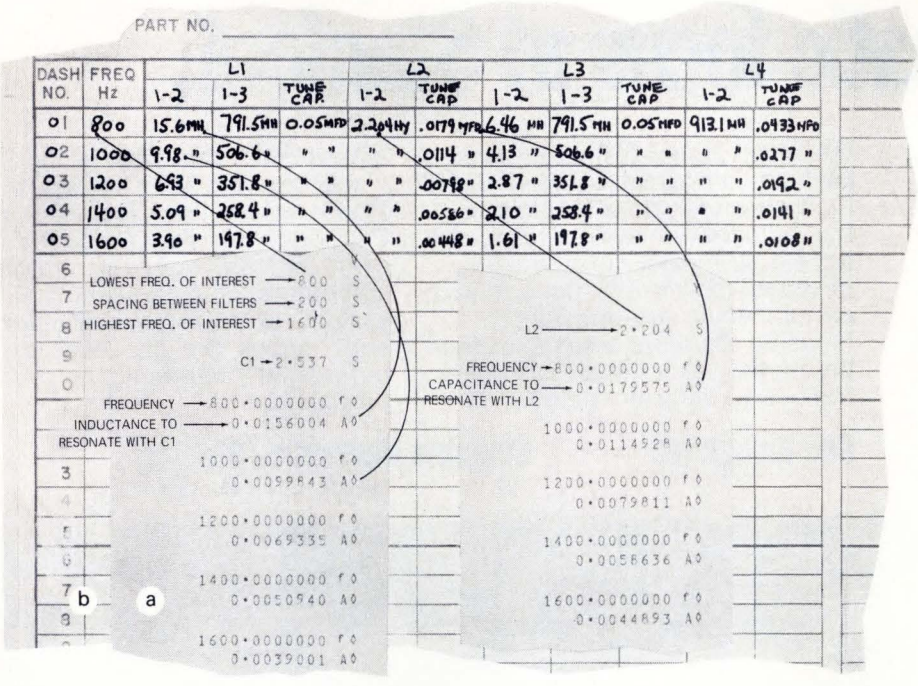


Fig. 8—**Sample print out (a)** of the frequency and inductance or capacitance required to resonate at that frequency. Tape information is transferred to the work sheet (**b**).

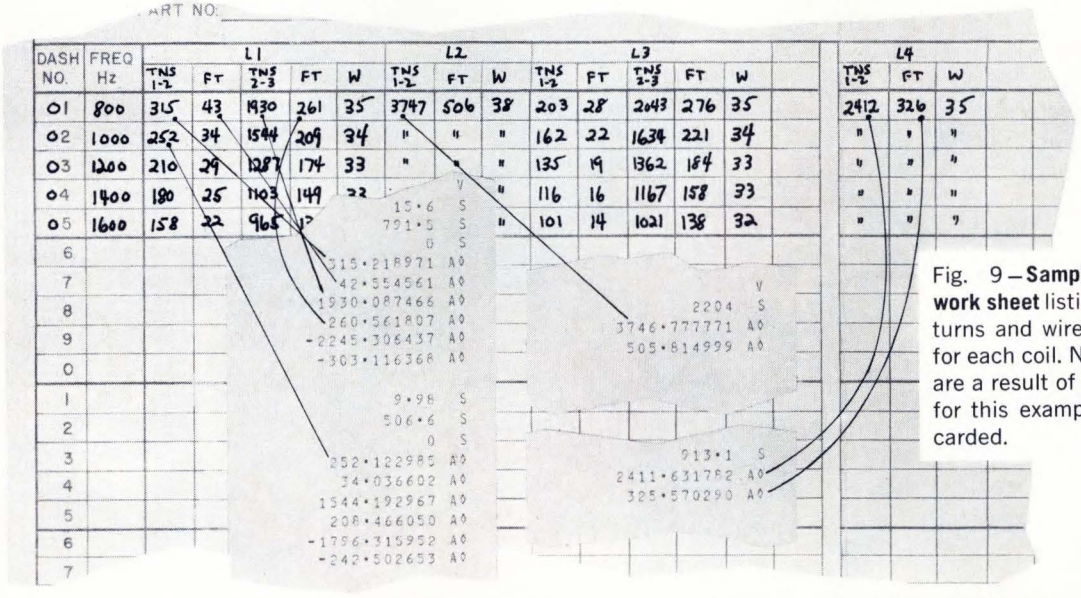


Fig. 9—**Sample printout and work sheet** listing the number of turns and wire length required for each coil. Negative numbers are a result of the program and for this example, they are discarded.

PROGRAMMABLE CALCULATOR ACTIVITIES

Desk-top programmable calculators have become one of the fastest-growing areas in today's market. With the constant introduction of new designs, these calculators provide greater problem-solving capacity at lower cost. Companies that have entered this venture include:

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440 Logue Ave.
Mountain View, CA 94040

Eugene Dietzgen Co.
2425 N. Sheffield
Chicago, IL 60614

Friden, Div. of the Singer Co.
2350 Washington Ave.
San Leandro, CA 94577

Hewlett-Packard
Box 301
Loveland, CO 80537

Mathatronics of Pennsylvania
241 Crescent St.
Waltham, MA 02154

Monroe Div., Litton Industries
550 Central Ave.
Orange, N J 07050

Olivetti-Underwood Corp.
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New York, NY 10016

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New York, NY 10017

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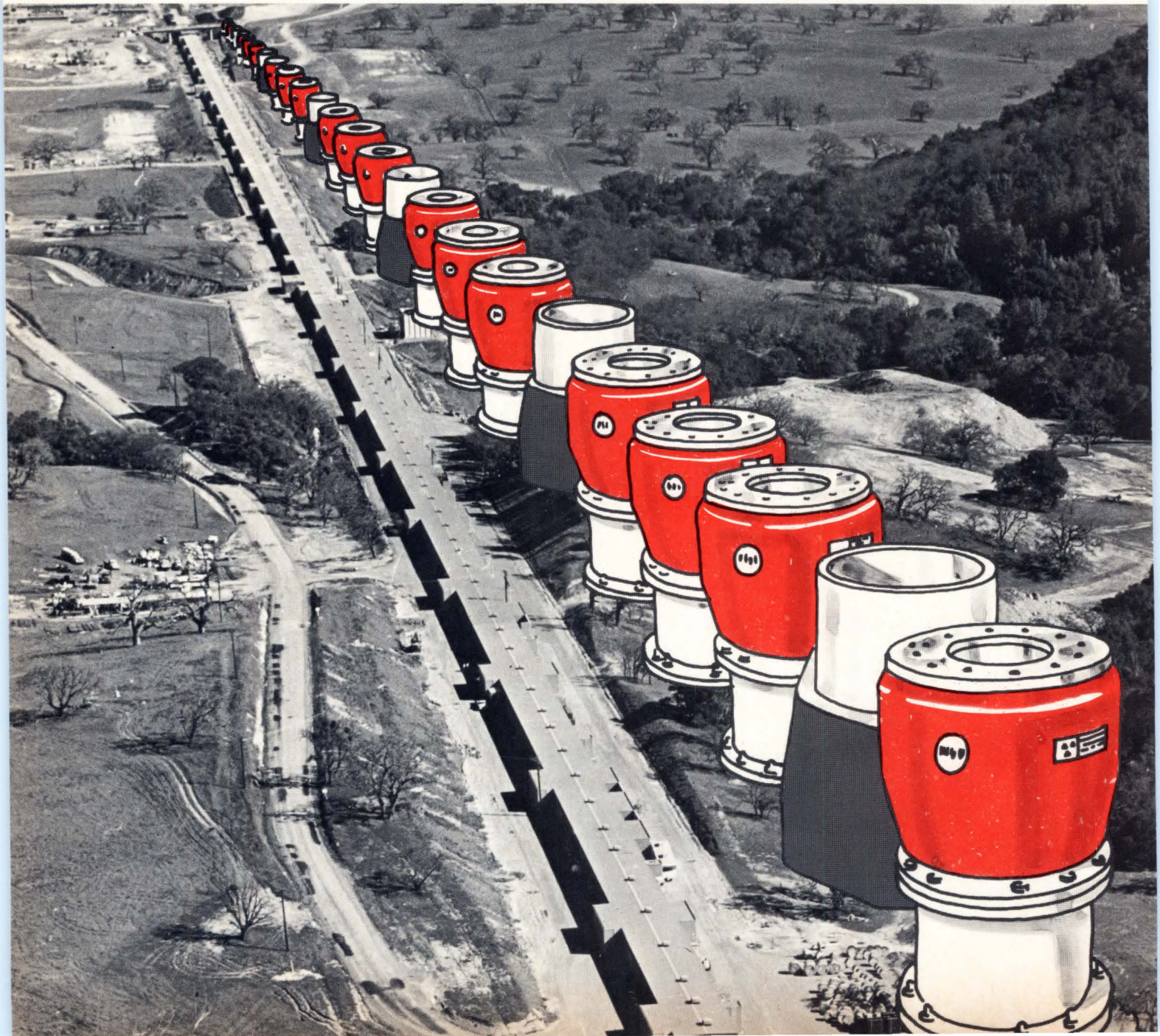


STREAMLINE FLOW GRAPHS FOR ACTIVE CIRCUITS

Flow graphs are effective for circuit analysis, but they often invite error by carrying extraneous detail. Judicious parameter selection and the superposition theorem tailor flow graphs—effectively.

ALLSTON L. JONES, Philco-Ford Corp.

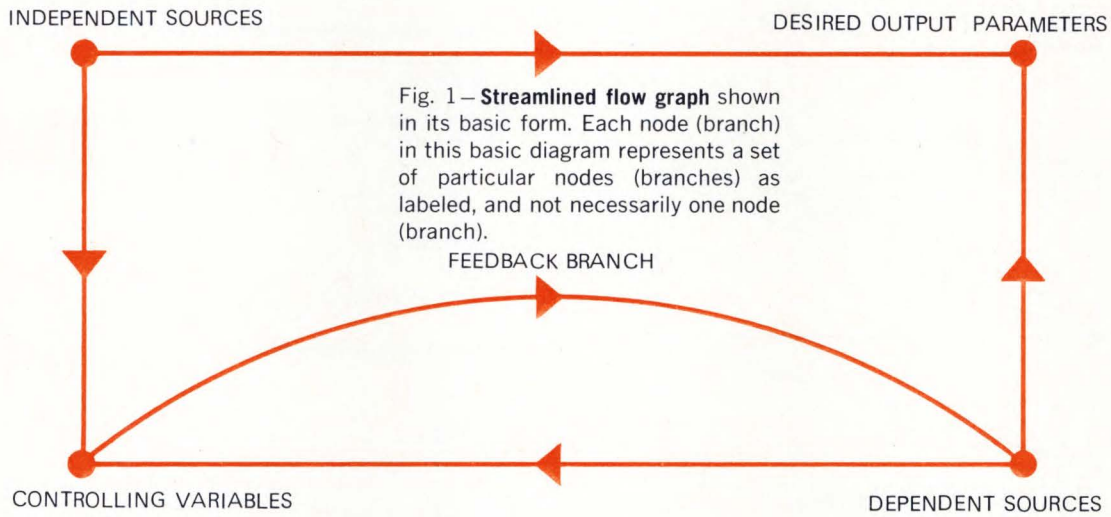


Fig. 1—**Streamlined flow graph** shown in its basic form. Each node (branch) in this basic diagram represents a set of particular nodes (branches) as labeled, and not necessarily one node (branch).

Designers frequently overcrowd their flow graphs with branch voltages and internode currents that create superfluous forward paths and loops. During flow-graph reduction, these added paths and loops usually demand more algebraic footwork—a tedium that easily introduces error. To maximize a flow graph's power as an analysis tool, it should depict only that information essential to solving the problem under study. Flow graphs can be quickly simplified by following a three-step recipe.

Selection and Superposition

Parameter selection and the superposition theorem—these are the keys to achieving the basic form of the streamlined flow graph shown in **Fig. 1**. Three steps must be followed to get this basic form.

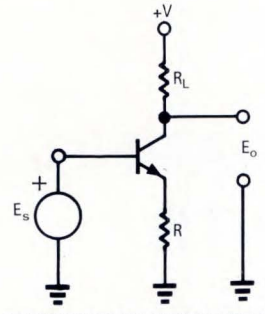
1. Select the minimum number of parameters to solve the problem, and using these, form the nodes of the flow graph. (As depicted in **Fig. 1**, the parameters to be selected are the independent and dependent sources, the controlling variables, and the desired output parameters.)

2. Apply superposition for each dependent and independent source in the equivalent circuit. This determines, one by one, the path gains caused by each of these sources.

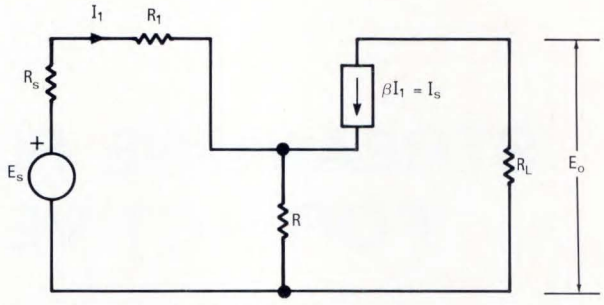
3. Add the feedback branches between the dependent sources and the controlling variables as shown in **Fig. 1**.

After drawing the simplified flow graph according to

(Continued)



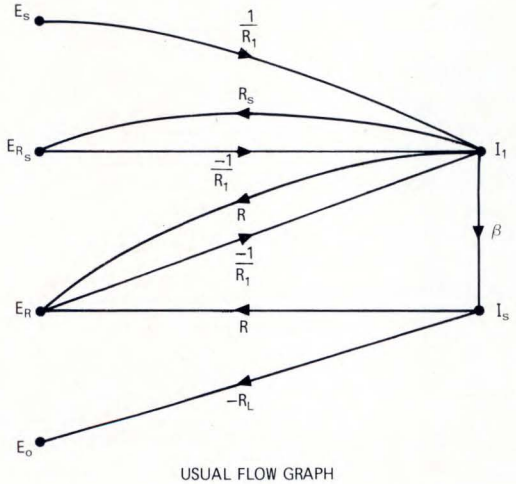
SINGLE-STAGE TRANSISTOR AMPLIFIER



EQUIVALENT CIRCUIT

PROBLEM: **USING FLOW-GRAPH TECHNIQUES, DETERMINE THE VOLTAGE GAIN E_o/E_s FOR THE SINGLE-STAGE TRANSISTOR AMPLIFIER.**

USUAL APPROACH



USUAL FLOW GRAPH

APPLYING MASON'S RULE

$$\frac{E_o}{E_s} = \frac{\frac{-\beta R_L}{R_1}}{1 + \frac{R_s}{R_1} + \frac{R}{R_1} + \frac{\beta R}{R_1}}$$

$$= \frac{-\beta R_L}{R_1 + R_s + (\beta + 1) R}$$

MORE EFFICIENT APPROACH

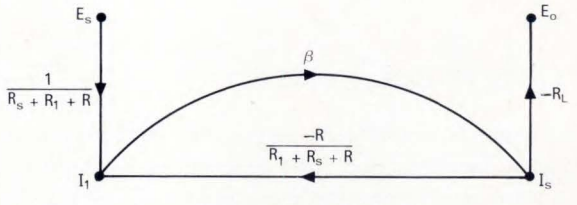
1. SELECT NODES FOR FLOW GRAPH: E_s (INDEPENDENT SOURCE); I_s (DEPENDENT SOURCE); I_1 (CONTROLLING VARIABLE); E_o (DESIRED PARAMETER).
2. APPLY SUPERPOSITION TO FIND INDIVIDUAL BRANCH GAINS:
   (a) EFFECT OF E_s

$$\frac{I_1}{E_s} = \frac{1}{R_s + R_1 + R}$$

   (b) EFFECT OF I_s

$$\frac{E_o}{E_s} = -R_L \text{ AND } \frac{I_1}{I_s} = \frac{-R}{R_1 + R_s + R}$$

3. GAIN OF FEEDBACK BRANCH: β



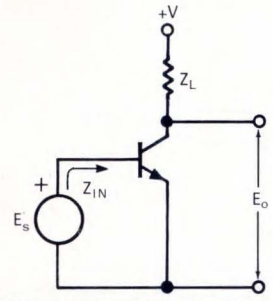
SIMPLIFIED FLOW GRAPH

APPLYING MASON'S RULE:

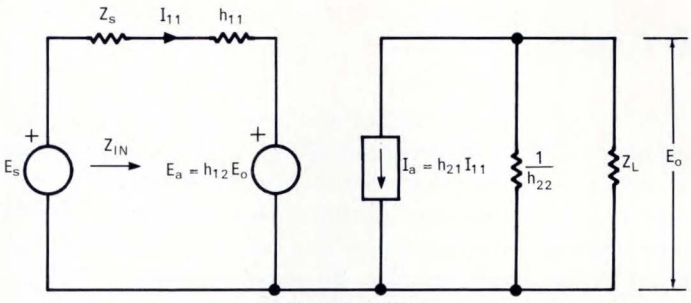
$$\frac{E_o}{E_s} = \frac{\frac{-\beta R_L}{R_1 + R_s + R}}{1 + \frac{\beta R}{R_1 + R_s + R}}$$

$$= \frac{-\beta R_L}{R_1 + R_s + (\beta + 1) R}$$

Fig. 2– **Example No.1** analyzes a single-stage transistor amplifier for its voltage gain E_o/E_s.



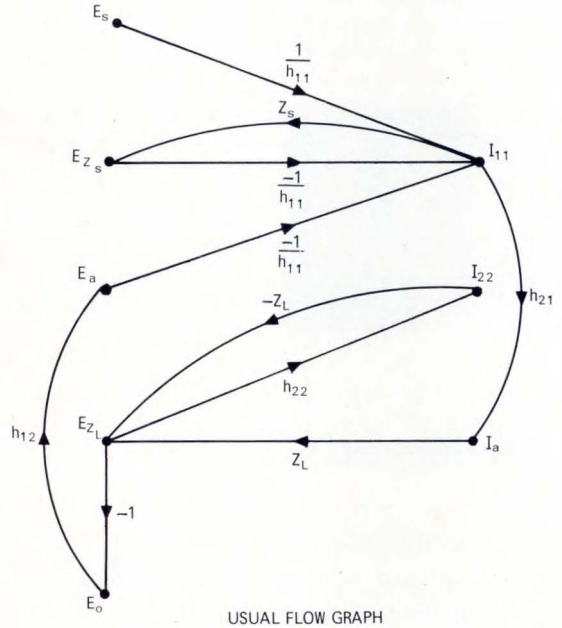
COMMON-EMITTER TRANSISTOR AMPLIFIER



EQUIVALENT CIRCUIT

PROBLEM: USING FLOW-GRAPH TECHNIQUES, DETERMINE THE VOLTAGE GAIN E_o/E_s FOR THE COMMON-EMITTER TRANSISTOR AMPLIFIER.

USUAL APPROACH



USUAL FLOW GRAPH

APPLYING MASON'S RULE

$$\frac{E_o}{E_s} = \frac{\frac{-h_{21}Z_L}{h_{11}}}{1 + \frac{Z_s}{h_{11}} + Z_L h_{22} - \frac{h_{12}h_{21}Z_L}{h_{11}} + \frac{Z_s Z_L h_{22}}{h_{11}}}$$

MORE EFFICIENT APPROACH

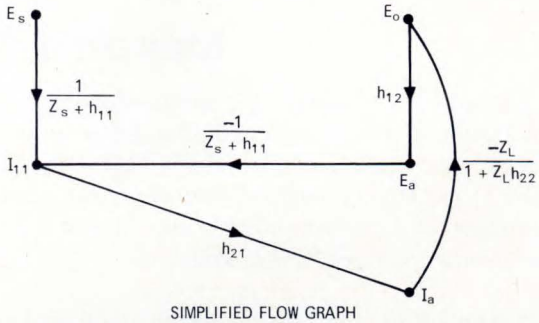
1. SELECT NODES FOR FLOW GRAPH: E_s (INDEPENDENT SOURCE); E_a AND I_a (DEPENDENT SOURCES); I_{11} AND E_o (CONTROLLING VARIABLES); E_o (ALSO DESIRED PARAMETER).

2. APPLY SUPERPOSITION TO FIND INDIVIDUAL BRANCH GAINS:
   (a) EFFECT OF E_s $\quad \frac{I_{11}}{E_s} = \frac{1}{Z_s + h_{11}}$

   (b) EFFECT OF E_a $\quad \frac{I_{11}}{E_a} = \frac{-1}{Z_s + h_{11}}$

   (c) EFFECT OF I_a $\quad \frac{E_o}{I_a} = \frac{-Z_L}{1 + Z_L h_{22}}$

3. GAIN OF FEEDBACK BRANCHES:
   $\frac{I_a}{I_{11}} = h_{21}$ AND $\frac{E_a}{E_o} = h_{21}$



SIMPLIFIED FLOW GRAPH

APPLYING MASON'S RULE

$$\frac{E_o}{E_s} = \frac{\frac{-h_{21}Z_L}{(Z_s + h_{11})(1 + h_{22}Z_L)}}{1 - \frac{h_{12}h_{21}Z_L}{(Z_s + h_{11})(1 + h_{22}Z_L)}} = \frac{-h_{21}Z_L}{(h_{11} + Z_s)(1 + h_{22}Z_L) - h_{12}h_{21}Z_L}$$

Fig. 3 – **Example No.2** analyzes a common-emitter transistor amplifier for its voltage gain E_o/E_s.

(Continued)

Flow Graphs (Cont'd)

these three steps, we now can perform some means of flow-graph reduction. By reviewing Mason's Rule (see boxed information), we can appreciate how the simplified flow graph can minimize algebraic manipulation. To illustrate this, two circuits are analyzed: a single-stage transistor amplifier (**Fig. 2**) and a common-emitter transistor amplifier (**Fig. 3**).

Final Note

The simplified flow graph method is by no means restricted to finding voltage gains. Although the resultant flow graph is primarily limited to those values for which it is tailored, it's often possible to determine other parameters without any changes. For example, the input impedance (Z_{in}) of the circuit in **Fig. 3** can be found from the same flow graph by letting $Z_s = 0$, solving for I_{11}/E_s, and then finding the reciprocal to get Z_{in}.

If several parameters are of interest, the simplified flow graph may not be simpler than the usual flow graph, but it will never be more complex. Generally, the designer who adopts this method will find that he has made his flow graph a more efficient tool . . . and he isn't likely to miss an essential forward path or loop because of superfluous detail. □

Databank

The author recommends the following references:

1. "Feedback Theory: Some Properties of Signal Flow Graphs" by S. J. Mason; Proc. IRE, Vol. XLI, No. 9, Sept. 1953.

2. "Feedback Theory: Further Properties of Signal Flow Graphs" by S. J. Mason: Proc. IRE, Vol. XLIV, No. 7, July 1956.

3. "Linear Graphs and Electrical Networks" by S. Seshu and M. B. Reed; Addison-Wesley, 1961.

EDN also recommends:

"Introductory Topological Analysis of Electrical Networks" by Shu-Park Chan; Holt, Rinehart, and Winston, 1969. This text contains an up-to-date discussion of flow-graph techniques for linear system analysis.

Allston Jones, Philco-Ford project engineer, designs timing and multiplexing circuits for a space vehicle telemetry generator. With an M.S.E.E. from Purdue University, he currently continues his education at Stanford University.

Mason's Rule Reviewed

Despite its complex derivation, Mason's Rule (or Gain Formula) continues to enjoy popularity, especially in the control systems field. Based on the cause-effect relationships between inputs and outputs of a system under study, Mason's Rule efficiently reduces flow graphs.

Mason's Rule: Let T be the overall graph gain and T_k be the gain of the k^{th} forward path from source to sink; then

$$T = \frac{1}{\Delta} \sum_k T_k \Delta_k$$

where:

$$\Delta = 1 - \Sigma P_1 + \Sigma P_2 - \Sigma P_3 + \cdots + (-1)^j \Sigma P_j$$

with:

P_1 = loop gain (*first-order* loop).

P_2 = loop gain products of all possible combinations of two non-touching* loops. (*second-order* loops).

P_3 = loop gain products of all possible combinations of three non-touching* loops. (*third-order* loops).

P_j = loop gain products of all possible combinations of j non-touching* loops (j-*order* loops).

Δ_k = value of Δ not touching the k^{th} forward path.

**Two loops are considered "non-touching" when there are no common nodes between them.*

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40752	20 A	600 V	2N5572	15 A	400 V
2N690	25 A	600 V	40671	30 A	600 V
2N3899	35 A	600 V	2N5543	40 A	600 V

NOTE: SCR ratings of 100, 200, & 400 volts and triac ratings of 200 & 400 volts are available in each family. Stud packages & isolated-stud packages are also available in each rating.

For further details and your copy of the latest thyristor catalog, THC-500, see your local RCA Representative or your RCA Distributor. Or write RCA Electronic Components, Commercial Engineering, Section 5-15/UR6, Harrison, N.J. 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

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CIRCLE NO. 60

Shunt Regulator Has Optimized Gain

ROY W. FORSBERG, Boston Regional Editor

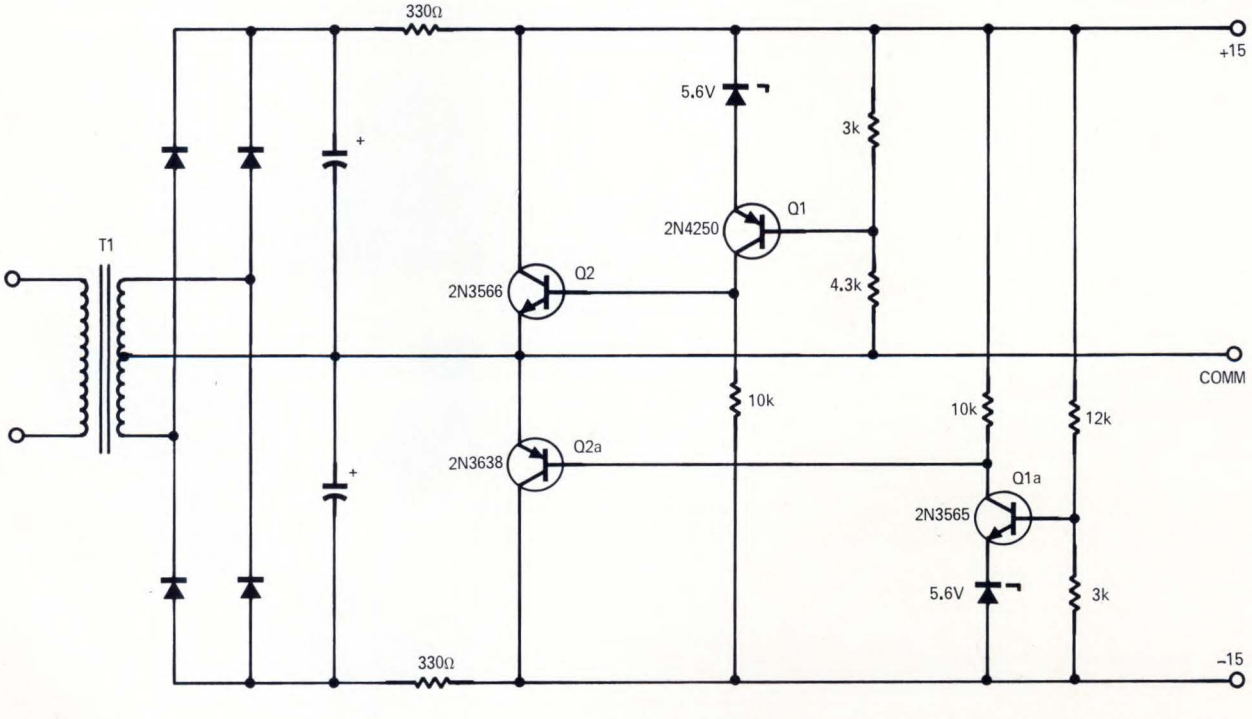
Power supplies for small IC systems seldom are scaled down for the small size, low cost performance needs of the system. Here is one compatible solution.

It seems illogical to design a small linear IC system and then use a power supply that is as big as the system itself, that makes up a substantial portion of the cost and that uses more power for its operation than it puts out. About 75 percent of small IC systems don't need precise regulation but do need more than zener limiting. One answer is to use a shunt-regulator circuit with optimized gain. A small IC system is one that uses 1 to 4 linear IC's such as op amps, multipliers or other function modules. These are commonly used in medical instruments, oceanographic measuring instruments, small computer peripherals like phone acoustic couplers, and environmental measuring instruments. This type of supply would also be used in very large systems to supply small circuits in different sections, thereby keeping down power supply noise and eliminating grounding problems.

The key to this power supply circuit is a high Beta shunt regulator driven by a current source. Q1 is made a current source by returning its collector through a high value resistor to the output of the other half of the supply.

What kind of performance can you expect from this economy supply? Surprisingly good! You get 25 mA at ±15V with 1-mV PP ripple, enough to power four moderate size IC's. Voltage regulation will hold within 0.2 percent for load variations from infinity to 600Ω, 0 to 25 mA output, and with line voltage changes from 105 to 125V. About 225 mW is consumed to get as much as 375 mW out. □

Semiconductor Circuits, Woburn, Mass. uses this idea of optimizing gain in a series of small IC power supplies.



Optimized shunt regulator supplies up to four typical linear IC circuits. Collectors of constant current stages Q1 and Q1a are returned through high-impedance (10K) resistors to the other half of the supply, thereby optimizing their gain, Matching of Q1 to Q2 results in an open loop gain reaching practical theoretical limits. In a sense, we pick up the gain of an extra transistor at about half the cost of supplies with comparable performance. This eliminates the need for additional transistor stages between Q1 and Q2. The −15V supply is made to track the +15V supply by referencing Q1a sense resistors to the +15V side rather than to circuit common.

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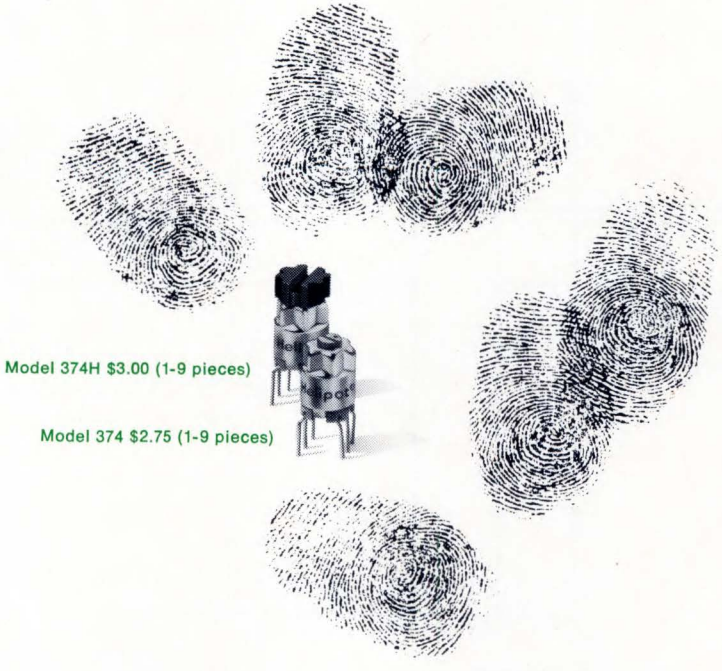

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CIRCLE NO. 30

"U" Cores Speed ROM Quick-Change

"Do-it-yourself" alteration of read-only memories? This design makes it easy, cuts down-time and costs with a 30-minute operation.

ROY W. FORSBERG, Boston Regional Editor

Read-only memories offer speed, low cost and nonvolatility in the expanding mini-computer and desk-top calculator market. Biggest drawback to widescale use in the past has been that ROM's were costly to alter, especially when fabricated with bipolar or MOS devices. This drawback no longer exists. Today there is a variety of alterable ROM's available. Resistor and diode types can be altered mechanically after manufacture; braid transformer types can be altered mechanically any time. Electrically alterable core and magnetic domain memories are being developed.

Braid transformer ROM's are the quickest and easiest to alter. Such an ROM follows the Diamond Ring Transformer principle (**Fig. 1**) originally developed by Bell Labs. Stringing wires through a single circular core is costly and difficult, so Memory Technology, Sudbury, Mass., came up with the "U" type core construction (**Fig. 2**) which is shown in the remainder of the illustrations. With this method, a technican in the field can alter a number of words in the

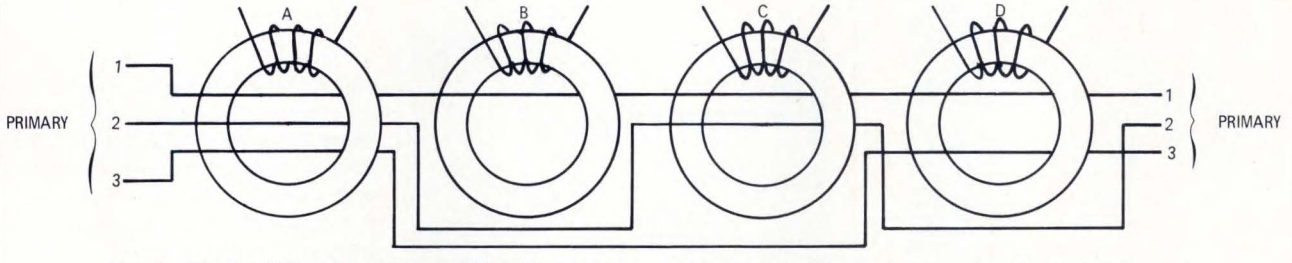

Fig. 1—**Diamond Ring** Transformer Principle is basically a string of cores on which an individual multiturn secondary, or sense winding, is wound. Primary winding consists of a single wire running either through the center of the core (to store a "1") or around the outside (to store a "0"). The single wire represents one word. When the primary is pulsed, all secondaries with a wire running through the core will sense an output representing a "1" state. Those cores with the primary wire running outside see no pulse and hence represent "0" state. Thus, primary wire No. 1 represents 1111, while primary wire No. 2 represents 1010, and finally primary wire No. 3 represents 1001.

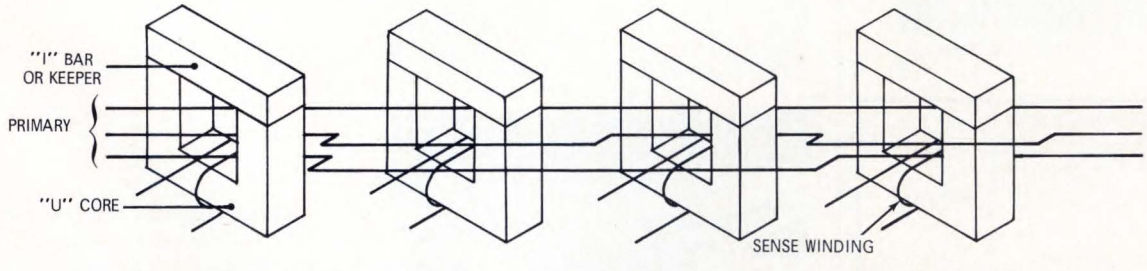

Fig. 2—**The toroidal core** is replaced by a "U" core with removable keeper. In manufacture, the sense winding is wound on the "U" core, pre-assembled braid is laid over the set of cores, and all keeper bars are simultaneously placed over tops of "U" cores via cover plate.

(Continued)

FOR A FREE REPRINT OF THIS ARTICLE, **CIRCLE NO. L64**

ROM's (Cont'd)

memory in about 30 min. In production, orders can be changed quickly and cheaply by changing the punched tape that controls the special loom that weaves the braid. In fact, complete alterations are so easy that a "Rapid Braid" service is offered by Memory Technology to make entirely new braids or crash changes within 72 hours. When a completely new program is required, a new braid can replace the old in minutes without having to change any of the electronics. □

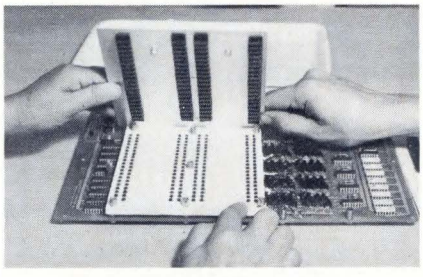

Fig. 3—**Cover plate,** with keeper bars attached, is shown being removed from the "U" cores. Core ends project through holes in the braid assembly. The braid is potted permanently which allows user to remove entire memory contents without removing the electronics.

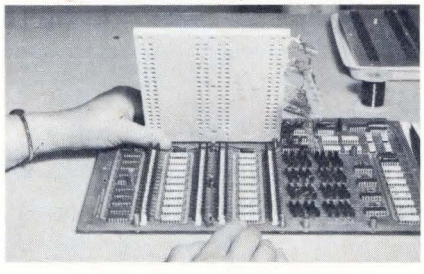

Fig. 4—**Braid assembly** and braid termination connectors are being removed from main circuit board. Notice "U" cores are permanently fixed to PC board.

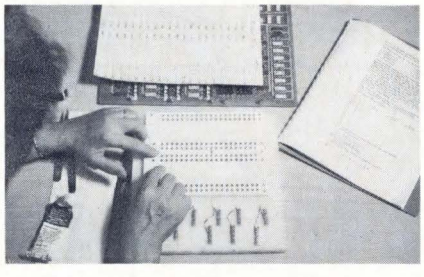

Fig. 5—**Wire number** containing word to be modified is located with a program chart and instruction manual. A new wire map is drawn incorporating bit changes and, using the map as a guide, new wire is strung on braid board and held down with quick-drying adhesive.

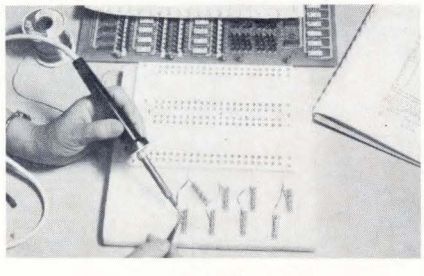

Fig.6—**One end** of the new wire is soldered to correct pin of braid termination connector as shown. Other end of wire is soldered to common current source pin.

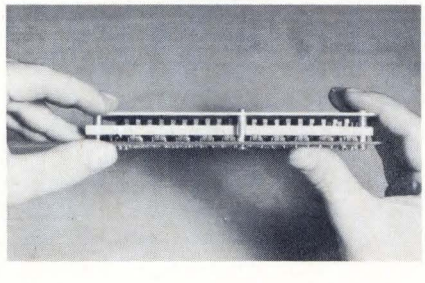

Fig. 7—**Braid assembly** is finally replaced over "U" cores, keeper assembly is replaced and job is complete.

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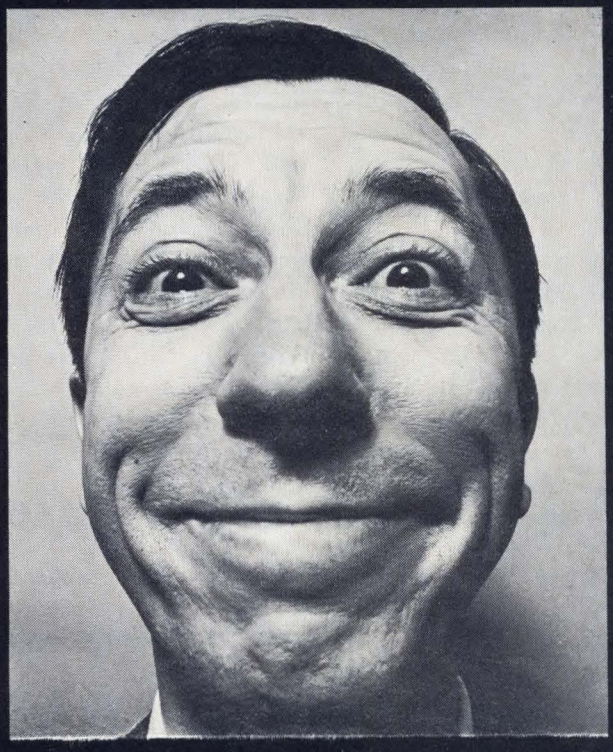

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CIRCLE NO. 31

Minicomputer Gets Tough!

THOMAS P. RIGOLI, San Francisco Regional Editor

Take one versatile minicomputer, add innovative packaging, and get a rugged computer that operates under extremes of shock, vibration, RFI, temperature and humidity. Then stick on a label: "Ruggednova".

Just how do you build an off-the-shelf, general-purpose minicomputer that can fly, travel the backroads and meet airborne, shipboard and ground-based demands of MIL-E-5400, 16400 and 4158? A West Coast firm tackled this problem just over a year ago. Two months ago they began making deliveries of their solution – a rugged minicomputer that can virtually "go anywhere" in harsh industrial and military environments.

Before entering a marketplace dominated by giants, Rolm Corp. of Cupertino, Calif., established a licensing agreement with Data General Corp. This agreement allowed Rolm to combine their rugged package concepts with the computer architecture of Data General's "Nova". Dubbed the "Ruggednova," Rolm's minicomputer owes its muscle to innovative packaging.

Shown in **Fig. 1**, an aluminum ATR box (7.61 by 10.25 by 12 in) forms the heart of the "Ruggednova." Designed to accommodate 14 rugged printed-circuit modules plus the power supply, this ATR also may be mounted in a 19-in RETMA rack. Five PC modules make up the central processing unit, leaving the remaining nine slots available for system options such as an extended arithmetic unit, ROMs and peripheral-interface modules. Each PC module has an aluminum cover fastened atop it to enhance rigidity. These rigid covers prevent flexing, and hence cracking, of the PC modules during shock and vibration. When emplaced in the ATR box, each of the covered PC modules is firmly secured by flanking aluminum wedges. Associated with each wedge are two screws that are accessible from the outside of the ATR box. When tightened, these screws draw the wedge in, thus creating a firm marriage between the PC modules and the ATR box. Besides enhancing package rigidity, the aluminum wedges also create an excellent ther-

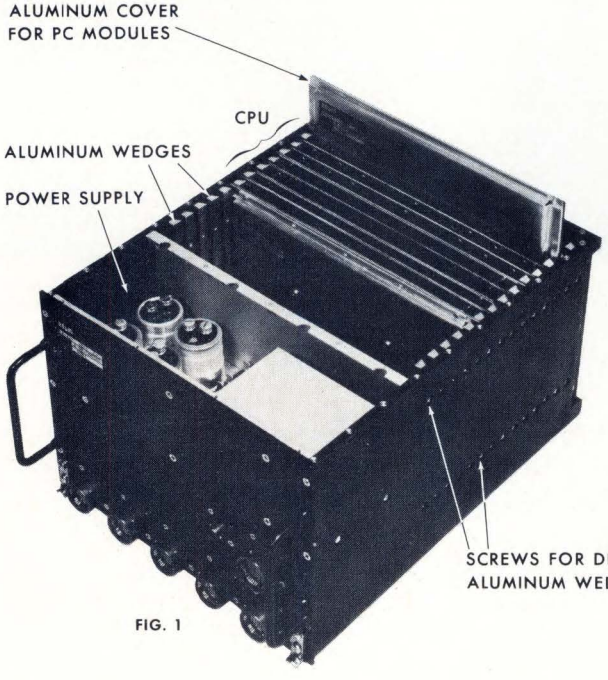

Fig. 1 – **CPU and power supply** are housed in an aluminum Aircraft Transport Racking (ATR) box. Aluminum covers prevent PC modules from "oilcanning" during shock and vibration. Aluminum wedges enhance both rigidity and cooling by forcing firm physical and thermal contact between the PC module and ATR housing. RFI gasketing (not shown) and compartmentalization insure that RFI integrity meets MIL-Std-461A.

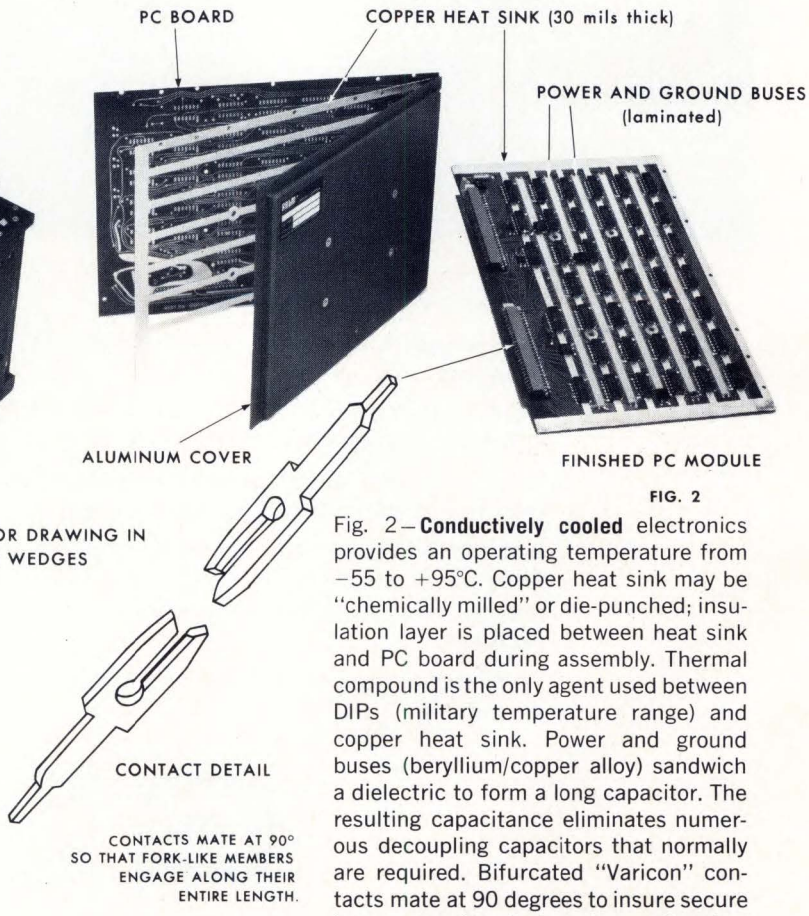

Fig. 2 – **Conductively cooled** electronics provides an operating temperature from −55 to +95°C. Copper heat sink may be "chemically milled" or die-punched; insulation layer is placed between heat sink and PC board during assembly. Thermal compound is the only agent used between DIPs (military temperature range) and copper heat sink. Power and ground buses (beryllium/copper alloy) sandwich a dielectric to form a long capacitor. The resulting capacitance eliminates numerous decoupling capacitors that normally are required. Bifurcated "Varicon" contacts mate at 90 degrees to insure secure interconnection during severe vibration.

mal contact between the PC module's heat sink and the ATR housing.

Needing no forced air or liquid coolant, the conductively cooled electronics provides an operating temperature range of −55 to +95°C. As shown in **Fig. 2**, the dual in-line packages are conductively cooled in an interesting way. Each DIP mounts on an all-copper heat sink that extends to the sides of the PC modules. This copper heat sink contacts the aluminum cover, and this in turn contacts the cold plate of the ATR box. Coupling this novel cooling system with extensive use of MSI TTL provides a mean-time-between-failure that exceeds 11,000 hours (calculated according to MIL-Hdbk-217A). To compare the "Ruggednova" PC module with its "Nova" counterpart, check **Fig. 3**.

The packaging rigor of the CPU also is extended to its options. **Fig. 4** displays two options that interface with the basic ATR box, the severe environment control panel and the core memory module. Interfaced to the ATR box via cables, the control panel may be operated locally or remotely. Highly reliable light-emitting diodes (Hewlett-Packard) are used for all panel indicators. Wide-temperature-range 4K-core memory modules, 3.25 inches deep, plug into the back of the ATR box. Up to eight memory modules (32K), sequentially plugged in, can be handled by the power supply. If desired, the maximum limit of 32K may be reached by intermixing the core memory modules and ROM printed-circuit modules.

Rolm's supermini can fly to 80,000 ft—endure explosive atmosphere, sand, dust and salt spray—resist fungus and live in 95 percent humidity. All environmental ratings meet the appropriate military specifications.

The CPU with four hardware accumulators, 16 priority interrupts, addressing capability for up to 62 peripheral devices, direct memory access, power failure protect and auto restart, teleprinter interface, power supply and 4K words (8K bytes) of core memory is priced at less than $20,000. □

Databank

For a brochure that fully describes the "Ruggednova's" electrical specifications, circle No. 401.

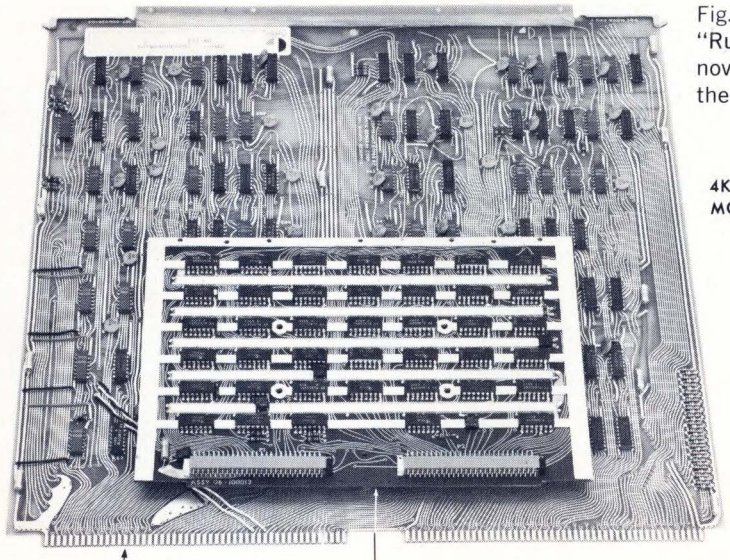

FIG. 3

Fig. 3—**Packaging difference** between "Nova" and "Ruggednova" PC modules. Although the "Ruggednova" uses the computer architecture of the "Nova", the packaging concepts are markedly different.

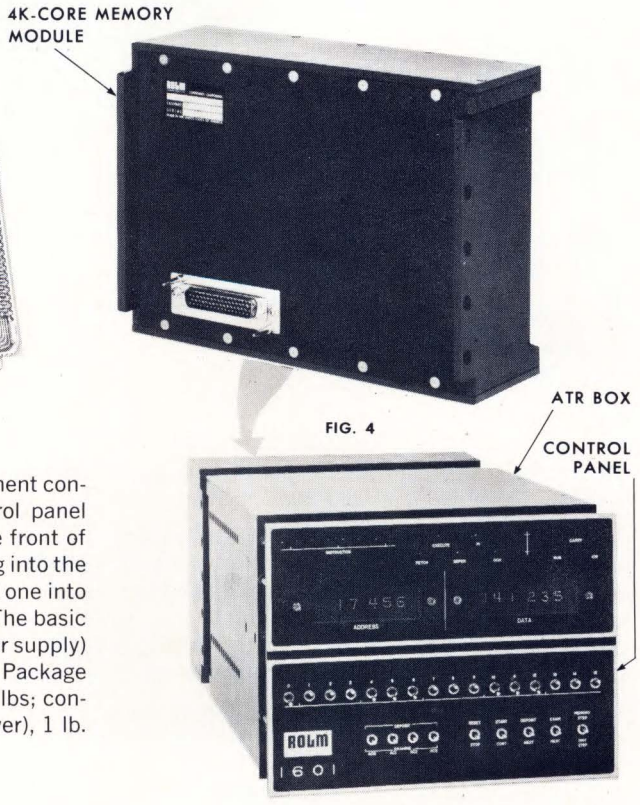

FIG. 4

Fig. 4—**Rugged options** include a severe-environment control panel and 4K-core memory module. Control panel interfaces via cables (locally or remotely) to the front of the ATR box while the core memory modules plug into the rear. Up to eight core memory modules, plugged one into the other, can be handled by the power supply. The basic package comprising the ATR box (CPU plus power supply) and one core memory module weighs 35 lb. Package weight breaks down as: core memory module, 9 lbs; control panel, 6 lbs; PC module (with aluminum cover), 1 lb.

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WIDTH	3 3/8"	4 1/16"	4 1/16"	4 1/16"	7 1/2"	7 1/2"	7 1/2"	19"	19"
DEPTH	6 1/2"	6 1/2"	9 3/8"	9 3/8"	9 3/8"	11 3/4"	16 1/2"	16 1/2"	16 1/2"
VDC	AMPERES								
3.6	2.0	3.8	5.2	11.0	13.1	21.0	32.0	48	85
5.0	2.0	3.7	5.1	10.5	12.6	20.0	31.0	48	80
6.0	2.0	3.2	4.8	9.0	12.4	19.0	30.0	47	80
12.0	1.2	2.5	4.0	7.3	10.0	15.0	21.0	33	56
15.0	1.2	2.2	3.5	6.0	9.0	14.0	19.0	25	45
24.0	0.80	1.4	2.5	4.0	6.7	11.0	14.0	20	32
28.0	0.66	1.3	2.3	3.5	6.0	10.0	13.0	19	28

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CIRCLE NO. 32

Synchronized Gating Kills ± One-Count Ambiguity

Because of the phase relationship which exists between counter main gate opening and input signal rise, frequency counters have trouble with their least significant digits. Synchronized gating solves the problem.

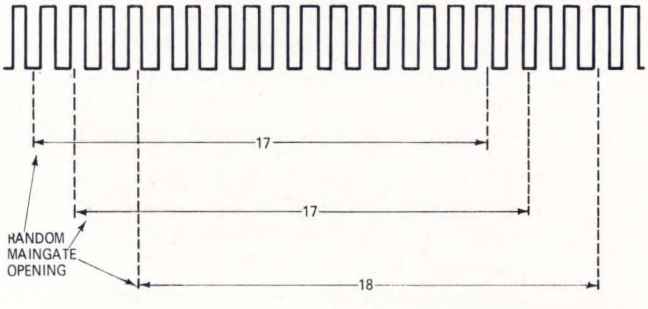
RICK WHITNEY, Itron Corp.

Digital counters can read one count too high or low, depending upon the point in the input pulse train at which the main gate opens. Eliminating this random phase relationship by synchronizing input pulse initiation and gate opening will cause the count to be the same for each measurement of a given, stable signal.

The possible error will be reduced to minus one count, and the transfer point resolution is increased substantially. This is the point at which the least significant decade transfers up one count, which permits precise setting of low frequencies beyond those frequencies that can be seen on the count display. □

Circuit additions to typical frequency counter required to synchronize main gate control with input signal shown shaded in block diagram. Objective is to enable main gate only when input signal crosses axis (or threshold). Main gate is enabled by flip-flop F/F2, as clocked by internal crystal oscillator pulses, which are locked out by time base gate until it is enabled by F/F1. F/F1 is set by a pulse representing an axis crossing from signal conditioner. Once time base gate is opened, next oscillator pulse will cause main gate to open in under 1 μs. It is important to note that time base divider was set to 9s after previous reading when sample rate delay reset counter for new sample. Oscillator pulse which causes main gate to open also sets time base divider to zero. After selected number of clock pulses has been received by time base divider, F/F2 will again be toggled and main gate closed.

By synchronizing main gate time with an input signal axis (or threshold) crossing, ±1 count ambiguity as indicated by floating gating can be reduced to minus 1 count. Further, transfer point resolution, where least significant decade transfers up one count, becomes an exact decade point, permits precise setting of low frequencies. For example, an external VFO can be set precisely to 400.000 Hz by adjusting it to point where counter readout display reads 399 Hz. VFO frequency is then slowly increased to where displayed count just changes to 400. Operator can now be sure of 400 Hz without ± one count ambiguity.



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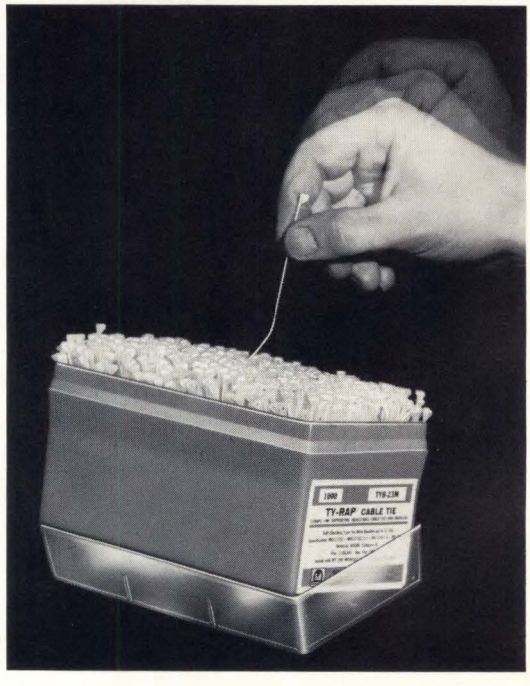

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441

CIRCLE NO. 33

CUSTOMER ENGINEERING CLINIC

Zener Zaps Regulator Shut-Down

ANTHONY J. SOFIA, Anco Corp.

Problem: An airborne power supply for a large number of op amps was designed with only a negative dc-to-dc converter in order to conserve size, power and weight (**Fig. 1**). However, when power is applied, the minus regulator shuts down, even though no short circuit exists.

Discussion: Voltage regulators were selected to provide foldback current limiting by means of sensing resistor R_s (**Fig. 2**), so that voltage developed across R_s at designed short-circuit current will shut the regulator down. Unfortunately, due to the inherent delay caused by converter start-up when power is applied, the positive supply reaches operating levels before the negative, leaving the op amps unbalanced. The resulting positive feedthrough voltage, sensed as a short-circuit condition at the minus regulator sense line, causes the regulator to shut down, even though the converter is supplying a high negative voltage to the regulator input terminal.

Solution: A zener diode placed across input-sense terminals (**Fig. 3**) prevents regulator shutdown under the above conditions. This method is proposed over other methods such as bleeding some converter voltage to the output or using a relay, because it is simple, reliable and has little effect on regulator operation. □

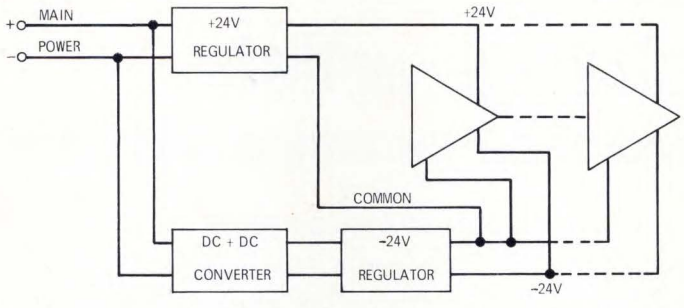


Fig. 1 **Airborne op amp power supply** using only one dc-to-dc converter.

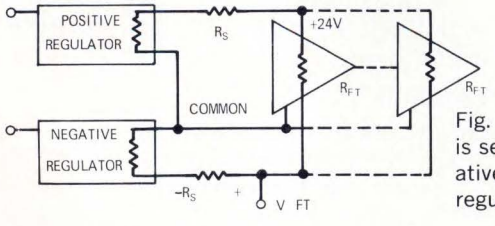
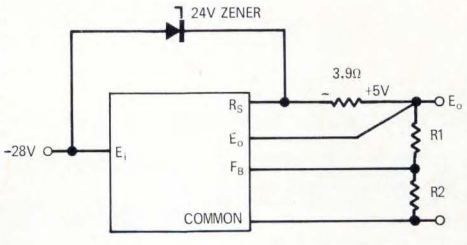


Fig. 2 **Op amp feedthrough voltage** is sensed as a short-circuit by negative R_s and shuts down negative regulator.

Fig. 3 **Regulator operation.** Assume +5V is applied to the regulator sense line as the converter starts to supply voltage to the input. As the converter reaches −19V, the zener conducts and starts driving the +5V to 0V, and the regulator, sensing a GO condition, turns ON. The zener turns off at −8V and has little effect on regulator performance.

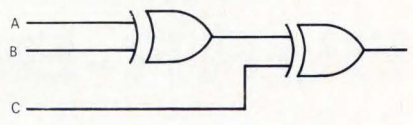


EDN will pay $50 for any problem-solution article accepted for publication.

NEXT ISSUE'S PROBLEM:

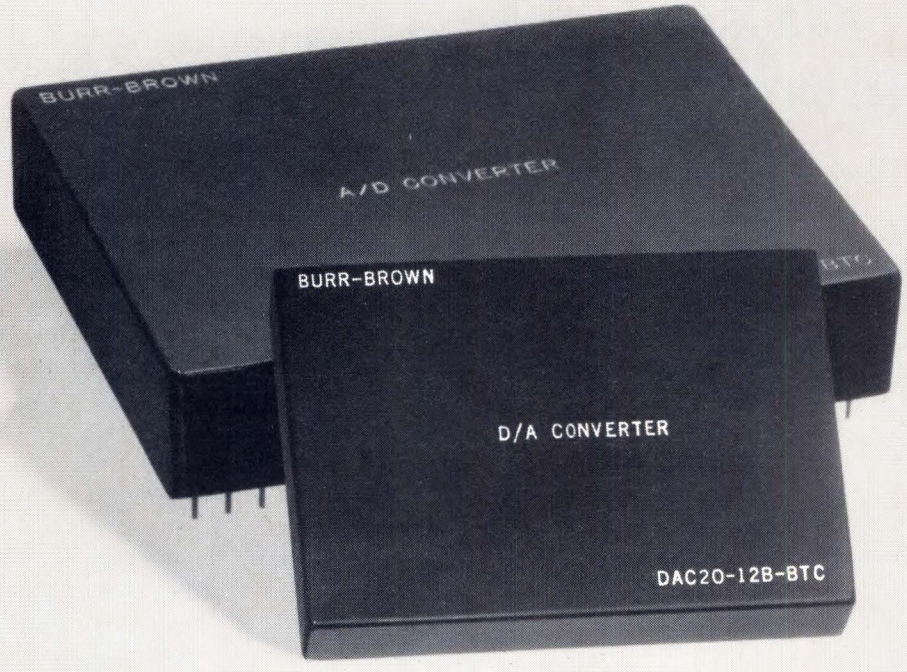
Cascaded Exclusive ORs Give Extraneous Outputs

At the outset, when two or more exclusive-OR elements are connected in cascade to obtain the exclusive-OR function of more than two variables, certain combinations give what appears to be a false output—until analysis proves their legality.



FOR A FREE REPRINT OF THIS ARTICLE, **CIRCLE NO. L67**

New, high-speed A/D-D/A converters from Burr-Brown



quick-change artists

with a practical blend of performance and price

ANALOG-TO-DIGITAL UNITS

These self-contained, 3.4" x 4.4" x 0.8" modules utilize a successive-approximation technique to achieve high-speed conversion. 8, 10, and 12-bit units are available from stock with accuracies commensurate with resolution. Modules are designed for PC board mounting.

MAJOR FEATURES

HIGH SPEED: 30 μsec for 10-bit conversion.
LOW DRIFT: 20 ppm/°C for 10-bit converter.
ACCURATE: $\pm\frac{1}{2}$ LSB relative accuracy for all models.
MANY OPTIONS: Operational input buffer amplifier. Four popular digital codes.

LOW COST (1-9 units):		
	8-bit	$195.00
	10-bit	$225.00
	12-bit	$295.00

DIGITAL-TO-ANALOG UNITS

With built-in reference, weighted-resistor switching network, and fast settling output amplifier, these are self-contained converters requiring only external power and input signals. 8, 10, and 12-bit units are available in a 3" x 2.1" x 0.4" package . . . ideal for PC board mounting.

MAJOR FEATURES

HIGH SPEED: 1.5 μsec for 10-bit conversion.
LOW DRIFT: 20 ppm/°C for 10-bit converter.
ACCURATE: $\pm\frac{1}{2}$ LSB relative accuracy for all models.
MANY OPTIONS: Optional input buffer register. Four popular input codes.

LOW COST: (1-9 units)		
	8-bit	$ 95.00
	10-bit	$125.00
	12-bit	$155.00

FOR COMPLETE TECHNICAL INFORMATION contact Burr-Brown, your Burr-Brown Engineering Representative, or use this publication's reader service card.

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Operational Amplifiers
Instrumentation Amplifiers
Active Filters
Multiplier / Dividers
A/D-D/A Converters

CIRCLE NO. 34

Op Amp Digest

Below you'll find the Fairchild op amp family. A circuit for every application. A trade-off for every system. A price for every parts list. Everything except a "super op amp" (see cover editorial to find out why). You can order additional information via the reader service numbers listed below.

μA715 – High Speed Op Amp
100 V/μS Unity Gain Inv. Slew Rate
300 nS Settling Time
65 mHz Bandwidth
70 nA Offset Current
Reader Service Number 71

μA725 – Instrumentation Op Amp
0.5 μV/°C Voltage Drift
128 dB Voltage Gain
120 dB Common Mode Rejection
0.6 pA/V $\sqrt{\text{Hz}}$ Input Noise Current
Reader Service Number 72

μA727 – Temperature Stabilized Preamp
2 pA/°C Offset Current Drift
0.6 μV/°C Offset Voltage Drift
300 MΩ Input Resistance
2 nA Offset Current
Reader Service Number 73

μA735 – Micropower Op Amp
100 μW Power Consumption
500 pA Offset Current
10 MΩ Input Resistance
Wide Supply Voltage Range
Reader Service Number 74

μA739 – Dual Low Noise Op Amp
2.0 dB Noise Figure
86 dB Voltage Gain
±13 V Output Swing
Wide Bandwidth
Reader Service Number 75

μA740 – FET Input Op Amp
10^{12} ohms Input Impedance
80 pA Input Bias Current
6 V/μS Slew Rate
Internal Frequency Compensation
Reader Service Number 76

μA741 – General Purpose Internally Compensated Op Amp
200,000 V/V Voltage Gain
Short Circuit Protected
Latch-up Proof
±30 V Differential Input Voltage
Reader Service Number 77

μA747 – Dual Internally Compensated Op Amp
Short Circuit Protected
Latch-up Proof
±30 V Differential Input Voltage
200,000 V/V Voltage Gain
Reader Service Number 78

μA748 – General Purpose Externally Compensated Op Amp
Short Circuit Protected
Latch-up Proof
±30 V Differential Input Voltage
200,000 V/V Voltage Gain
Reader Service Number 79

μA749 – Dual General Purpose Op Amp
92 dB Voltage Gain
20 mHz Bandwidth
Latch-up Proof
Short Circuit Protected
Reader Service Number 80

μA777 – Precision Op Amp
30 nAInput Bias Current
1.5 nA Input Offset Current
Low Offset Voltage and Current Drift
Short Circuit Protected
Reader Service Number 81

SAVE $6.05

Bargain Corner

SAVE $6.05

Keep your eyes peeled for this space. Almost every month it will carry glad tidings of new prices. Here's one for openers:

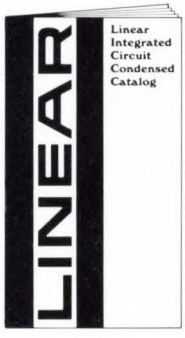
Four Quadrant Analog Multiplier
μA795C – was $12.00 now $5.95*

(Don't miss new prices on μA742 TRIGAC – see facing page)

SAVE $6.05

*Price based on 100 pieces.

SAVE $6.05



Hot Off the Press

You can take it with you. We've just published an all-new Fairchild Linear Condensed Catalog. It's pocket sized so that you can lug it around with you. For a free copy, use reader service card number below:

Reader Service Number 82

WIN $100

Win Fame and Fortune

WIN $100

Fill in this box.
(Your circuit here)

By now you ought to be down to the final strokes of preparing your entry in our recently announced Linear Applications Contest. Here are the rules, remember?

1. Get all the facts on a Fairchild Linear IC.
2. Design the world's greatest application for it.
3. Send to: Fairchild Linear Contest, P.O. Box 880A Mountain View, California 94040.

All entries will be judged by the editors of EEE Magazine. Every month, they will select the most imaginative application and give us the designer's name. We'll publish the winning design and give the winner $100 upon publication. Ready. Set. Design!

WIN $100

WIN $100

FAIRCHILD SEMICONDUCTOR

LINEAR

In case you haven't noticed, Fairchild has modified a long-standing posture against "second sourcing" (last month's editorial "Farewell NIH" pretty well spelled this out).

A one-sentence summary of our new position would read like this:

If a linear circuit — any linear circuit — is worth making, we're going to make it, regardless of its point of origin.

Got the point? Fine. Now hear this:

EDITORIAL

Fairchild doesn't make "The Super" Op Amp. Here's why:

There has never been, isn't now, and probably never will be a *true* ultimate op amp.

Ideal op amps exist only in textbooks. They can't cut the mustard in the real world of systems design where trade-offs like slew rate vs. power consumption or common mode rejection vs. input current make the critical difference.

Then there's dollars. Cost vs. performance. A $60 or a $28 or even a $15 super-beta, or FET, or high-gain, or whatever-you-call-it op amp simply isn't going to make it past an experienced designer very often (except as a tinkerer's toy). Who wants to live with the dual problem of paying too much in order to lose design flexibility?

Smart engineers want options. They want to meet many different system requirements. And there's only one answer to this type of requirement:

A complete family of op amps.

Not just one or two devices which are obsoleted quickly by higher priced "A" versions. Not a "complete line" of three or four circuits. Modern systems can't be built with just a hammer and a saw. It takes a complete tool kit.

We offer a true family of op amps. A tool kit of fifteen separate circuits. At the base of our family is a solid core of low cost general purpose op amps to meet 80% of your system's requirements. On top of these, we have a complete set of complementary special purpose amplifiers designed for various combinations of low input currents, high accuracy, high speed, low power, temperature stability or high CMRR.

It's conceivable, we admit, that some day in the future there will be a true, ultimate, universally useful, supercalifragilistic op amp. We're looking for it inside Fairchild. And outside Fairchild. If we find it, we'll build it. And if we do, you can count on not having to compromise either system design or cost/performance to use it.

TRIGAC PRICE REDUCTIONS THREAT TO MECHANICAL SWITCHES & RELAYS.

New prices on Fairchild's μA742 "TRIGAC" make replacement of troublesome electro-mechanical components a reality. Countless applications are now economical (oven and room temperature controls, ON-OFF motor controls, level detectors, fan controls, etc.).

New μA742 Prices:
@ 100 was $4.95 now $2.35.
Special new 1000 piece price $1.95.
Immediate shipment available from stock.

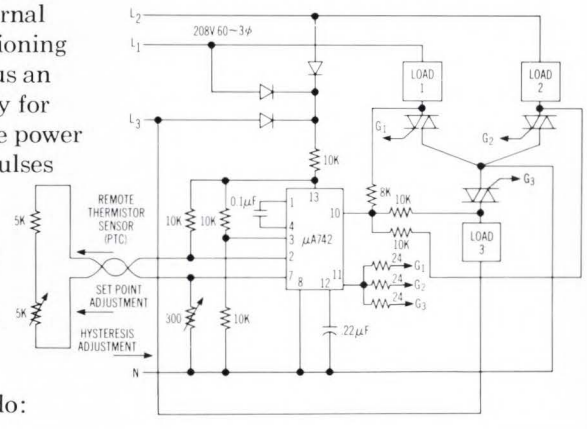
μA742 "TRIGAC"–Powerful Solution to Power Control Problems

Electrical Performance/Features
- Operation directly from DC or AC 50 Hz to 440 Hz (24 VAC to 440 VAC).
- Bridge Sensing with adjustable Hysteresis.
- Minimizes RFI with Resistive or Inductive Loads.
- Large Output Pulses – 1 Ampere Peak.
- Minimum external components required.
- High Noise Immunity.
- No electrolytic capacitors required for most applications.

The μA742 Zero-crossing AC Trigger performs all the signal-processing required to provide precision control of large loads by small sensors, while eliminating RFI problems by switching at the zero-crossings of the load *current*. Additional features are the internal provision for time-proportioning and dead-band control, plus an internally regulated supply for operation directly from the power line. One ampere output pulses trigger even large thyristors directly. Half-cycle firing with resultant DC in the load is prevented by special internal logic design.

Here's an example of what the "TRIGAC" can do:

3 PHASE ZERO-CROSSING DUAL-THRESHOLD TEMPERATURE CONTROLLER 208 V 3ϕ60~



Micropower Exists–μA735

Minimizing power drain, weight and space gives design engineers ulcers (how come the system power supply designer is the last one to know you've overrun the allotted system power consumption?).

Here's good news. Relief exists:

The μA735 micropower operational amplifier uses only 100μW at ± 3.0 volts.

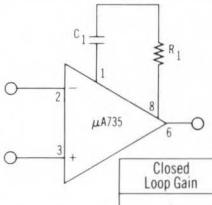
Systems such as space vehicles, aircraft, and portable medical equipment will benefit from the use of the μA735 by shrinking bulky batteries. It gives you low quiescent currents. It also gives you versatile, accurate and cool operation without the customary design tradeoffs.

In addition, the μA735 simplifies design of high impedance instrumentation circuits due to its extremely low input currents.

Here are some typical device specifications:

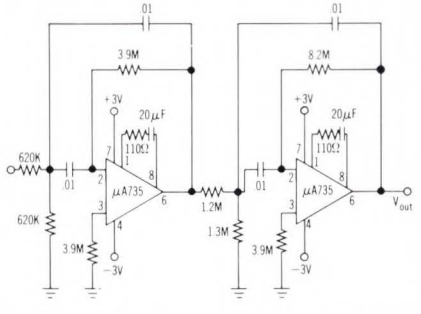
input offset current	500 pA
input bias current	5.0 nA
input offset voltage	1.0 mV
supply voltage range	± 3 volts to ± 18 volts
power consumption	100 μW
open loop voltage gain	20,000
input impedance	10 mΩ
noise	.5 pA / $\sqrt{\text{Hz}}$

Smart engineers who like to minimize component count, can now take advantage of a new simplified frequency compensation scheme that applies over the entire supply voltage range of the μA735.



Closed Loop Gain	C_1	R_1
1	20nF	110Ω
10	2nF	1.1kΩ
100	680pF	11kΩ

Most engineers like to eliminate those large, expensive, hard-to-find capacitors that hog space and dollars. Here's a nifty little application which will avoid large capacitors in low frequency, active filter design. And with very low supply current drain!



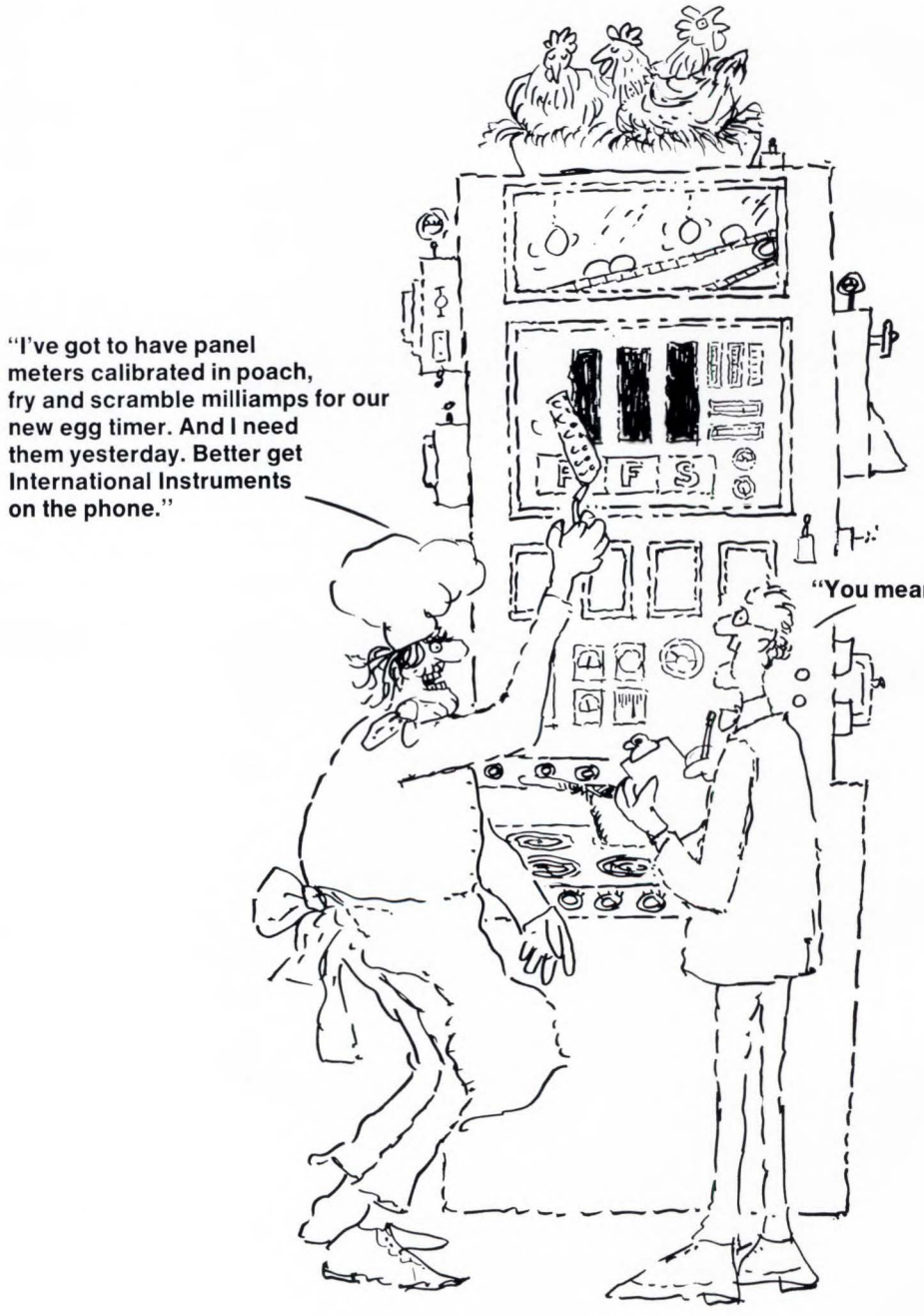
This circuit has a center frequency at 10 Hz, 12 dB rolloff with −3 dB points at 6.5 Hz and 14 Hz. The μA735 lets you use small capacitor values and large resistors for frequency shaping at a few Hz, due to the μA735's low input offset current.

The new price is low, too –

μA735	−55°C to +125°C	$30.00 @ 100
μA735B	−20°C to +85°C	$22.50 @ 100
μA735C	0°C to +70°C	$15.00 @ 100

See? Micropower does exist; alive and in quantity at your Fairchild distributor.

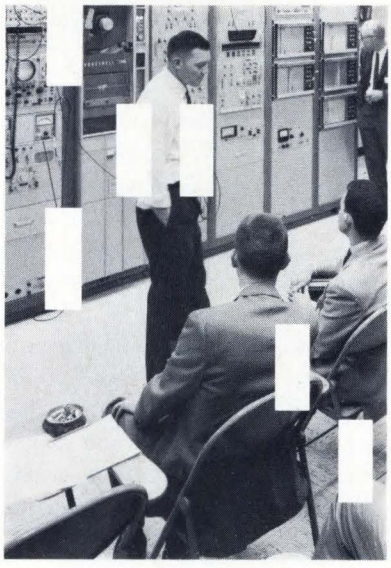
SIGMA



He means both. Now that International Instruments and Sigma have joined forces, you can get I.I.'s fine panel meters even faster than before, through the expanded sales/service network created by the merger. Sigma's applications-wise distributors and engineers join the experts at International Instruments to make I.I.'s various edgewise and round meters (particularly specials) easy to come by . . . and at the right price. Find out what it's like to have your order on the front burner. **International Instruments Division, Sigma Instruments, Inc., 88 Marsh Hill Rd., Orange, Conn. 06477. Phone: (203) 795-4711.**

STEPPING MOTORS • PANEL INSTRUMENTATION • SNAP SWITCHES • OPTO-ELECTRONIC DEVICES • AND RELAYS

CIRCLE NO. 39



Data Base Profiles Sounding Board/70

When EDN asked for volunteers for an opinion sampling group, the response ran into the thousands rather than the anticipated hundreds. Now the Data Base returns are in, and they disclose even more surprises.

DONALD K. COLLINS, Staff Editor

It's very satisfying to have an opinion sampling group large enough to be statistically significant, but quality is as important as quantity. That's why EDN sent a Data Base questionnaire to the more than two thousand engineers who volunteered for Sounding Board/70. Now that all the responses are in, one fact looms above all the rest—Sounding Board/70 is a statistician's dream.

Here are some more facts you'll want to keep in mind as you look at the graphs on the next few pages and see how the Sounding Board/70 membership is distributed:

—The average Sounding Board member is 34.5 years old, has been in engineering 9.2 years, has a bit more than a B.S., earns just a twitch under $14k, and tends not to be formally affiliated with any professional group.

—The average Sounding Board member is vitally concerned with questions of professionalism, unionism and security.

—By far the largest portion of Board members reserve judgment when it comes to approval or disapproval of engineering unions.

Duties and Degrees

Out of the 2046 who replied, 1255 are straight designers, 615 have supervisory duties, 59 are department heads, and 47 are at the general company management level. This is a ratio of nearly one man with supervisory duties for every two without, although it wouldn't be accurate to picture the situation as one "chief" for every two "Indians". A great many of those 615 with supervisory duties are working designers in

(Continued)

addition to being responsible for assigning work loads and making sure deadlines are met.

There were 2521 responses to the question "What degrees do you have?" Of that number 62% or 1542 hold a B.S., and 21% have their M.S. Next come those with an Associate degree (7%) or none (6%), then a sprinkling of B.A.s (25%), M.A. (1.3% and the fairly rare Ph.D. (1.3%). Note that the sample (2521) is larger than the number of respondents (2046) because of the necessary overlap in the M.S. and B.S. categories. All in all, the distribution corresponds remarkably well with national figures over the whole electronics design field. A statistician would probably call this a nearly-ideal population for an opinion group. Certainly the distribution is more representative of the whole profession than EDN had hoped to get.

Age and Longevity

A glance at **Fig. 1** reveals a population that is quite normally distributed about a median (50% above, 50% below) of 34.5 years. The mean age of the Board members is nearly two years above the median, however. This is primarily due to some of the long-timers who make up the extended "tail" to the right. If you're inclined to think of electronic design as strictly a young man's game, think again. There's a total of 64 men who are 55 and over, and clear down at the tail end there are three who are 64, one who is 65, and even one practicing 75-year-old.

Both the mean and median are skewed to the right of a normal population figure simply because the survey started with 20-year-olds, and there are very few employed electronics designers under 18.

Figures on length of time in engineering will shake you up a bit, too. The average (median) engineer in the group has been in engineering for 9.2 years and the mean of the whole Board population falls at 11.6 years. The tail of this curve is also extensive; beginning with a dozen who have chalked up 35 years in the game, it falls away to the single man who was a practicing engineer when the superheterodyne receiver was introduced. In his 49 years as a practicing engineer, just think of the developments he must have seen!

Now, About the Money . . .

Figure 4, which deals with distribution of income, could be misleading unless you realize one fact. This distribution includes the whole spectrum of Sounding Board/70, and that means management, supervisors, designers and everybody. There are really two curves overlapping in **Fig. 4**, one for engineers without management responsibility and one for those at the super-

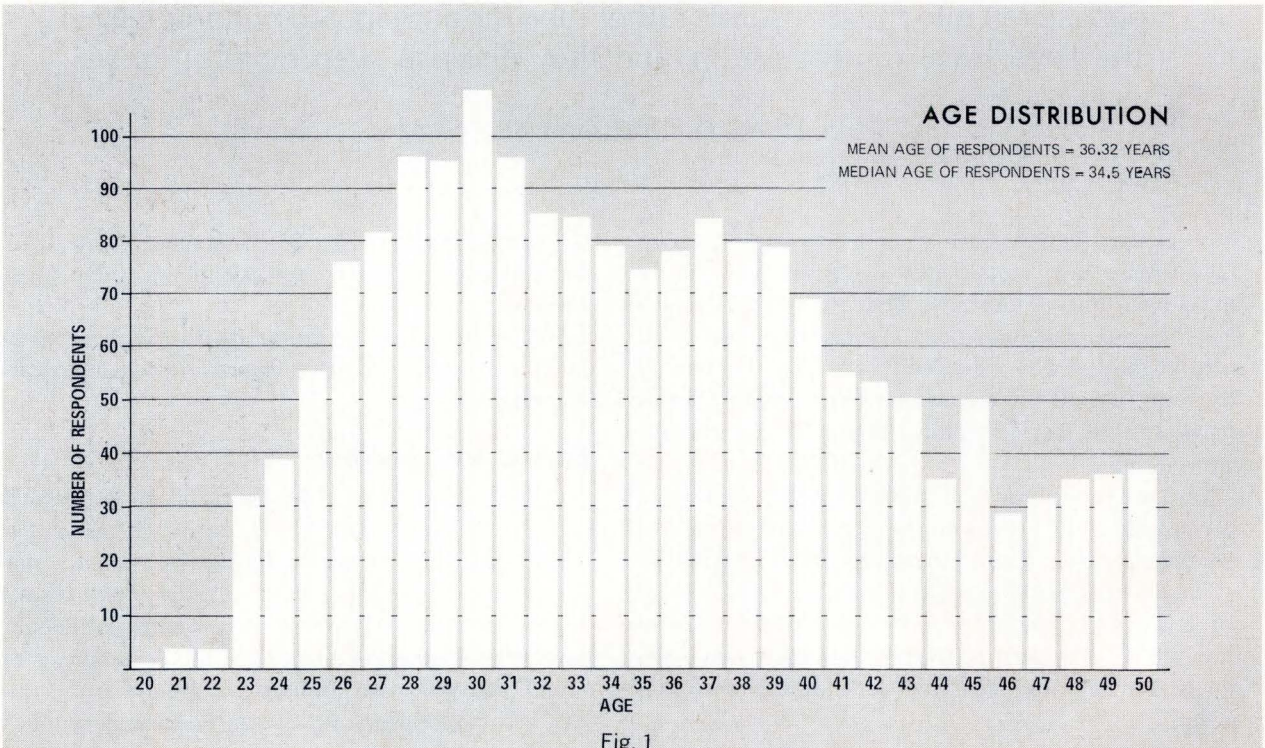


Fig. 1

visory and management level.

The median salary for this conglomerate group is $13,898, and the mean figure is $14,521. It is important to bear in mind that both figures take in corporate managers as well as neophyte engineers. But all of them have opinions, and that's what we're interested in from Sounding Board/70.

. . . And About Professionalism

In this sampling, one of the surprising returns is the number of engineers who don't belong to any professional organization. There are 920 of them, and if you take into account the multiple answers that this question drew, this figure is nearly as large as the number who belong to all organizations combined. That is, 816 listed themselves as members of IEEE, but many of these engineers also listed themselves as members of at least one other group such as NSPE.

Opinion on unions was a surprise, too. Of those who held opinions, the ones who approve of unions outnumber those who disapprove by a good 20%, 688 to 553. The real surprise, though, is in the number who were undecided or who reserved judgment: 786, or somewhat more than one-third of the Board. This high proportion is strongly correlated with the number of Board members who want to see EDN investigate and report on alternatives to unions. It's pure speculation, of course, but a big part of the reason for reserved judgment and a call for information from these large groups may well be reflected in the small number who actually belong to a union—74 in all, or slightly less than 4% of the total sampling. These are the ones who have direct experience with present-day engineering unions. Lacking hard facts, many of the rest reserved their judgment.

The Board Sounds Off

The last question on the survey sheet drew the most astonishing response. Members were asked to check one of seven fields they would like to have EDN investigate and report on. You could practically hear their hoots of derision as they checked multiple answers. In all, 1238 respondents checked two or more answers. In the order of preference, the set questions which Board members want EDN to probe are:

—What are the alternative to unions? 842 of the 2046 wanted to know about this one.

—How are engineering unions working out? (621 replies.)

—How to change IEEE so that it meets our needs? 575 wanted to know.

—How to maintain my professional status without joining a union? 438 replied.

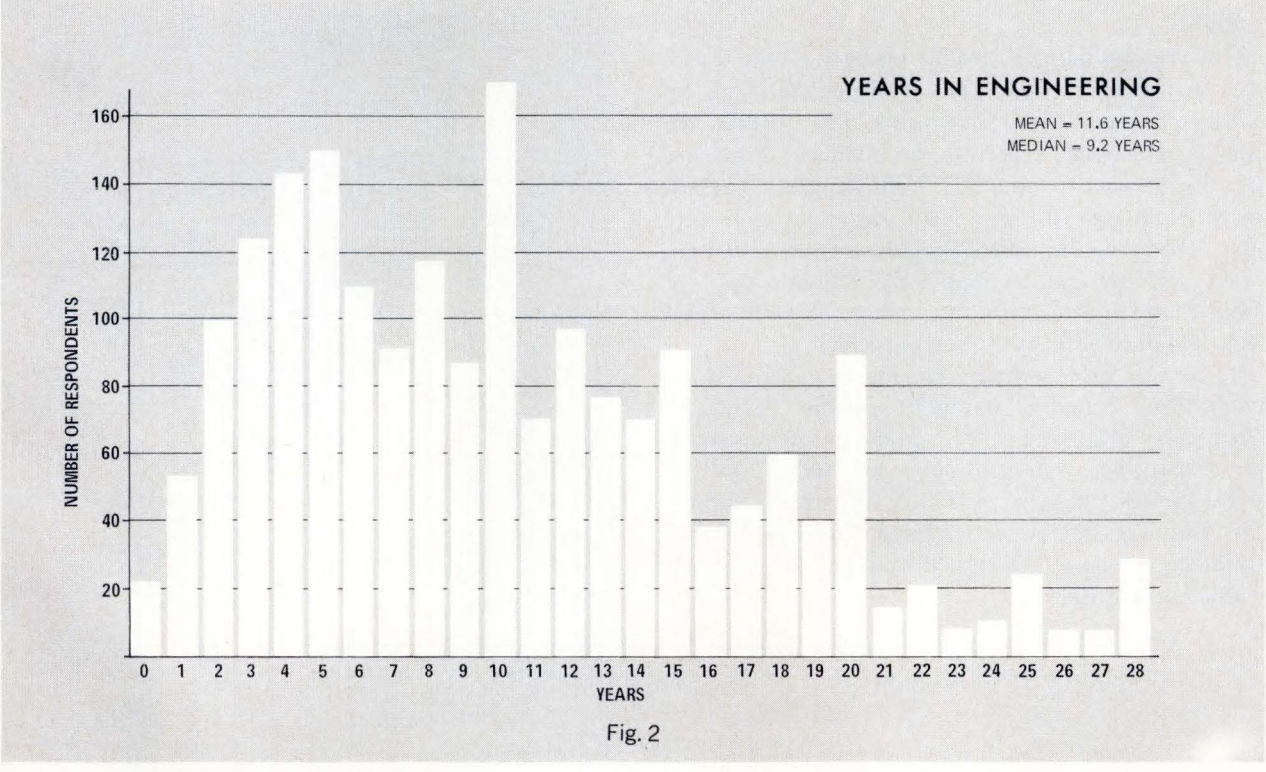


Fig. 2

(Continued)

– Pension/retirement plans available to engineers? 422 want ED to survey and report on this one.

– How to maintain my professional status even though I join a union. 397

– What management thinks about unions concerned only 244 respondents, yet even this low number amounts to better than 10% of the total.

– And, finally, 351 members of Sounding Board/70 felt constrained to comment in the blank marked "Other". They wrote in the front of the sheet, on the back of the sheet, and they appended other sheets to the questionnaire.

They discussed topics that ranged from bargaining methods to the implications of unionism. Some of the

– research to determine what engineers' real needs are, not what they think they are.

– immediate employment prospects in the face of cutbacks and layoff.

– continuity of employment and of benefits that engineers contribute to. Large numbers called for some kind of portable pension/insurance plane.

– concern about establishment and maintenance of professional status, including licensing and other plans.

– concern about some of the implications of unions.

– and many, many proposals for alternatives to unions.

Now that Sounding Board/70 has been profiled, analized and systematized, what happens? EDN, in response to Board members requests, will research the "hot" questions and report on, for instance, "What are the alternatives to unions?" We'll sample Sounding Board/70 on their feelings about these questions and report the results to all EDN readers. Some of the answers, no doubt, will be predictable; others will reveal shifts in engineers' thinking about themselves and their role in relation to the rest of society.

But don't expect pronouncements or general statements about Sounding Board/70 opinions. They'll be expressed as percentages for, against or uncommitted, and EDN doesn't expect to point out "significant" responses unless they are, actually, statistically significant. Results of most questionnares will be reported in "Signals and Noise" columns during the next year. It will be interesting. □

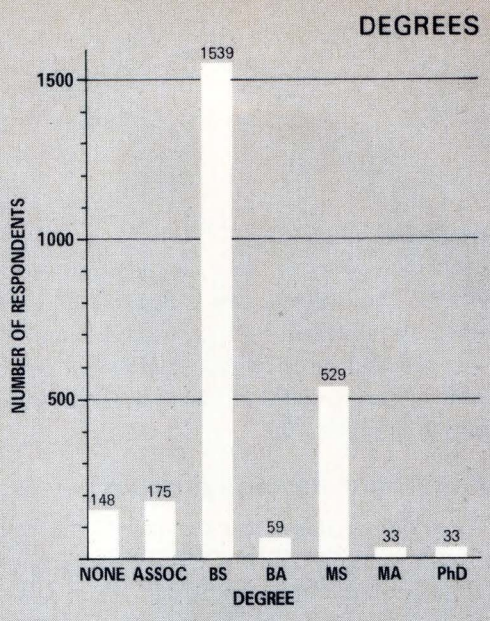


Fig. 3

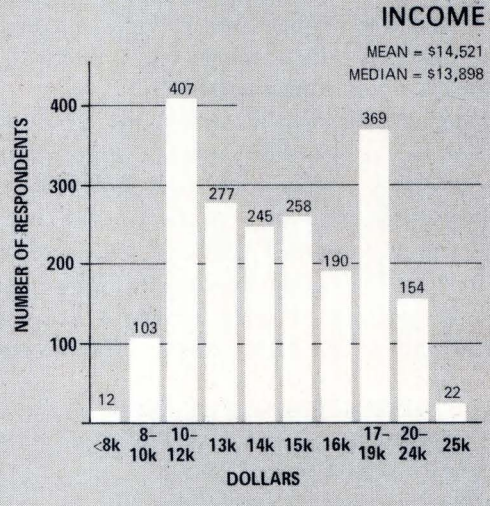


Fig. 4

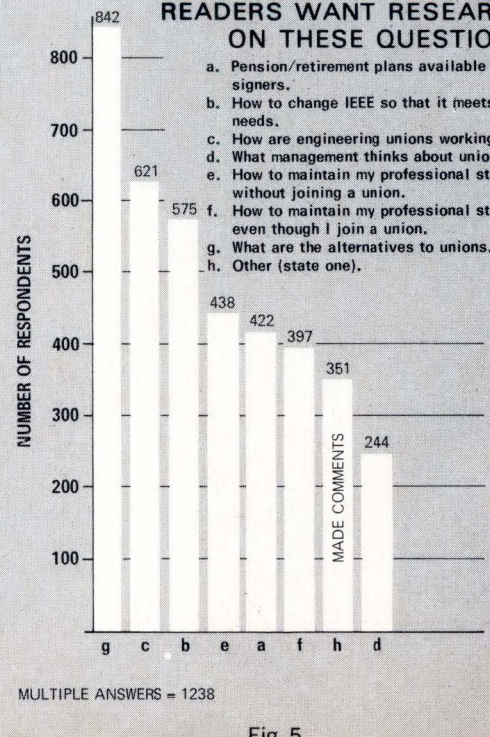
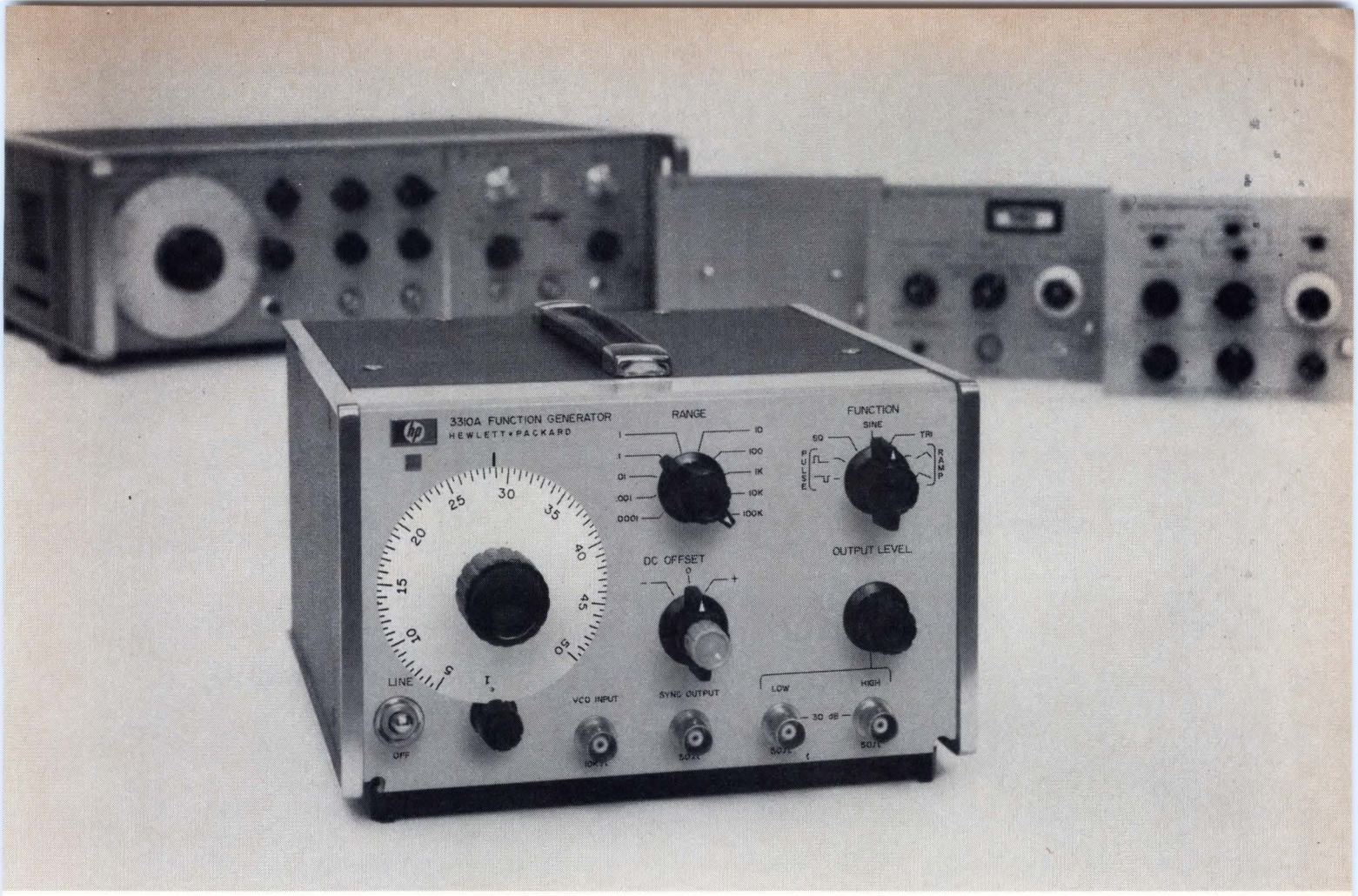


Fig. 5



Need a function generator? Don't waste your money!

Make sure you get the function generator that best fits your needs... in both price and capability. It's that simple.

Or at least it sounds simple. Then you sit down to make a list of all your technical requirements . . . present and future. Next you try to match those requirements against all of the instruments available. Finally, you make trade-offs of specific performance features versus X dollars saved.

When you are all done, hopefully you wind up with a function generator that has the best performance/price ratio for your particular needs and budget.

But there is an easier way!

HP manufactures, sells and services a complete line of function generators with a long history of proven performance. Even the newest function generators take advantage of HP's experience and conform to the high quality standards you have come to expect in any HP instrument.

To get all the information you need to determine exactly what you want in a function generator... just turn to page 267 of your 1970 HP catalog. You get more than just a list of products, you get the background information you want to determine your specific needs.

If you need a low-cost general purpose function generator, pay special attention to the HP 3310A. This one does so much that it's actually more than just a function generator.

You not only get the usual sine, square and triangle functions—but both positive and negative going pulses and ramps. Add dc offset, a frequency range of 0.0005 Hz to 5 MHz, all solid-state reliability and a price tag of only $575 and you will see why we say this one is more than just an ordinary function generator. You save both money and space.

With the HP 3310A you can test and demonstrate the response of differentiator and integrator circuits. Use the triangle output to show how a sine wave may be synthesized. Use the ramps to demonstrate the action of a comparator circuit.

You can even use a combination of pulses and ramps to simulate the action of a mechanical function to an analog computer. This is a function generator with such potential that you'll be using it for more applications than any other signal source you now own.

If you need more information, just call your local HP field engineer. He will be glad to help you solve any measurement problem you may have. Or, write to Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland.

090/4

HEWLETT hp PACKARD

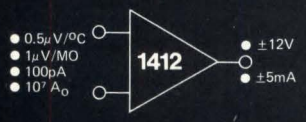
SIGNAL SOURCES

CIRCLE NO. 9

Teledyne Philbrick Nexus introduces its combination "Hole-in-One" Chopper Stabilized Operational Amplifiers. The 1412 "Mini-Chopper" that is hermetically sealed and the 1701 Low Cost Discrete Chopper Amplifier, both individually designed to meet your most exacting requirements. Looking for a better than par score? Read the card below.

MODEL 1412 "Mini" chopper-stabilized operational amplifier.

- Miniature Size
- Extremely Low Voltage and Current Drift
- Hermetically Sealed Package
- Low Initial Offset Voltage
- High Gain
- Wide Power Supply Range
- Input/Output Protected
- Cost ($104 in hundreds)

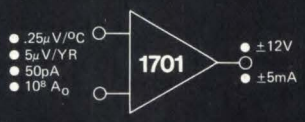


MODEL 1701 Low cost, chopper-stabilized operational amplifier.

- Very Low Voltage and Current Drift
- Low Initial Offset Voltage
- High Gain
- Wide Power Supply Range
- Input/Output Protected
- Low Flicker Noise
- Low Cost ($49 in hundreds)

Now add up your score card and you'll find that you're a winner when you team up with Teledyne Philbrick Nexus' Analog-State-of-the-Art.

Write today for your free copy of the new 1970 Teledyne Philbrick Nexus Catalog.



For further information, contact your local Teledyne Philbrick Nexus representative or Teledyne Philbrick Nexus, 20 Allied Drive at Route 128, Dedham, Massachusetts 02026. Telephone: (617)329-1600 Prices F.O.B. Factory U.S.A.

TELEDYNE PHILBRICK NEXUS

No. 1 should do more . . . you expect us to.

Teledyne Philbrick Nexus chopper-stabilized Op Amps reduce your handicap

30 mA Blows Link, Programs ROM

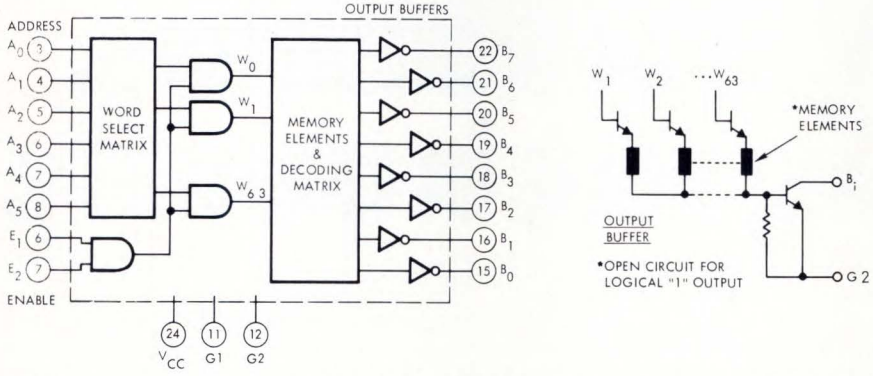
Monolithic bipolar read-only memory permits users to field program the device with nothing more than a power supply capable of providing 30 mA – and do it after the 88 × 155 mil chip has been hermetically sealed. Engineers at the Microelectronics Div. of Radiation Inc. note that their 512-bit memory, called PROM should prove attractive in systems applications involving many devices with different programs.

Now, the user can stock a single type of read-only memory for all applications through both breadboard and production phases of design. Volume requirements then can be satisfied using programming procedures implemented either by the customer or by Radiation.

Using dielectric isolation and special processing techniques, the circuit contains a 6-bit decoder, a 512-bit memory matrix (64 eight-bit words), and open collector output buffers permitting wire-OR capability. Access time is 65 ns and fanout current is 20 mA into a 30 pF load at room temperature. Total operating power is 400 mW/device at 25°C.

Both military (ROM 0212) and commercial ROM 0512) versions are available in a 24-pin hermetically sealed 1/4- by 3/8-in flat pack. For 100 to 999 quantities, the prices are $61.50 for the military unit and $47 for the commercial. An additional $50 is charged if Radiation performs the fusing operation for quantities of less than 10. Radiation Inc., Microelectronics Div., Melbourne, FL 32901.

329



ROM 0512 and 0212 are programmed by "blowing" a nichrome link in the emitter of the output buffer circuit. To record a "1" in the memory, simply address the desired bit and apply 30 mA into the corresponding B output line of that bit.

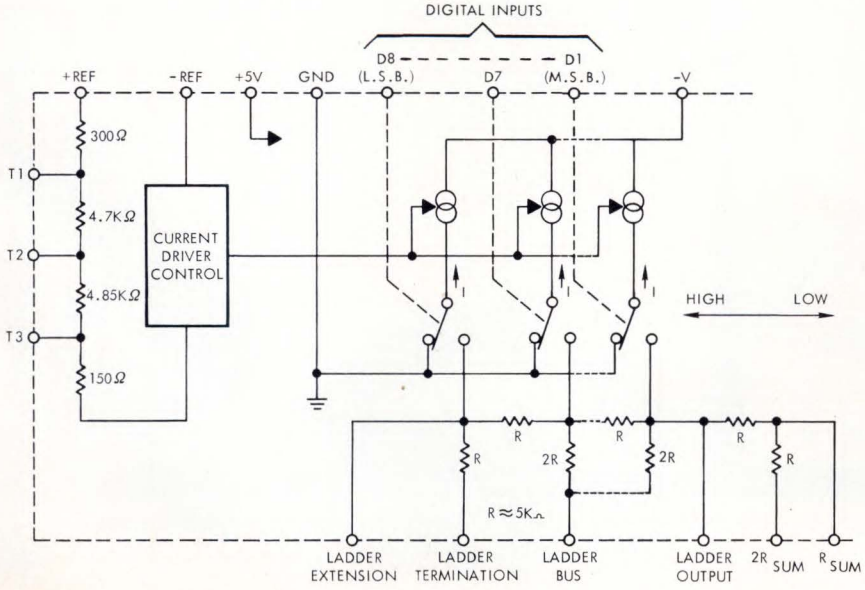
Monolithic Chip Contains Complete D/A Converter

Current mode D/A converter and resistor ladder network are incorporated on one chip. Designated RI-1080, this MSI device introduced by the Microelectronics Div. of Radiation Inc. offers the systems designer weight reduction, increased reliability and high performance over the full military temperature range.

Depending on the external voltage reference, RI-1080 operates in three modes – bipolar, unipolar positive and unipolar negative. The device contains eight current switches, associated bias and level switching networks, and a thin-film R-2R ladder network. Eight-bit resolution is offered with ±0.5 percent accuracy, LSB. Worst case settling time is 1 μs to 0.5 percent LSB of final value. This allows conversion rates in excess of 1×10^6 words/s.

Only ±5 and −15V power supplies are required and maximum power dissipation is 130 mW. Voltage reference range is 4 to 10V. Either DTL or TTL compatible digital inputs are accepted.

This device is available off-the-shelf in a 24-lead flat pack. Unit price for the military version is $82.50 in quantities of 100 to 999. Radiation Inc., Microelectronics Div., Melbourne, FL 32901. **325**



1400V, 5.0A Transistors. Delivering now, in quantity.

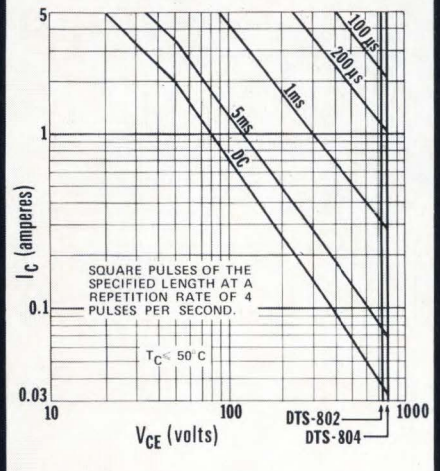
The Kokomoans' new DTS 802 and 804 NPN triple diffused silicon high energy transistors are here. You can order them from your Delco Radio distributors now in sample or production quantities. They were specially designed for high voltage inductive switching from rectified 3 phase 220 line, and magnetic deflection circuits in large screen color TV receivers.

They've been application-tested from production lots by prospective users with stringent reliability requirements. They do the job. And their energy handling capability is verified by Delco Pulse Energy Testing.

The high energy reliability of Delco silicon power transistors has earned them a reputation for survival in the toughest switching jobs. It's a built-in advantage, vitally important where circuits are subject to transients or fault conditions.

Now you can simplify the design of high energy circuits with reduced size, weight, and component cost. Convert HV tube circuits to solid state reliability without the complexity associated with high current, low voltage devices. And fewer components mean higher reliability.

For prices and delivery or additional data on Delco's new DTS 802 and 804 contact us or your nearest Delco Radio distributor.

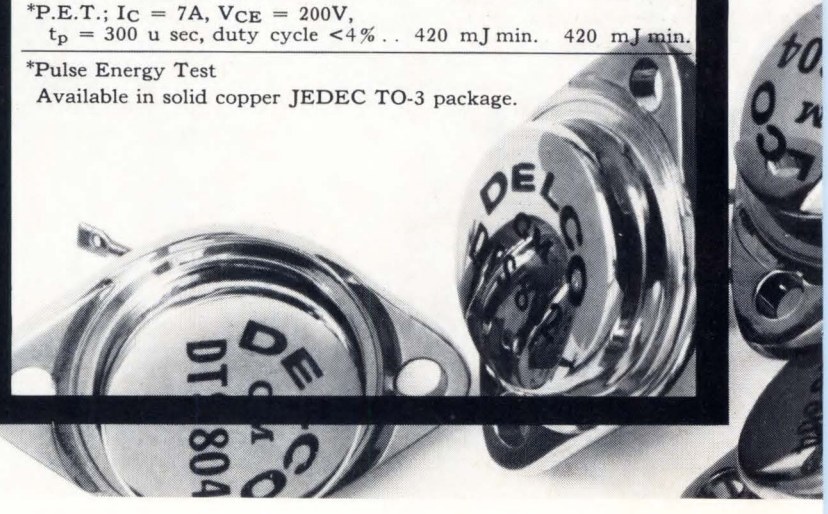


SAFE OPERATING CURVES

PARAMETER	DTS-802	DTS-804
Collector to emitter voltage (V_{CEX})	1200V max.	1400V max.
Collector to emitter voltage (V_{CEO})	1000V max.	1000V max.
Sustaining voltage (V_{CEO} sus)	750V min.	800V min.
Emitter to base voltage (V_{EBO})	5V max.	5V max.
Collector current (I_C) continuous	5A max.	5A max.
h_{FE}, I_C = 3.5A, V_{CE} = 5V	2.2 min.	2.2 min.
*P.E.T.; I_C = 7A, V_{CE} = 200V, t_p = 300 u sec, duty cycle <4%	420 mJ min.	420 mJ min.

*Pulse Energy Test

Available in solid copper JEDEC TO-3 package.



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• Lake Engineering Co., Ltd. (416)-751-5980

Kokomoan's Regional Headquarters. Union, New Jersey* 07083, Box 1018 Chestnut Station, (201) 687-3770 ■ Santa Monica, Calif.* 90401, 726 Santa Monica Blvd., (213) 870-8807 ■ Chicago, Illinois* 60656, 5151 N. Harlem Avenue, (312) 775-5411 ■ Kokomo, Ind. 46901, 700 E. Firmin, (317) 459-2175 Home Office ■ **Office includes field lab and resident engineer for application assistance.*

THE KOKOMOANS ARE IN POWER

DELCO RADIO

DIVISION OF GENERAL MOTORS

KOKOMO, INDIANA

CIRCLE NO. 37

Lead Storage Battery That's Drier Than a Dry Cell

An exclusive, patented, gelled electrolyte replaces sulfuric acid in a completely new battery construction. The GEL/CELL brings to portable instruments and appliances an economical rechargeable battery that combines the power and rechargeability of wet batteries with the handling ease of dry batteries. Among its advantages over NiCd batteries are high cell voltage, absence of cell reversal and absence of memory. Compared to wet cells, the GEL/CELL can be permanently installed, shipped or charged upside down, has long shelf life and requires no maintenance. Significant features of GEL/CELL rechargeable batteries are:

Gelled Electrolyte: No liquid to splash around or ooze out. Externally, battery is completely sealed.

Rechargeable: Can be recharged 100 to 400 or more complete charge/discharge cycles, depending on type of charger. If battery is not completely discharged during each cycle, 1000 or more cycles of operation are possible.

Long-Lasting: Ideal for stand-by service. When "Floated" at a constant voltage of 2.25V per cell, can be maintained for years, will automatically recharge itself.

Maintenance Free: Water or electrolyte is never added. Battery is sealed. No need to check liquid levels or perform other routine maintenance.

Small Size and Weight: Compact size and high power-to-weight ratio produce ideal self-contained portable power pack for tape recorders, TV sets, medical apparatus and test instruments.

Use and Recharge in Any Position: Can be permanently installed upside down or on its side with no loss of capacity or danger of leakage. Even when tilted or inverted, full capacity is obtained because the gelled electrolyte does not flow away from plates exposing active material. Can be charged upside down.

Long Shelf Life: Special calcium grids lose very little capacity in storage. Stand losses range from 2 to 3% per month at room temperature to 10 to 12% at 95°F and less than 0.5% at 0°F.

No Permanent Cell Reversal: When totally discharged due to extended power outage or equipment accidentally left ON, there is no danger of permanent cell reversal or loss of ability to recharge.

Wide Operating Temperature Range: A fully-charged battery operates over a temperature range of −76°F to +158°F (−60°C to 70°C). Batteries are rated at 68°F (20°C).

High Discharge-Rate Capability: GC 680 delivers up to 80A continuously—higher currents intermittently. Even the little GC 210 battery delivers 15A continuously for one minute.

Series or Parallel Connection: May be connected in series to obtain any multiple of 2V or in parallel to obtain other than standard capacities.

High Impact Polystyrene Case: Plastic case is non-conductive and chemically neutral. It will not rust or deteriorate, nor will it support fungus or other organic growth.

Absolutely Safe: If excessive pressures build up due to abnormally high recharge currents, patented "one-way" relief valves immediately release the pressure—then automatically reseal. Only clean, dry gas is released. No corrosive fumes and no possibility of explosion, rupture, bulges or corrosion.

Safe Shipment: Sealed construction permits parcel post or air shipment. There is no need for special precautions, expensive containers, warning labels or slow means of transportation.

Highly Dependable: The 2V per cell open-circuit voltage is highest for any commercially available battery.

No Memory: Some applications require short, repetitive periods of use which consume only a small portion of the total battery capacity. Under these cyclical conditions, nickel-cadmium batteries forget their actual capacity and become conditioned to deliver only the small amount of power normally required. GEL/CELL battery delivers full rated power, irrespective of previous use history.

Competitively Priced: Basic material is lead. Unlike silver, nickel or cadmium, lead is low cost, readily available, and not subject to government set-asides. Globe Battery Div., Globe-Union Inc., 5757 No. Green Bay Ave., Milwaukee, WI 53201.

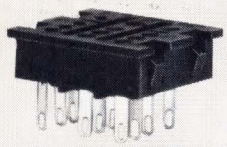
326

This little relay is new!

It's about a third as big as the others. Costs less, too. Its 3PDT contacts will switch 3 amperes.

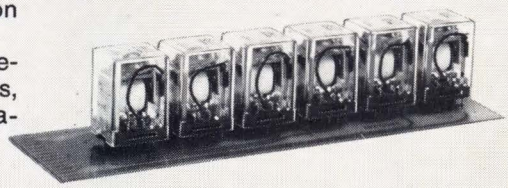
This little relay saves money and chassis space. It measures only 1″ x 1″ x 1⅜″ high. It costs only $4.60 in single lots*. It may be mounted directly to a chassis, in a socket or on a printed circuit board.

Meet our new KNP Series . . . designed for reliable duty in appliances, vending equipment, business machines, machine tool controls and a host of other applications.



This relay has Underwriters' Laboratories component recognition (File E 22575—Magnetic Motor Controller) for 1/10 HP, 120V AC; 3 amperes, 32V DC resistive; 3 amperes, 240V AC.

Two sockets are available. The first snaps into a metal chassis and requires no retaining spring. It has pierced solder terminals. The second is designed for use on p.c. boards. Both sockets can be furnished with a grounding lug.



KNP relays may be ordered with printed circuit terminals for direct mounting on p.c. boards. The assembly of six relays shown above requires a board space of only 6¾″ x 1″.

KNP SERIES SPECIFICATIONS

Arrangements: 1 Form C (SPDT), 2 Form C (DPDT) and 3 Form C (3PDT).

Rating: 3 amps @ 30V DC, resistive, or 120V AC. Also available with silver-cadmium oxide rated 3 amps @ 30V DC, inductive, or 120V AC.

Voltages: To 120V AC, 50/60 Hz. To 110V DC.

Pick-up @ 25°C: AC: 85% of nominal voltage. DC: 75% of nominal voltage.

Expected Life: Electrical: 100,000 operations minimum @ rated load. Mechanical: 10,000,000 operations minimum.

Temperature Range: —45° to +70°C.

Get full information today. Call your local P&B sales engineer or write directly to Potter & Brumfield Division of American Machine & Foundry Company, Princeton, Indiana 47570. Phone 812/385-5251.

*3PDT, 24V DC model. Quantity discounts apply.

STANDARD P&B RELAYS ARE AVAILABLE FROM LEADING ELECTRONIC PARTS DISTRIBUTORS

AMF | POTTER & BRUMFIELD

CIRCLE NO. 38

PCB Design and Documentation Made Easy

A comprehensive printed-circuit design and documentation system, described in a 16-page illustrated booklet, is based upon three "experience engineered" products: (1) a printed circuit design template, (2) preprinted mylar, and (3) dot sepia mask. These three products in conjunction with the printed-circuit layout guide and specification sheet (also available to qualified personnel without charge) and the design booklet constitute an effective printed-circuit design and documentation system.

The Booklet

The booklet, officially titled "Printed Circuit Design and Documentation, a straight forward system" consists of 16 illustrated pages describing the products and their relationship to the total system.

Step by step procedures, process outlines and checklists are included to make the booklet a self-teaching class that is helpful to the "old pro" and indispensible to the newcomer to PCB design. The booklet also serves as an orientation course for new employees. A smaller replica of the printed-circuit layout guide and specification sheet is included in the booklet. (Booklet free to qualified personnel.)

P. C. Layout Guide And Specifications Chart

Standardization eliminates the need to question each specification unless a specific application requires a deviation. Once established for a given company, the guide will substantially reduce the time necessary to research and specify the mechanical requirements of each circuit. A layout and specification guide should be treated as a recommendation and not a law. Use it as a place to store frequently-used information. It is a valuable training aid for newcomers to printed-circuit layout. (Guide and chart free to qualified personnel.)

Printed Circuit Layout And Drafting Template

One of the most time-consuming aspects of layout is the allocation of the individual parts as they will appear on the scale version of the final board. This accurate, comprehensive, scaled template saves appreciable time in the original design and inking of the final drawings. It includes 31 different component configurations applying to thousands of manufacturers' types. The many cutouts can be adapted to similar component types, further expanding its application. (Price: 2:1 template, $8.50; 4:1 template $14.50)

Preprinted Mylars for Printed Circuits

A preprinted mylar provides an accurate, stable base that includes spaces for all of the board fabrication specifications. The completed tape-up is a "communications capsule" that occupies little space but contains volumes of information. One document can totally specify the part. By itself the mylar is a specification control form and checklist. If all the blocks are full, the board is completely specified (excepting unusual requirements which wouldn't normally be included in standard forms). (Price: $1.00 to $6.50, depending on size and weight)

Dot Sepia Masks

Dot sepia masks, in conjunction with the mylar tape-up, assist in producing component assembly drawings. The dot sepia process is a simplified method of rendering a printed-circuit tape-up on a dot pattern for the component assembly drawing. This process will remove information pertaining to the construction of the printed circuit board and replace it with a new title and component block for assembly, test, etc. The process replaces drafting time with photo and masking techniques, thus saving time and minimizing errors. (Price: $9.50 to $45.00, depending on size) HAPCO Inc., Box 1205, Boulder, CO 80302

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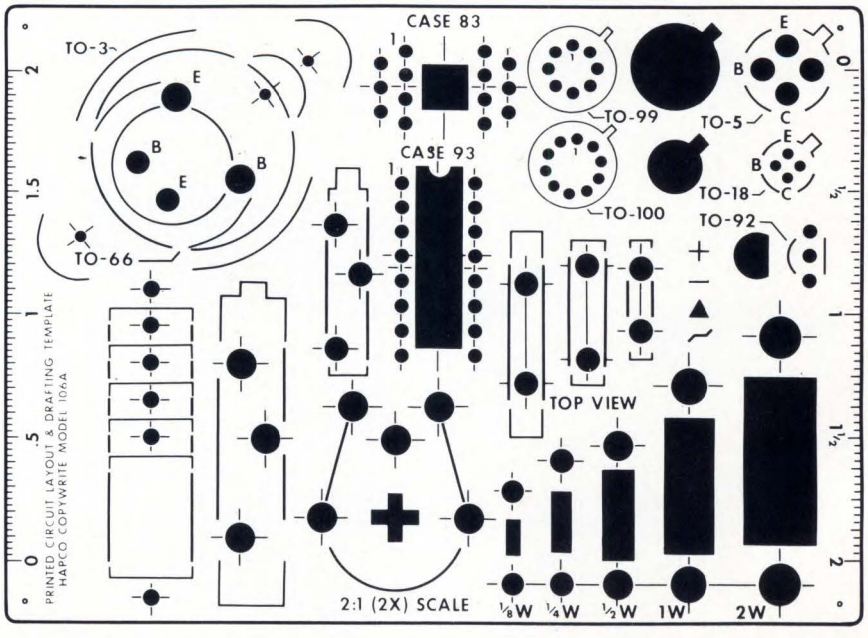

Printed Circuit Layout Template saves up to 40% of normal printed-circuit design and layout time. With the entire HAPCO system, as much as 70 percent of the normal drafting time can be saved. Template comes in either 2:1 or 4:1 scales.

Photocells ain't what they used to be...

they're a heck of a lot better

Photocells are doing jobs today that they couldn't have done ten—five—or even two years ago. There have been that many improvements!

HIGHER STABILITY
MORE UNIFORM RESPONSE TO COLOR TEMPERATURE
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Let us show you how the "light touch in automation and control" can help solve your problems. Call (914) 664-6602 or write Clairex,® 560 South Third Avenue, Mount Vernon, New York 10550.

CLAIREX ELECTRONICS

A DIVISION OF CLAIREX CORPORATION

CIRCLE NO. 39

Decoder Programmer for Programmable AC Power

Automated test procedures recently received a boost with the introduction of Elgar Corp.'s decoder-programmer for their line of ac power supplies. These precision programmable oscillators accept binary or BCD 8421 parallel entry logic, or they may be manually set. In either case, the input signal code is visually indicated on the front panel. Output signals from the decoder programmer control phase angle, frequency and amplitude of single or polyphase power amplifiers up to 9 kVA. Frequency may be automatically selected to three significant digits from 45 Hz to 10 kHz. Standard output voltage is 0-130V (with 0-32V and 0-260V options) in 0.1V steps.

Fully solid state, the DP Series may be driven from a computer, a tape programmer or remote controller. Standard input logic voltages are "0", 0-0.5V; and "1" 5V dc. Storage options are available to keep the program in a hold position. Remote load sensing of voltage amplitude at load point is provided, and output voltage can be amplitude modulated from 0-10 percent at an externally generated frequency. Frequency response of programmed voltage is ±0.1 percent from 45 Hz to 5 kHz. Voltage regulation is ±0.01 percent no load to full load and for ±10V input line change. Long term stability is ±0.1 percent for 1000h under constant conditions. Input power to the decoder programmer is 100W max, 105-125V or 210-250V single phase, 47-425 Hz. Standard rack mounting size, 3-1/2 by 14 by 19 in.

In combination with the appropriate power amplifiers and automatic programs, the DP Series decoder programmers are ideally suited for gyro testing, for production or laboratory testing of aircraft or missile systems, or for any applications requiring programmed, simultaneous control of voltage, frequency or phase angle to a load. Prices range from $1745 to $2495, depending upon the requirements for single or three-phase, amplitude control alone, frequency control alone, or both. Elgar Corp., 8195 Engineer Rd., San Diego, CA 92111.

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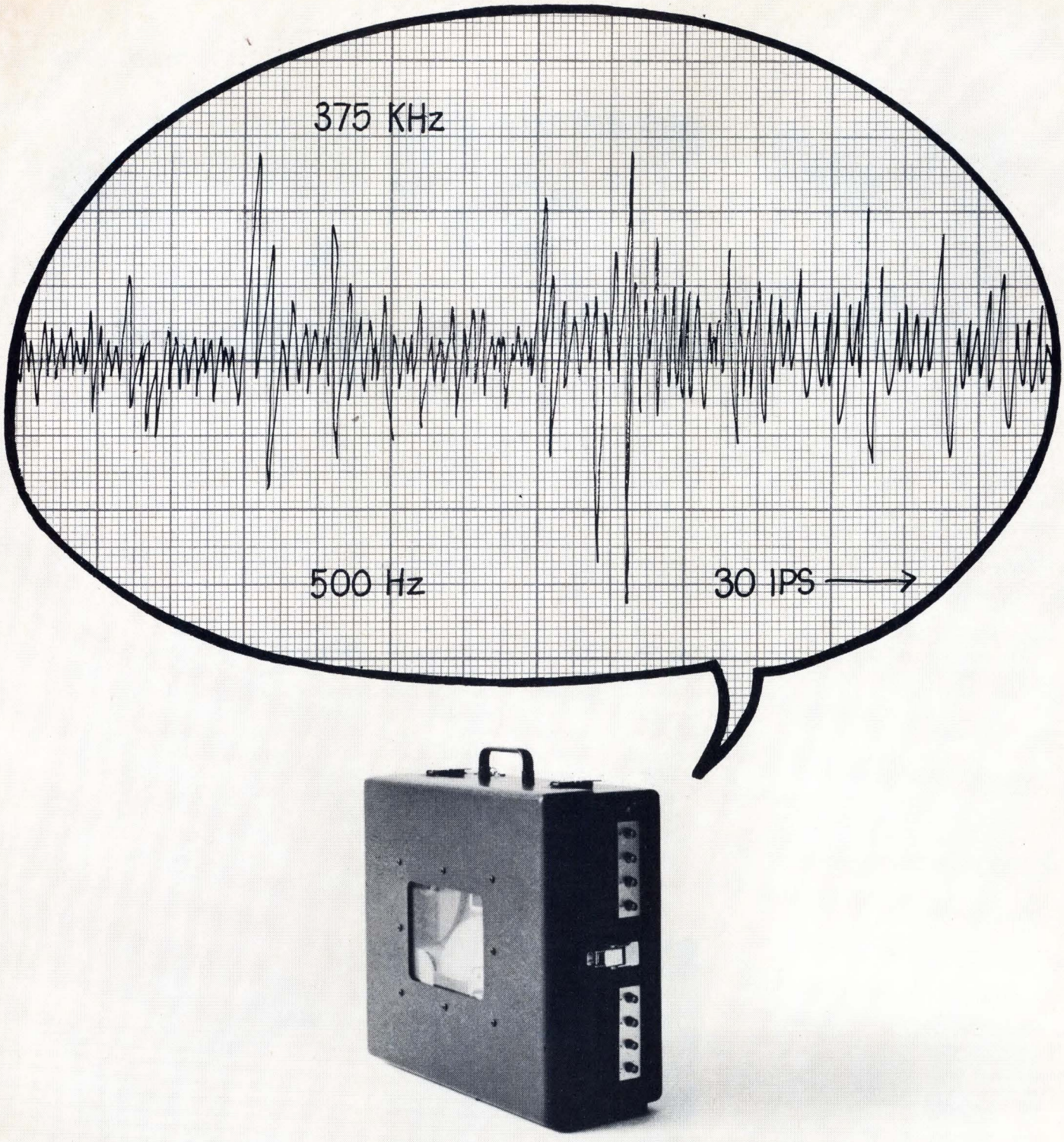


No other 28-lb. data recorder can make that statement.

Now available, our new 417 WB speaks wideband to the tune of 374.5K Hz at 30 ips. Of course it's not the only recorder that meets IRIG specs for wideband Group II. But it's the only one that weighs less than 50 lbs. (The 417 WB's 28 lbs. also includes its carrying case and self-contained battery, by the way.) And it's the only one small enough to fit under an airplane seat.

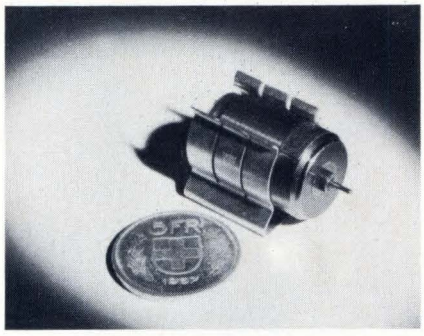
So, when you have to hit the trail for data, let the new 417 WB take a load off your back. And off your mind. It needs less maintenance and fewer adjustments than any other portable recorder. It ignores bumps, jolts, vibrations and odd mounting angles. It normally draws only 25 watts of power. It records on seven channels. And it matches large rack machines for accuracy.

But that's just a taste. For the full 417 WB story and spec sheet, write Mr. Fred Romer, Dept. 412-10, Lockheed Electronics Company, Plainfield, New Jersey 07061. Or call him at (201) 757-1600. He, too, speaks wideband.

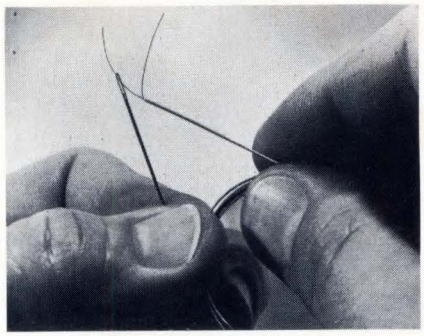
Lockheed Electronics

A Division of Lockheed Aircraft Corporation

Two miniature single-channel buffer amplifiers, C70 3168 201 and 202, weigh only 2.2 oz and measure <1 in³. Characteristics common to both amplifiers include: 200 KΩ ±0.1 percent input impedance, ±0.05 percent gain stability, ±0.01 percent (±0.5 mV) linearity, 30V rms max signal voltage, 0 to 10V rms signal input range, 28V dc power input and 200 KΩ load. Singer-General Precision, Inc., 1150 McBride Ave., Little Falls, N J 07424. **330**



High-performance, low-cost servo tachometer, Model 330/2055T, features a precious metal commutator and an unusual rotary configuration. Model 330/2055T has an output rating of 2.9V/1000 rpm with a ±1 percent linearity and a ripple factor of <±1.5 percent. Units are only 0.86 inch in diam, 1.29 in long and weigh 2.3 oz. Price in 100 quantities is $10.70 each. Micro Mo Electronics of New England, Box 227, Sudbury, MA 01776. **333**

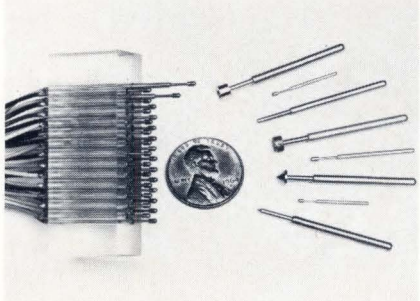


Ultraminiature 50Ω coaxial cable has an outside diameter of 0.03 by 0.019 nominal. Center conductor is 42 AWG wire, dielectric is modified "Teflon", whose dielectric constant is considerably below that of "Teflon". Drain wire (for terminating) is 36 AWG, shield is aluminized "Mylar" and jacket is "Vylex" (a "Mylar" laminate). In spite of its very small size, this coax can be stripped easily. Berk-Tek, Inc., Box 60, Reading, PA 19607. **336**

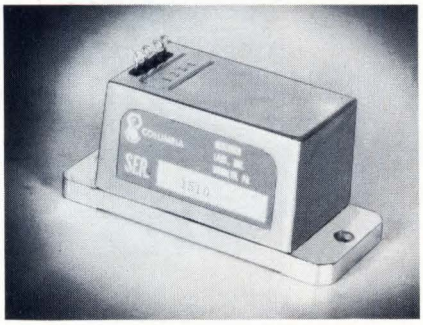
Transistorized indicator lights for integrated circuits require no special power supply in interface circuitry. Subminiature in size, they accommodate a T-1-3/4 incandescent bulb with miniature flange and have double-turret terminals. Also, they operate directly from standard TTL, DTL, RTL micrologic modules and come in a choice of stovepipe or cylindrical lens shape and full range of colors. Dialight Corp., 60 Stewart Ave., Brooklyn, NY 11237. **331**

Two 5-turn conductive plastic precision potentiometers, Model 3521 for bushing mount and Model 3571 for servo mount, have standard linearity of 0.5 percent in contrast to 1 percent previously. Power capacitance is 1.5W at 70°C, derating to 0 at 105°C. Resistance range is from 500 to 500,000Ω. Quantity prices are under $15 each for the Model 3521 and less than $21 each for the Model 3571. Bourns, Inc., 1200 Columbia Ave., Riverside, CA 92507. **334**

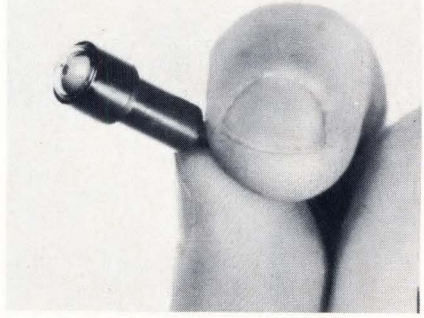
Miniature coaxial connectors designated "Nu-Lok" 1200 C Series require only two crimping tools for installation. These connectors are available in hermetically sealed style for non-RF applications and environmental resistance styles for high-impedance circuits and RF applications to 1 GHz. 1200C Series may be used with either single connector coaxial cable or non-shielded cables, in sizes up to 18 AWG. Cinch-Sales, 1501 Morse Ave., Elk Grove Village, IL 60007. **337**



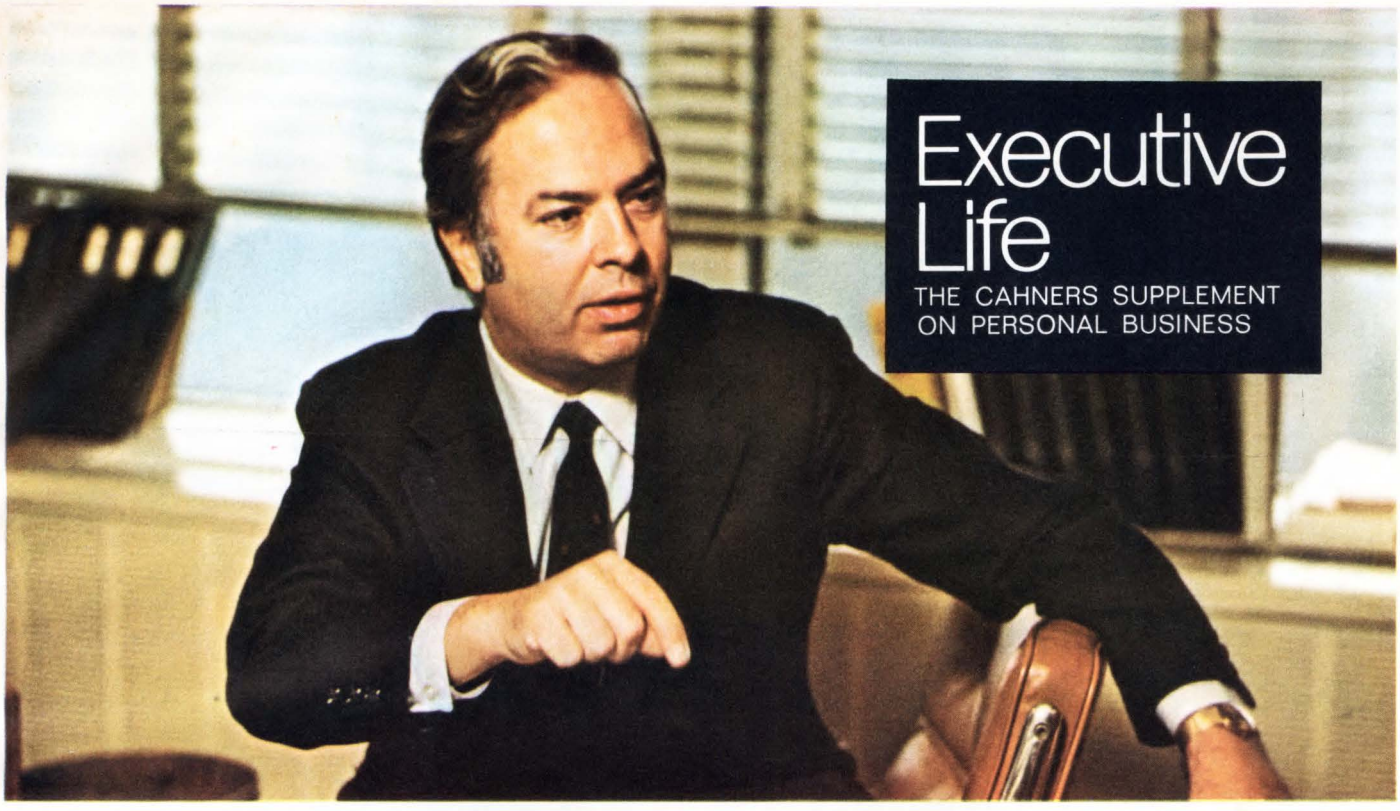
Snap-out spring probes provide a contact system with reliable operation in applications where high contact density, quick connection and ease of contact replacement are required. Probes are retained in a receptacle which is mounted in the insulating structure. Conductors are attached to the receptacle by crimping, soldering or push-on terminations. Probes may be snapped out for replacement – no need to remove conductors. ECI 4331 E. Mission Blvd., Pomona, CA 91766. **332**



Servo or force balance accelerometers, Series SA-107, adapt state-of-the-art aerospace technology and measure inertia throughout the range of ±0.5 to ±10 G. Accuracy is better than 0.2 percent of full scale, and the resolution is <0.001 percent of full scale. Standard units operate from ±15V dc at 12 mA. Prices start at $125 in quantities of 1 to 1000 units or more. Columbia Research Laboratories, MacDade Blvd. & Bullens Ln., Woodlyn, PA 19094. **335**



Low-cost microminiature fault-isolation indicator responds to a fault signal – transient or continuous – by a color transfer of its display mode. Display latches into place magnetically until reset is accomplished by energizing reset coil momentarily. Size, only 0.32 in max diam, makes these indicators attractive for central control operations by being grouped on remote fault isolation panels. A. W. Haydon Co., 232 N. Elm St., Waterbury, CT 06720. **338**



"The second six months? The Feds have a plan: Stimulate, get ready for expansion, but don't talk about it." — Dr. Pierre Rinfret.

Worrying About the Slowdown? Don't.

BY DR. PIERRE A. RINFRET,
President, Rinfret-Boston Associates, Inc.

Editor's Note: *In December, 1968, Dr. Pierre A. Rinfret — the young, pragmatic, business-oriented economist — predicted with virtually 100% accuracy the major turn of events in our 1969 economy. He was laughed at for saying then that the 10% surcharge would actually be inflationary, and that we would be paying interest rates of 8 to 8.5%. He was right on both counts. Earlier this year at J.K. Lasser & Company's "8th Annual Business Conference for Thoughtful Businessmen," Dr. Rinfret discussed our 1970 economy. What follows are his surprising "scenarios" for the first and last six months of this year.*

I want to discuss what I call the 3 S's of the American economy at the present time. What I want to talk about is "The Scenario for a Synthetic Slowdown." To put it another way, I call the American economy right now a "polluted" economy, an economy which in many ways is developing along lines similar to our biological and, if you will, our ecological environment.

I want to start off with a few key thoughts. First, let me remind you of something I've been saying for quite a few years now: there is no such thing as business, there is no such thing as economics. We are not living in a business world, we are not living in an economic world. What are we living in? We are living in a political-economic world. There is not one major decision in the American economy today — its direction, its course, its level — that is not, in fact, either directed by or influenced by the decisions people are making in Washington.

Dr. Pierre A. Rinfret is President and Chief Executive Officer of Rinfret-Boston Associates, Inc., and Chairman of The Rinfret Management Company. A world-famous economist, he was previously Chairman of the Board of Lionel D. Edie & Company, Inc. An Adjunct Associate Professor at N.Y.U., he earned his Doctorate at the University of Dijon in France. He consults with many of the largest companies in the country and serves on the Board of Directors of a number of others.

And I would suggest to you, very seriously, that this country is developing a master economic plan and that the direction of our economy, in both the short run and the long run, is being developed more and more according to a plan developed by the politicians in Washington. To me, this is now a fact of life.

Second, no one — and I don't care how old he is — no one has ever lived in the kind of environment we had in 1969 or the kind of environment we will have in 1970. There is no historic experience, there are no guidelines, there is very

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little theory to explain the kind of environment we have and are going to have.

Third, I would suggest to you that surprises are a way of life, particularly in the American economy. The surprises are that the unthinkable becomes mundane. And I remind you of one thing: in 1966, everybody said the American economy could not survive with 6 percent money. Remember that? Now everybody says, "Wouldn't it be nice if we had cheap money?" What's cheap money? Six percent — the good old days. The American economy has survived 6 percent, 7 percent, 8 percent, 9 percent since 1966, when we couldn't survive 6 percent money. Our economy has grown over $175 billion and smashed every economic record in the history of the world — at 9 percent money, to everybody's great surprise, particularly the economist's, who are always the lousiest business analysts around.

The great surprise is that not only did we survive with 9 percent but we established new records. We seem to thrive on adversity. In fact, in my concept about this country, the more adverse conditions are, the better it is. Now, we're in a slowdown today. Only an economic fool would say the American economy is not slowing down. Of course, it is. The rate of growth is dropping, production is not rising. All the indicators show that we are in the midst of an economic slowdown in real terms.

"Inflation is supposed to be our responsibility. Baloney!"

Our First Intentional Slowdown

But let me surprise you, in one sense: it is a synthetic slowdown. Do you realize that this is the first slowdown ever generated intentionally in the history of the United States? For the first time in our history, we have said — on purpose, with intent, forethought and malice — that the American economy shall slow down. Do you realize that today we are writing economic history? It's the first time in the history of the United States that a slowdown was brought about intentionally and brought about successfully.

Think of it this way. What have we done? We have suppressed demand. We haven't turned it off, we have suppressed it. We've turned active demand into latent demand. This raises some key questions. Do we stay slow? Do we start back up? When? Are we going to stay down here? Is this the beginning of a recession? Is this the beginning of deep trouble? Is this, in fact, the beginning of a repetition — forgive the expression — of those great, wonderful years, the Eisenhower years, which were the lousiest set of economic years we've ever had? Eisenhower was a great man. I was an Eisenhower Republican; I loved him dearly, but when I looked at the performance of the American economy, I used to shudder. He had high inflation, low growth, and high unemployment.

That's a combination! Is this the beginning of the same combination again? No.

Let me give you a scenario of what I think the development of the American economy will be in 1970. And I want to warn you in advance that some of the things I'm going to say are going to shock you and you're going to say, "He's crazy, berserk! Our politicians can't think that way."

They can't think that way? Let me write you a political scenario of 1970. First, you want to develop a low rate of growth for the first six months of 1970. You don't want to bring the economy down, you just want to slow it down so its rate of growth is on the order of 2 percent a year. Why do you want to do that?

Well, the reason is that you don't want to throw anybody out of work. When the American economy grows 2 percent a year, no one loses a job. This is a very critical fact because the silent majority stays at work. And if they don't stay at work, they're not going to stay silent. So you keep the silent majority employed by making sure you have a nominal rate of economic growth. No one loses a job, there's no unemployment increase by job loss. That's a very important fact.

Second, you let the new entries into the labor force go unemployed. A million and a half people a year come into the labor market and they can't find jobs. They are looking for jobs, but the economy is only growing 2 percent, it's keeping everybody who's already employed at his job, but it's not creating new jobs. Now, who are the new entries into the labor force? They're the kids — they're 18 to 24. Who cares about them? Most of them don't vote. The trouble with them is that they're a vocal minority. Washington looks at them and says, "To hell with you, you never supported us, all you do is give us headaches." And so, believe it or not, your vocal minority stays unemployed. You are very careful with this policy — you keep the silent majority employed and the vocal minority unemployed.

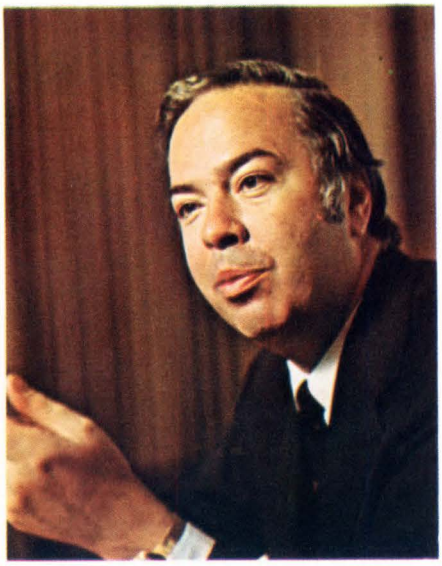
Now, here's another key question: if there is any increase in unemployment and jobs are lost, who will lose the first set of jobs? The blacks. They become unemployed before the whites, at a rate that's 2.5 times as high as for the whites. As the party in power, you don't particularly care about them either — only 3 percent of them voted for you. And so you've got an increase in unemployment among the kids and the blacks, but your great silent majority stands there and supports you because it's still fully employed.

Stimulate Expansion, But Don't Talk About It

Now, that's the scenario for the first six months. What about the second six months? The answer is very interesting: stimulate, inflate, get ready for expansion, but don't talk about it. Talk anti-inflation while, in fact, you pursue inflationary policies. Let me give you some illustrations. Every day of the week you hear that the Government is anti-inflationary. Mr. Nixon wrote a letter to 2,200 labor and industry leaders in which he talked about the fact that the Government had gotten its house in order, had done everything it knew how to restrain its spending, cut its spending, cut its commitments. The Government now is in an anti-inflation position. If there's any inflation, it's the responsibility of labor and industry.

I hate to say it, but if you believe this, you are a sucker. It's not true. Most of the claims of the Administration are false. If they are not outright lies, they are half-truths. Let me list four major things the Federal government is doing.

First: tax cuts. There was a cut in the surtax from 10 percent to 5 percent on January 1, 1970. There will be another cut from 5 percent to nothing on July 1. There will be two income tax cuts in 1970. You may have noticed recently the problem the Administration is having in fighting off additional tax cuts. Congress is tax cut-minded. Why? It happens to be running for election in 1970.



"Take your banker to lunch. Get your money, now! And don't worry what you have to pay for it."

Second: increased Social Security benefits. How much? Well, the Administration asked for 10 percent, Congress thought that was cheap, it advocated 15 to 20 percent. According to the Senate Finance Committee, Social Security benefits will go up 15 percent in 1970. So we'll have $6 billion released into the economy beginning January 1, 1970, without an offsetting tax increase.

Third: the Federal government doesn't have a surplus. They're the biggest liars in the history of mankind. They are lying statistically, they are lying morally, and they are lying verbally. Go ask the Director of the Budget, as a friend of mine did, whether there's a deficit in the budget. Mr. Mayo answered that it depends on how you count the deficit. My friend quoted our view that if you put the budget on an historic basis and you include all Federal borrowing, the Government is in deficit. Mayo's response was that you don't include all the borrowing, because the Government excludes a certain amount of borrowing.

When I heard this, I called my accountant and said, "Could I have a new balance sheet on my company? I'd like to leave out the liabilities, if you don't mind." But Mayo said that the Government doesn't include the Commodity Credit Corporation, the Export-Import Bank, or the Federal Home Loan Bank Board. My friend asked what happens if you include them. Mr. Mayo's answer was that if you have to include them, there is a deficit. My friend asked how much the deficit would be. The answer was $6 billion.

How come? Well, Johnson changed the budget in 1968. He decided to exclude public borrowing for certain public agencies, which were called private agencies even though they borrow money for public use. But you don't count that, you see, because that's a new system of accounting. So there's a deficit of $6 billion in fiscal 1970, and maybe $8 to $10 billion in fiscal 1971.

Fourth: government spending is going up, $8 to $10 billion.

Let me put it to you simply: how can the Federal government be anti-inflationary when it is advocating a cut in personal taxes, a cut in corporate taxes, an increase in Social Security benefits, an increase in the deficit, and an increase in Federal spending? If that's anti-inflationary, I don't want to be around when they get expansionary. They'll kill us. Now they're sitting there and telling you, "We are restraining the American economy. Therefore, you are responsible for inflation, not we." You go down to Washington, you listen to that garbage — forgive me, but it infuriates me — and *you* take the responsibility.

Capital Goods Boom in 1970.

Here's another point: in 1970, there will be another capital goods boom — plus 8 percent over 1969. No question about it; five different sources have verified that fact. The Department of Commerce confirmed that capital expenditures in the first six months of 1970 will go up 8 percent over 1969. If you've got a capital goods boom, you can't have a recession. It's that simple. Now, with Government inflationary and stimulating, with capital goods up, can they ease money? Of course not. Can the Federal Reserve ease in this environment? Of course not. Is it going to ease in the light of all these stimuli? I don't think so.

Let me give you some numbers. Last year I had the pleasure and delight of being high man on the totem pole and for 1970, so far, I'm still high man. In 1969, we will have turned out $933 billion in goods and services, Gross National Product. In 1970, GNP will be $1,000 billion — one trillion dollars. By the end of the year, it will be somewhere around $1,050 billion. I give you my word of honor that on July 2, 1970, at 12:32 in the afternoon, the economy will pass a thousand billion dollars. There's going to be a clock in the Department of Commerce ticking it off.

Last week I asked my staff, "What kind of numbers do you have on 1970?" Want to know what the answer was? They had raised the GNP number to $1,003 billion. I said, "How come you're raising it?" They said, "We're having trouble holding it down." That's interesting. Most people are having trouble getting the estimates to go up; we're having trouble holding them down.

Let me mention a few other indicators. Industrial production will set another all-time record in 1970. About after-tax profits I disagree totally with most people: you may be surprised in 1970 and see as good a year as 1969 which, incidentally, is an all-time record. In fact, 1970 may see a modest gain. Prices will go right on up — by 4.5 to 5 percent, if we're lucky. It was 6 percent this year. Labor costs will go up 8 to 10 percent. But labor isn't getting anything. Believe it or not, the average worker in manufacturing has no more take-home pay today than he had five years ago. Interest rates will go higher — 9.5 to 10 percent for Triple Aaa money by July, 1970. You know what I said last year? I repeat it: take your banker to lunch. Wine him and dine him. Take him to dinner if you have to, but get your money. Don't worry about what you're going to pay for it. What the hell, it's tax-deductible anyway. Money is going to be a scarce commodity throughout the year.

No Recession

What kind of economy will it be? An economy that will grow, an economy that will expand, an economy that will not have a recession, but an economy in which we will break every record ever established, including the cost of money, the cost of labor, and the price level. We'll have more inflation, higher labor costs, higher interest rates, and the highest level of economic activity ever established in the history of the world by any one country.

I say optimism. Why not? Ignore the economists. They don't know what's going on, you do. The economists' record for ten years shows excessive pessimism and underestimation of our strength. In ten years, they forecast three recessions that never occurred. I don't mind that, but they missed the two that did occur.

Optimism. This is the greatest economic machine in the history of the world. Why? Because we adapt, we are flexible, we learn how to live with our environment. Nine percent money isn't going to stop this country. Optimism. Why not?

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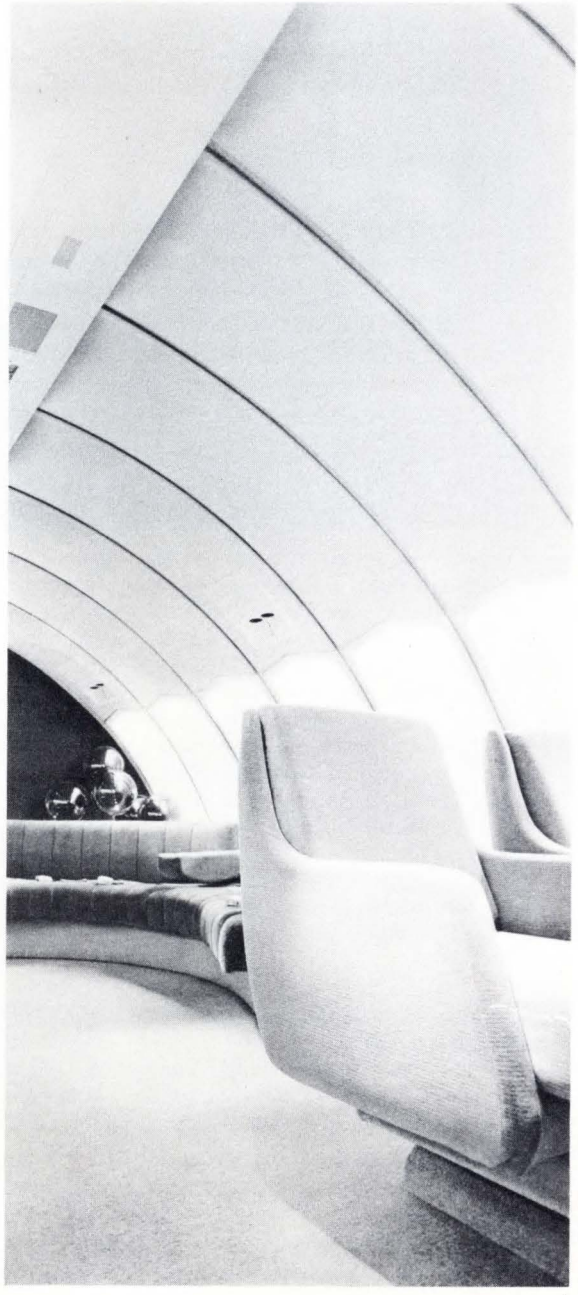

Q. White Weld makes a point of seeking out young companies and bringing them to market. Why?

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Q. What makes you decide a company has unusual promise?
A. Generally, we use four categories to decide on the marketability of a company. People. Products. Prospects. Price. The first two are qualitative. That is, we look at the quality of the management and the competitive position of the products in the marketplace. The other two categories are quantitative. Prospects are obviously what the future holds for the company. By price I mean the price of the securities we would offer in relation to the company's earnings. If it's not a fair price we're not interested.

Q. Do you offer young companies anything special?
A. Imagination, for one thing. Time after time White Weld has succeeded in coming up with effective solutions simply because we are willing to depart from classic textbook patterns. Then, too, we work closely with the issuer after the offering. We make a market for the company's stock, disseminate financial information on the company, advise on dividend policy, debt financing and, of course, mergers and acquisitions. As the leading investment banker overseas, White Weld is also useful to the new company if and when it decides to expand abroad.

"We look at the quality of the management..."

Q. Do you make broad distributions of initial stock offerings?
A. All the time. Through our many offices here and abroad we work with large numbers of individual retail clients as well as institutional investors. We've more than enough retail business to accommodate offerings from within if we wanted to. But, for optimum geographic coverage, we handle virtually all of our issues through large syndications. White Weld believes it's important to have this facility for widespread distribution today. You could say it's one of the reasons we've become one of the largest investment bankers in the country.

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Does Money Really Motivate?

BY DR. FREDERICK HERZBERG, Professor
Department of Psychology
Case Western Reserve University

What is the role of money in terms of employee motivation? Dr. Herzberg believes it has far less significance than many managers think. Viewed within the context of the Motivation-Hygiene Theory, salary soon slips as a source of motivation.

Does more money really motivate employees? Many hardheaded businessmen believe it does. I don't. Salary is a necessary reward for work. But it does not motivate people to work more effectively. The only way to motivate an employee is to give him challenging work in which he can assume responsibility.

Still, many managers believe that money is the key to motivation. Yet if salary is the chief motivating element, we can assume that financial incentives would increase employee productivity in some predictable fashion. But they don't. Studies have shown that the amount of money an employee receives is only tenuously related to his actual and potential output. Opsahl and Dunnette, in their fine review of this matter, said that . . . "not only do financial incentives operate with different efficacy in different situations, but often they do not even lead to increased production."

A clearer picture of salary and motivation emerges when we look at something called the Motivation-Hygiene Theory. This theory came out of an examination of engineers and accountants. At least 16 other investigations, using a wide variety of populations, have since been completed. Hence, the original research is one of the most replicated studies in the field of job attitudes. Here are some of the findings:

The factors that make people satisfied in their work and frequently lead to superior performance are separate and distinct from the factors that make people dissatisfied. Hence, the opposite of job satisfaction is not dissatisfaction, but rather, *no* job satisfaction.

The factors that contribute to job satisfaction and superior performance are called *motivators*. All motivators, it turns out, are *intrinsic* to a task and are realized through *personal* accomplishment on meaningful tasks. Motivators are such things as achievement, responsibility, the actual doing of meaningful work, and the opportunity to learn. When a job offers an employee these things, it allows him to fulfill the human needs for competence, effectence and psychological growth.

The hygiene factors are those things that are *extrinsic* to a task; they are in the environment in which a job is performed. These elements — such as company policy, fringe benefits, salary, supervision, and working conditions — are related to dissatisfaction when they are not met or fulfilled. And even when these factors are extremely good, they do not create sustained motivation.

The theory points out that motivators are the primary cause of job satisfaction, and hygiene factors are the primary cause of job dissatisfaction. For example, salary becomes more than a reward for work, it becomes a right. And unless the ante is continuously raised, the psychological reaction of employees is that the company is turning back the clock.

The motivators produce long-term effects, in that the employee performs consistently better and for longer periods than in a motivator-depleted task. When hygiene is improved there may be a temporary and mostly spurious rise in performance. However, the temporary rise is more the result of the removing of a decrement in output than any real gain. The rise will be short-term.

The motivators and their effects on the individual are additive; gains in employee competency and growth consistently build on each other. The hygiene factors, on the other hand, are cyclical and constantly need to be replenished. Benefits given by management quickly be-

come a right of the employee. Once an improvement in working conditions or a raise is given, this level becomes the base point from which bargaining begins later. In short, hygiene factors must be constantly improved, and can be a constant source of dissatisfaction.

The motivators are related to the feeling of being psychologically "more than" one was before. This "more than" feeling is a function of *actual* psychological growth, of growth in skills. An employee can measure his gain in new knowledge, his increasing effectiveness in problem solving, in being more creative. Conversely, salary always seems to relate to a feeling of being "less than" someone else. And this feeling in human beings is threatening. It grows out of the child's dependence on others who are larger and in control. As the child matures and becomes "less than" in a comparative sense, he develops the feeling of being denied. The feeling of "less than" leads to the belief that one is being treated unfairly. Certainly in wage and salary schedules the major concern is with equity of payment.

So salary is classified as a hygiene factor, for these reasons: its short-term effects on job attitudes; its relation to the *extrinsic* aspects of the job; and in its relation to two kinds of avoidance needs of the individual — avoidance of the economic deprivation felt when income is insufficient, and avoidance of feelings of being treated unfairly. Finally, there is money's cyclical and replenishment quality. There will always be a call for more.

Salary and dissatisfaction

Salary, then, is related to the environment of the job (not when an employee does, but when he receives for what he does). It is related to periods of dissatisfaction and when adequate, has short-term effects.

Many managers think money motivates because it often appears to produce job satisfaction. This appearance is often deceiving. The key is whether productivity increases and remains at a high level. This seldom happens, especially in less than meaningful tasks.

When viewed by itself without a meaningful task, salary operates more as a payoff for what the employee is *not permitted to do*. With increasing job specialization and job simplification, employees are paid as much for what they are not given a chance to do as for what they do. In this case, salary is used to buy off the unused portion of a man's ability. *Increases in salary will be looked on as deserved payment for endured pain.* The effects of wage increases will be short-term (if any), the demands for more will continue, and unfairness will be the battle cry.

But make no mistake, hygiene factors are important. Many people will not classify salary as a hygiene factor because they have the mistaken notion that hygiene is unimportant. The implication is that since motivators are tied to the human need for growth, they are more important than hygiene factors. This is not so. The need to avoid pain is as vital to man as the need for psychological growth.

It is obvious that industry has realized it must do a good job of meeting the hygiene needs of employees. When hygiene is adequate, the employee will respond with an average or adjusted performance. He adjusts to the design of the job, the group standards, the company policies; in short, the "goodness" of the environment. If extra hygiene is added, such as bonuses, the company may get a temporary rise in performance. But it may deteriorate to the old level when the bonus is removed or perceived to be a right rather than a reward.

Motivation or superior performance, however, comes from the task itself. People want to actualize themselves. Motivation does not lead to achievement; rather it is achievement that leads to motivation. But real achievement requires a task that makes it possible. The task must be one which allows the person to achieve, to be responsible and to demonstrate competency if it is to lead to superior performance.

In this situation we may look at the man on the assembly line. He is saying you are paying me for my pain, for my unused talents and capabilities, not for my motivation. Since you are not using my abilities or my growth potential, this releases my concentration to focus on my pain.

This, in effect, teaches that avoidance of pain is the only goal of work, and leads to the perplexing statement that typifies the wage and salary — motivation problem, "The only way to get people to do anything is to pay more."

Money can be Measured

Why do we still get the feeling coming from many quarters that salary is the key factor in industry or life in general? There are a number of reasons, but the most important have to do with the empirical quality of money. If you do not have numbers, factor analysis and correlations, all statistical significance are meaningless. The measurement of all other variables in the workplace and in industrial motivation have presented difficult measurement problems. Money, however, has all the qualities an empiricist could ask for:

1. It is easily compared. If you can derive a number for productivity, turnover, absenteeism and other "hard" data, a dollar figure can be derived also. Money is one of the very few variables behavioral scientists can measure in ratio scale. Even though correlation coefficients are not supposed to be taken as cause and effect, this is sometimes passed over lightly. Therefore, empiricists will probably continue to claim magical properties for salary since it is one property that they can compare.

2. Money is easily manipulated. Its numerical quality means we can double, triple, divide, multiply or generally juggle (in actuality or in our imagination).

3. Money is easily given. Most managers believe this, even though the men who hold the purse strings don't. We do know that it is easier to give than take away. Red circle rates are only one indication of this. It may be interesting to contemplate the effect a general announcement of reducing wages, benefits and other monetary "privileges" would have. The "privilege" quickly becomes a right.

4. The fourth point, related to the other three, is that money is the most propagandized of all elements in the work situation and perhaps our society. Motives tend to be defined monetarily. If someone feels something wrong, he asks for more money. The something wrong may be the lack of growth possibilities. Yet, since money is said by union leaders, successful entrepreneurs, the jet set, the banks and credit agencies to be the elixir to solve all problems, the obvious response, when a vague feeling of lack arises, is to ask for money.

The answer, of course, is not more money, but job enrichment. But, you say, not all jobs can be enriched. Right. The argument for job enrichment can be summed up quite simply: If you have someone on a job use him. If you can't use him on the job, get rid of him, either via automation or by selecting someone with lesser ability. If you can't use him and you can't get rid of him, you will have a motivation problem. And more money won't help.

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I DIDN'T KNOW WHAT THE AUDI WAS EITHER, UNTIL LAST MONTH

BY J. ROBERT DALEY
Director of Finance & Administration
Greater Boston Chamber of Commerce

To be considered "typical" in any respect is somehow a bit deflating yet at once complimentary. When the Porsche people asked me to test drive their new foreign car — called the Audi — I was not only surprised but stunned. What I know about the inner workings of engines you can write on the head of a pin.

As it turned out, however, such ignorance is an asset; most "typical" new car buyers, I was told, also know precious little about those hidden mechanical innards.

Porsche said that I am "typical" because I am 38, I have a median versus a mean salary, two conventional American sedans, and a penchant to trade them in every three years. What they didn't know and what they were delighted to hear was that I love new cars. I'm not sure why except to say that I greatly enjoy shopping for, trying out, and then driving off in Detroit's latest.

It is partly because I have never owned a foreign car that Porsche wanted me to drive their new Audi. They knew I would come equipped with all those built-in doubts about reliability, service, parts, and comfort — those age-old bugaboos that Americans wonder about when it comes to foreign cars.

So being typical, I accepted Porche's offer and the results follow. My impressions are based on having driven the Audi from New Jersey to Boston — on a turnpike and in stop-and-go traffic. My analysis, hopefully, is typical.

New Only To Our Shores

I had never heard of the Audi either. It sounded like the name of some African bird that shrieks a lot. Actually, it means "listen" in Latin. This, I found, has no significance; it just came out that way when four German auto manufacturers merged in the early 1900s and combined their first initials. Also way-back-when, the Germans were making Audis. I learned that Audis were first built in 1909 by someone called August Horch. The Audi established a reputation for performance and quality, winning the 1911 Austrian Alpine Trials, then one of the world's toughest competitions.

The Horch factory continued to produce Audi passenger and sports cars until 1933 when four independent companies merged into Auto Union. Audi production was discontinued during World War II. After the war, Auto Union was reorganized in Ingolstadt, Germany, where Audis are made today. So the car is new only to our shores.

I was told all this when I went to Porche-Audi headquarters in Englewood Cliffs, New Jersey, where Jack Reilly, vice president, unveiled the Audi to me.

My first impression was that it looked like a smaller Mercedes-Benz. This is no coincidence because while the Audi company is now a subsidiary of Volkswagen, VW bought the company from the Mercedes people. And that unmistakeable mark of German craftsmanship is evident in the Audi.

I don't kick tires, but I am still hooked on slamming doors. I have never slammed a Mercedes door, or a Porsche for that matter, but I'm sure that the solid "thunk" of the Audi's door is the same. That "thunk" symbolizes your first visual impression of the interior — scads of honest-to-goodness leather. There is something about the Audi's interior appointments that reminds you of the furnishings in an old English men's club. Things last. There are reclining seats, full carpeting, and quality-looking wood veneer on the dashboard.

The exterior design has a subdued air of elegance. It's terribly simple, yet done with enough tasteful dash to satisfy your ego. They like to refer to the Audi as a luxury car at a moderate price.

Front Wheel Drive is a Gas

The car is comfortable to sit in. The reason, Jack told me, was that orthopedic surgeons designed the seats. This is a

Introducing Audi.

The revolutionary new car from Germany that moves, stops, turns, etc., differently from every car on the opposite page.

Almost every car in the world moves by means of the rear wheels pushing it.

The Audi moves by means of the front wheels pulling it.

Most cars' front brakes (whether they be drum or disc) are located on the outside of the axle just inside the wheel hubs.

The Audi's front brakes (which *are* disc, by the way) are located towards the middle of the axle.

Most cars turn by means of a series of gears and levers.

The Audi turns by means of gears alone.

Most cars also do other major things the same way.

While the Audi does most of them another way.

What it all adds up to is this:

The advanced automotive principles that German engineers used in designing this car make it perform like nothing you've ever driven before.

And we're not talking about subtleties. But differences that will be apparent to you the moment you drive the Audi out of the showroom.

Which is what we'd like to invite you to do right now: drive an Audi out of the showroom and around the block a few times. (You can find out where your nearest Porsche-Audi dealer is by calling 800-553-9550 free. Or, in Iowa, call 319-242-1867 collect.)

It's quite an experience. **Audi®**

Suggested price, East Coast P.O.E., for 100 LS (as shown): $3,795. Other models start at: $2,995. (West Coast P.O.E. slightly higher.) Local taxes and dealer delivery charges, if any, additional.

"first", I guess, and it has paid off. It's a 4½-hour drive to Boston, and at the end of it I didn't have that half-day driving hangover with accompanying back pain.

There are two models of the Audi. I drove the top of the line — the 100 LS, which comes with either two or four doors on a 105.3-inch wheelbase. The less expensive Super 90 model has a 98-inch wheelbase.

Both cars have four-cylinder, water-cooled engines. But 100 LS doesn't drive like four cylinders. I had no trouble getting that extra zip needed to pass other cars. Neither car has an automatic transmission, but shifting — which I haven't done in years — was easy and fun. Shifting actually gave me more of a sense of driving, which may be atypical, but I like it.

I had never driven a car with front wheel drive before either, which the Audi has. And there *is* a difference. The car responded better, quicker somehow, which takes some getting used to. But once you understand how well the car can maneuver, it is a good feeling. I don't really know what it means, but they told me that part of the reason for the Audi's easy handling is rack and pinion steering. As a result, the driving wheels pull the car in the direction its wheels are pointing.

The Audi has power brakes, which are standard equipment, with inboard disc brakes on the front wheels and drum brakes on the rear.

As a gadget lover, I was quick to try all the Audi's levers and switches. One novel feature is its closed-window ventilation system. There are numerous fresh-air outlets on the dashboard, even one that was aimed at me through the speedometer.

The air outlets can be opened individually and in various degrees so that a comfortable amount of fresh air flowed in. One of the things that has long distressed me about several cars I've owned has been the ventilation systems. In the winter, I can never seem to get a happy medium of warm air; no matter how much I fiddle with the dials, it is either too hot or too cold. Not so with Audi system. It *can* be regulated properly. And the air not only comes in, but they have made provisions for it to go out. Exhaust vents on the shelf under the back window drag stale air to the outside through the rear window posts. I was driving at 60 mph most of the trip back, and according to the Audi manual, at that speed air inside the car is changed every 15 seconds, even with the windows rolled up. I believe it, because when I'm driving I smoke a lot.

Good Mileage

I started off with a full tank of gas and stopped once for lunch in Milford, Conn. Total miles driven were 223, and I figured I got 26 miles to the gallon. With a heavier load (I was alone), Jack Reilly says I would have averaged around 24 miles per gallon on the open road and 20 in the city.

Speaking of a heavier load, there is ample room in the car for five adults. The front seats are bucket types, and there is a surprisingly wide back seat. The trunk is large enough for five people's luggage.

When I arrived in Boston, I had an opportunity to test Jack Reilly's claim that the car will accelerate from zero to 60 mph in about 12 seconds. While I couldn't actually do that because the distance between stop lights restricted "dragging", I did jump on the accelerator once or twice and was not at all disappointed in the Audi's pickup.

There are scads of hard facts about the car that I neither understand nor care much about. But for any car buffs, I'll list a few:

The engine size, for example is 1760 cc (107.5 cubic inches), which is identical in both models. But the 100 LS has 115 horsepower, 15 more than the Super 90. Weights of the Audis range from 2205 pounds for the Super 90 two-door, to 2380 pounds for the 100 LS four-door.

Like all cars today, there are a host of options that can be selected, so it is difficult to talk exact price. However, the car I drove — the 100 LS — carries a suggested retail list price of $3,695, while the four-door version is priced at $3,795. The Super 90's sticker price begins at $2,995.

What about service and parts? Since Audi is now a subsidiary of Volkswagen, Jack Reilly points out that the logistics for a maintenance plan — in conjunction with Porsche — is a leaf out of VW's book, and already is set up. Curiously enough, you can't buy an Audi at your local VW dealer. VW's Porsche Division, now called Porsche-Audi, is distributing the car.

What About Original Doubts?

What about my inherent American skepticism about foreign cars after all this?

First of all, I doubted originally that any foreign car would give me a real comfortable, long-haul ride. The Audi did.

I doubted too that the four cylinders would give me the power I am accustomed to. The Audi's high compression engine did. (Something about weight is pertinent here, but I'm not sure why.) While other cars have front wheel drive, or rack and pinion steering, or inboard disc brakes, or other unusual features, I get the feeling that the majority of cars do not have the whole package put together the way Audi has.

I'm not good at summing up, so I won't. But Jack Reilly did, beautifully:

"In this day of advanced technology," he said, "you have a right to expect certain things in the car you drive. You expect it to handle responsively. Stick to the road. Stop quickly. Protect its occupants. Be comfortable to ride in. And be economical to operate. We decided it's time for you to get what you expect. So we designed the Audi. We gave the Audi front wheel drive, to glue it to the road, even on sharp turns and in gusty crosswinds. We gave it inboard disc brakes, next to the gearbox, so they could be bigger, keep cooler, stop better. Posture fitted seats and a host of other features. So that now you can get what you expect in a car. At last."

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89 Franklin St., Boston, Mass. 02110

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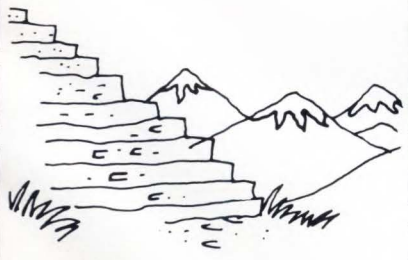

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Please phone me immediately to complete arrangements. ☐

I'm interested in traveling to Spain with a business group. PLEASE call me with information about your special low-cost group plans. ☐

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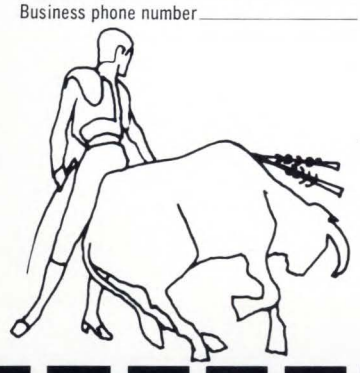

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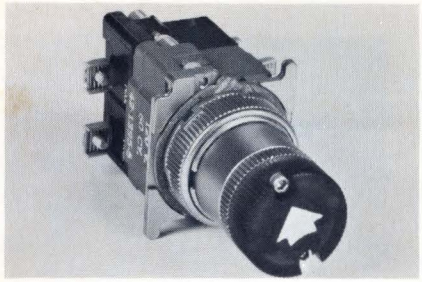
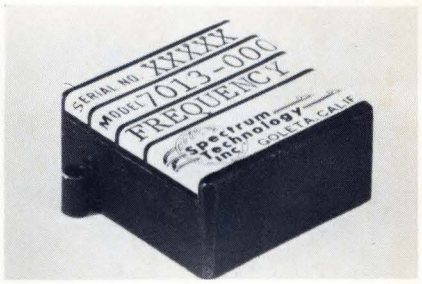
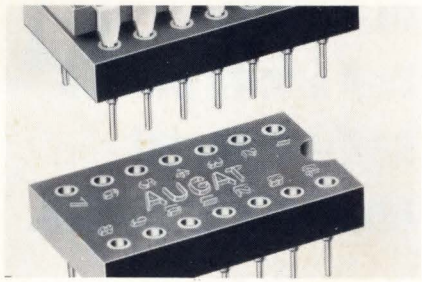


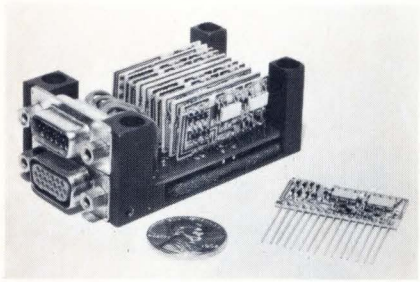
Oiltight illuminated selector switch provides visual indication of operation from a distance. Available in two-, three- and four-position maintained and three-position spring return to center from right and left. Lens caps are offered in red, green, amber, blue, white and clear. Price range is $9 to $13. Cutler-Hammer, Box 463, Milwaukee, WI 53201. **339**



Subminiature temperature-compensated crystal oscillator, Series 7013, comes in 1/2-in³ package. Frequency range is 6 to 20 MHz with ±1 ppm stability. Output drives either TTL, DTL or RTL logic, or it can be supplied with sine wave output. Price is $100, depending upon quantity. Spectrum Technology, Inc., Box 948, Goleta, CA 93107. **342**

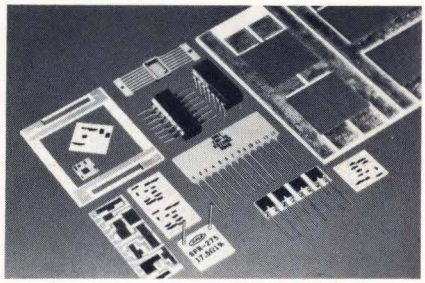


In 14- and 16-contact, low-profile dual in-line sockets are constructed from glass-filled nylon, molded with polarization notch. Raised numbers permit easy contact identification. Body dimensions are 0.45 in wide by 0.75 in long by 0.18 in high off the board surface. Price range of $0.78 to $1.41. Augat Inc., 33 Perry Ave., Attleboro, MA 02703. **345**

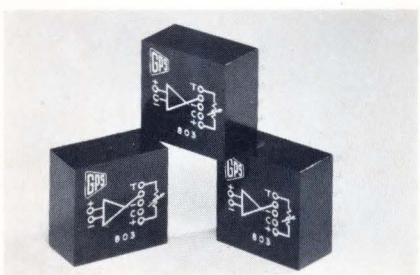


Analog expander module provides subcommutation of 16 analog channels and one word/frame. Each of the 16 analog inputs is switched sequentially onto a common bus with four FET analog gates controlled by a logic circuit in the expander. Expander accepts 16 positive input signals ranging from 0 to 5.1V dc and power consumption is 9.4 mW. Weight is 75g and the unit measures 1 by 1-1/2 by 2-1/2 in. Spacetac Inc., 1 Garfield Circle, Burlington, MA 01803. **340**

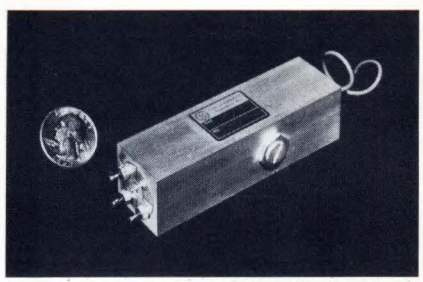
Monolithic Gaussian crystal filter, Model 6354MB, is more reliable and costs less than conventional Gaussian filters. Model 6354MB is a three-pole filter housed in a cold-welded TO-8 enclosure. Other specifications include 10.7 MHz ±0.25 kHz center frequency, 2.5 kHz ±0.25 kHz −3 db bandwidth, 17.5 kHz max −40 dB bandwidth. Source impedance is 500Ω resistive and load impedance is 2 kΩ resistive. Damon Corp., 115 Fourth Ave., Needham, MA 02194: **343**



Thick-film microcircuits meet wide variety of circuit needs and are custom designed to application requirements. Present standard power capabilities are 20 W/in² with higher ratings possible through special packaging and mounting design. The circuits offer surface resistivity/square of 10Ω to 1 MΩ and capacitance of 10 pF to 100 μF. Resistance can be matched to within ±0.1 percent. Dale Electronics Inc., Box 609, Dept. 860, Columbus, NE 68601. **346**

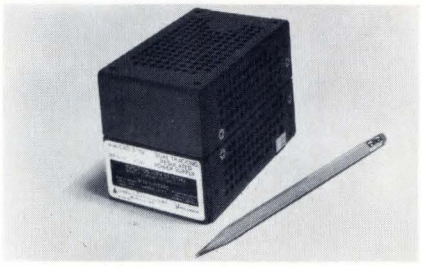


One of a family of six FET differential op amps, Model 803 provides many desirable characteristics to the user. These characteristics include <15 pA bias current, 10^{11}Ωinput impedance, offset temperature coefficient of 10 μV/°C and a slewing rate capability of 10V/μs, 20 mA output. The Model 803 is priced at $60 each. GPS Corp., 14 Burr St., Framingham, MA 01701. **341**

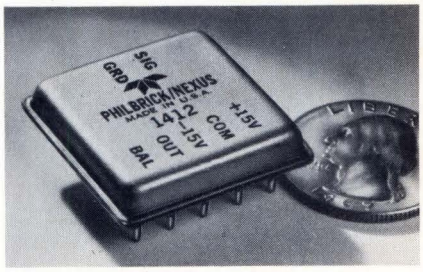


High performance and longer service life are two of the built-in features in the C-2020A microwave circuit module (MCM) oscillator. Typical specifications for the 4-oz unit include nominal frequency of 1090 MHz, peak power output of 500W, trimmable tuning of ±10 MHz and output impedance of 50Ω. General Electric Co., Tube Dept., A&SP Inquiry Processing, 316 E. Ninth St., Owensboro, KY 42301. **344**

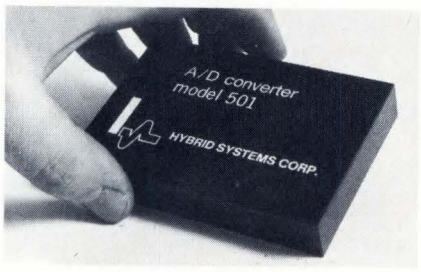
Ultraminiature dual dc power supply, Model BPM-15/150, can power up to 50 operational dc amplifiers. This 1.6 in³ device has a power density of 3W/in³. Model BPM-15/150 operates directly from 150V ac power line, provides an output of ±15V dc at 150 mil (5W). Voltage regulation for load changes of no load to full load is ±0.05 percent. Datel Corp., 943 Turnpike St., Canton, MA 02021. **347**



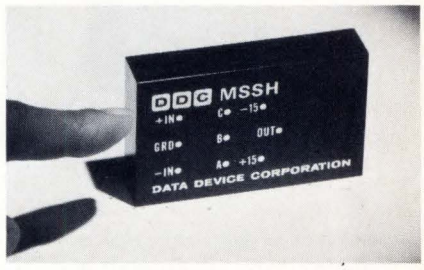
Dual output tracking power supply, Model LXD-3-152, features a tracking accuracy of 0.1 percent absolute voltage difference for all conditions of line, load and temperature. Regulation is 0.1 percent line or load. Ripple is 1.5 mV rms, 5 mV pk-pk. AC input is 105 to 132V ac, 57 to 63 Hz. Temperature coefficient is 0.03 percent/°C. Lambda Electronics Corp., 515 Broad Hollow Rd., Melville, NY 11746. **348**



Chopper-stabilized operational amplifier, Model 1412, combines two significant advances in the state-of-the-art technology. Electrical features for this 1.125 by 1.125 by 0.2-in unit include ±5 mA ±12V min output, ±25 μV initial offset voltage, ±0.25 μV/°C and ±2 pA/°C drift, ±30 pA bias current and a 10^7 gain. Unit price is $125 (1-9). Teledyne Co., Philbrick/Nexus Research, Allied Dr. at Rt. 128, Dedham, MA 02026. **351**

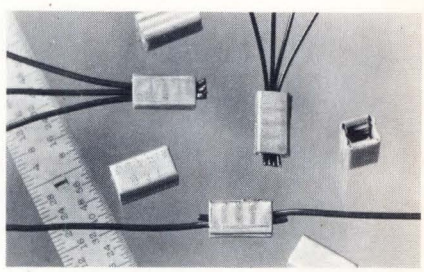


Self-contained 10-bit A/D converter converts full 10 bits in <30 μs. Input signal range is from 0 through 10V. Model 501 contains its own reference, clock and all digital logic required for operation. The 2.8 by 4.1 by 0.615-in unit is fully encapsulated and suited for printed circuit mounting. Price for 1 to 9 is $195 each. Hybrid Systems Corp., 95 Terrace Hall Ave., Burlington, MA 01803. **349**



Sample and hold modules, designated MSSH Series, provide sample accuracy to 0.01 percent in 5V common-mode signal. Drift in hold mode is <1 mV/100 ms. Acquisition time is 10 μs max and aperture time is 100 ns max. Units are available with accuracy of 0.01, 0.02 and 0.05 percent. Prices are from $200 to $300 depending on desired accuracy. DDC, 100 Tec St., Hicksville, NY 11801. **352**

Analog multiplier, Model 5822 provides the user with conventional four-quadrant multiplier performance, coupled with the unusual wide bandwidth of dc to 30 MHz. It is packaged in a module measuring 1-in square by 0.5-in high. Other features include 3 percent maximum untrimmed error and 73 dB null rejection at 5 MHz. Price is $87 each for 1 to 2, $79 each for 3 to 9. Optical Electronics Inc., Box 11140, Tucson, AZ 85706. **350**

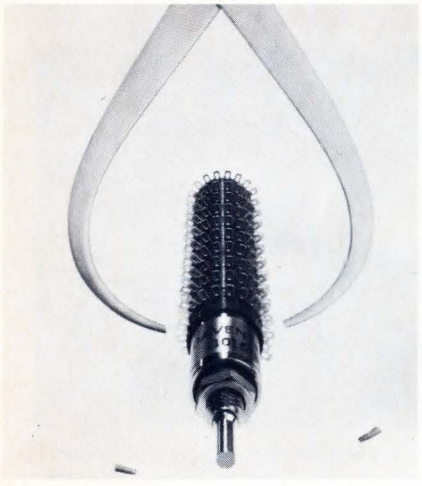


Connections to magnet wire can be made easier and faster than before with the solderless "Sta-Kon" film insulation piercing connectors. These connectors accommodate two, three or four wires in solid-to-solid or solid-to-stranded combinations. In addition, each connector handles a wide range of wire sizes from 12 to 20 gauge, copper or aluminum. Thomas & Betts Co., 36 Butler St., Elizabeth, N J 02707. **353**

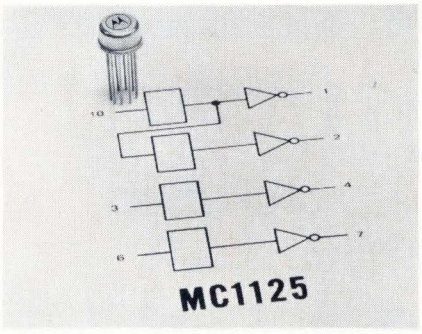
Components

A 256-character "Self-Scan" panel display, Model SSD0000-0014, accomodates an eight-line, 32-character/line message. The formed alphanumeric characters are 0.18 in wide by 0.25 in high and are displayed in a 5 by 7 dot matrix. The panel dimensions are 8.8 in wide by 4.3 in high by 1/2 in deep. This unit is an eight register, 32 digit/register display, including refresh memory, power supply and keyboard for entry of characters into the display. Burroughs Corp., Box 1226, Plainfield, N J 07061. **354**

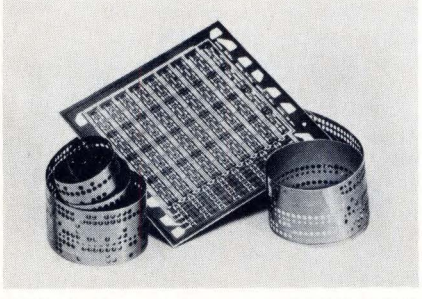
Unusual space saving assembly combines "Imelec" M4X legend display unit with choice of digital readouts. "Imelec" M4X window is 2-5/8 in wide by 1 in high, displays up to 12 legends. Double-lamp illumination of up to six legend plates is also available to meet "Fail-Safe" requirements. Information appears in white or a choice of colors. "Imelec" M4X legend display and digital readouts will accept any flanged base T1-3/4 subminiature lamp. Inter-Market, Inc., 312 Waukegan Rd., Glenview, IL 60025. **355**



With a diameter of only 9/16 in, Series "S" is claimed to be the world's smallest 20 position rotary selector switch—ideal for high-density electronic packaging. Available in one pole 2-20 positions, and four poles 2-5 positions, the new subminiature switch offers as many as 10 decks with spacing of 18°, 22-1/2°, 36° and 45°, shorting and non-shorting. Series "S" switch meets military standards. Daven, Div. of Thomas A. Edison Industries, Grenier Field, Manchester, N H 03103. **356**



Monolithic quad MOS unit MC1125G consists of four toggle-mode flip-flops with buffered Q outputs that use no standby power when driving capacitive-coupled loads. Typical power dissipation is 75 mW and operation is from dc to 1 MHz, input capacitance is 2.5 pF and cross-talk is under 1 percent. The primary use is for frequency synthesis as required in organ circuits, digital dividers and counters. Motorola Semiconductor* **360**

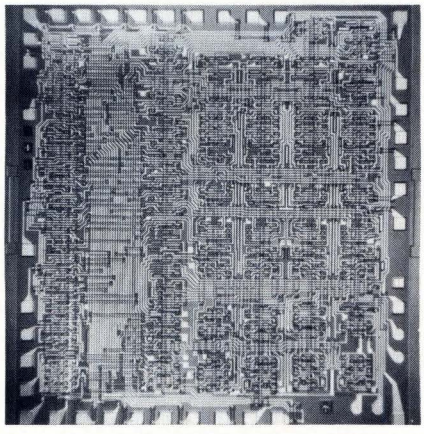


MOS random access memory MC1170L features a 400 ns typical access time. The 64-bit device is organized as 16 words of 4 bits each and full decoding is performed on chip. Power dissipation is about 325 mW when operating from −30 and −15 sources. Temperature operation is from 0 to 75°C, and price in quantities from 100 to 999 is $13.70 each. Motorola Semiconductor* **361**

*Motorola Semiconductor Products, Inc., Box 20912, Phoenix, AZ 85036.

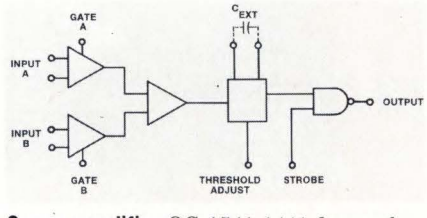
Medium scale IC's that are pin-for-pin replacements for the Fairchild 9300 Series include a 9300 four-bit shift register, a 9301 BCD-to-decimal decoder, 9304 dual full adder, 9309 dual four input multiplexer, 9310 high speed BCD decoder counter, 9312 eight input digital multiplexer and a 9316 four bit binary counter. In 100-up quantities, prices range from $7.95 to $16 each (−55 to 125°C) and from $5.30 to $11.75 (0 to 75°C). Advanced Micro Devices Inc., 901 Thompson Pl., Sunnyvale, CA 94086. **362**

Light sensitive device CA3062 combines a photosensitive section and amplifier and two 100 mA driver transistors on a single monolithic chip of silicon. Operating either as a normally OFF or normally ON photo-switch, it can drive a lamp, relay or triac without additional amplification. In a 12-lead hermetic modified TO-5 package, price is $2.95 each in 1000 lot quantities. RCA* **363**

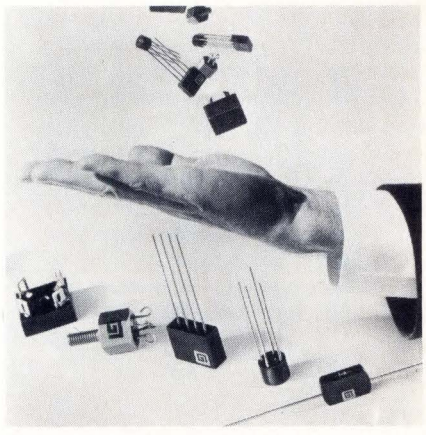


COS/MOS 4-bit parallel processor chip has the basic arithmetic capability of a medium size, medium speed computer (aside from memory and data buffering). Its 16-instruction repertoire permits it to add, subtract, multiply and divide as well as to perform many other complex operations. Standby chip power is <0.1 mW and maximum computer power at 1/2 MHz clock rate is approximately 10 mW RCA* **364**

*RCA/Electronic Components, Commercial Engineering Dept., 415 S. Fifth St., Harrison, N J 07029.

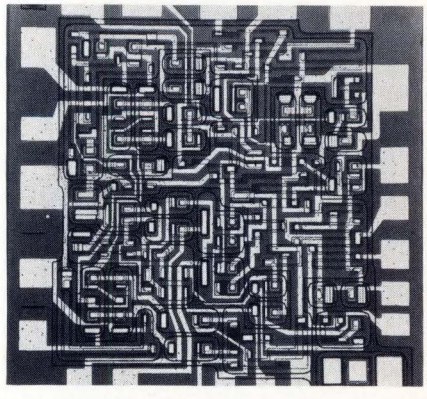


Sense amplifier QC 1541-1441 for use between core memory and TTL circuits is a dual-channel gated amplifier with dual-differential input amplifier and single-gate output, compatible with TTL logic levels. Input threshold normally is 17 mV but can be adjusted within a 10 to 25 mV range. Other features are a 1 mV typical offset voltage, 20 ns propagation delay and typically <140 mW power dissipation. In 100-and-up lots, price is $5.75 each. Qualidyne Corp., 3699 Tahoe Way, Santa Clara, CA 95051. **365**



Single and three-phase bridges with voltages from 50 to 600 PRV incorporate an improved heat-sinking method by which the diodes, heat sink and terminals become an integral unit. Five products include single-phase bridges of 10A, 3A and 1.5A, an alternate 1.5A in a round case and high-voltage module rated to 10 kV. Semiconductor Assembly Div., General Instrument Corp., 65 Gouverneur St., Newark, N J 07104. **366**

Read only memory EA 3100 is 256 word, 10 bits/word or 2560 bit MOS memory that operates from a two-phase clock. In 100 lots, price is $83.50 each. Electronic Arrays, Inc., 501 Ellis St., Mountain View, CA 94040. **367**



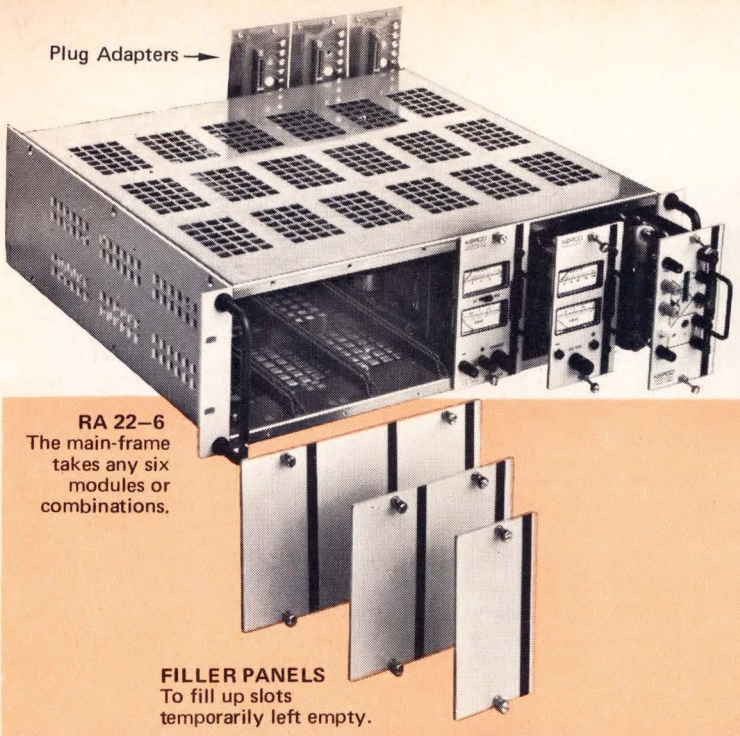
Linear integrated circuits for phase-locked loop application are available. The first two circuits in the family are the N560 and N561 phase-lock signal conditioner/demodulators. The 561 version has provision for AM synchronous demodulation. Frequency range for both units is from 1 Hz to 30 MHz, and the lock range is adjustable from ±1 percent to ±15 percent. Typical stability is 0.06 percent/°C, and in 100-up quantities prices are $18 and $22 each respectively. Signetics Corp., 811 E. Arques Ave., Sunnyvale, CA 94086. **368**

KEPCO™

6-in-a-RACK

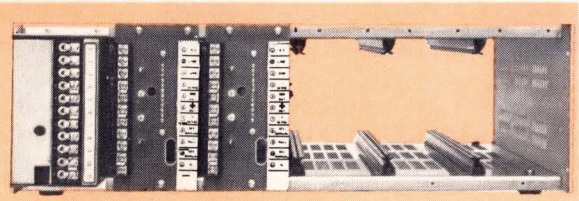
FAMILY OF PLUG-IN POWER SUPPLIES

The unique one-sixth rack size for regulated voltage and current sources, and power amplifiers, provides exceptional packaging density and enormous flexibility in intermixing the eighteen available models. Models plug into housings that accommodate one, two, three or six units.

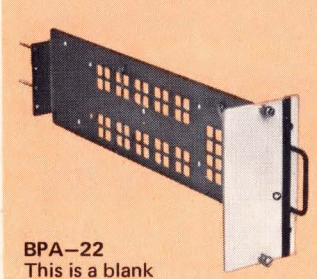


RA 22–6
The main-frame takes any six modules or combinations.

FILLER PANELS
To fill up slots temporarily left empty.

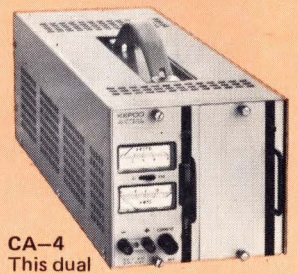


This is the rear of the 6-unit, rack mountable housing, RA 22–6, showing the location of the plug adapters, PC–2, which interface each model's male PC connector to an easy-to-use barrier strip. There is space for a bolt-on overvoltage protector (shown mounted on the left-hand slot). If you look carefully, you can see the coding pins which you can use to uniquely encode each slot so that no one can get the supplies mixed-up.



BPA–22
This is a blank slide assembly which you can use to mount your own circuits—or the lower-cost, unmetered Kepco power modules.

CA–3
Use this single unit housing to convert any of the plug-in supplies and amplifiers to a self-contained bench model.



CA–4
This dual housing will permit you to custom-make your own dual supplies. No tools or soldering; just plug in the supplies and plug-in the line cord!

CA–5
A 3-unit housing provides you with considerable flexibility in your choice of voltage or current regulators or, perhaps, a three amplifier manifold.

CC

CURRENT CONTROLLERS

Kepco's CC Series programmable current regulators feature a capacitorless output circuit that responds to load changes at speeds up to 2 μsec/V. A 10-turn current control with dual range sensing, operate a low-noise integrated control amplifier to provide exceptional stability and resolution. Regulation is 0.0005% for line, 0.005% for load.

MODEL	AMPS	VOLTS
CC 7–2M	0–2	0–7
CC 15–1.5M	0–1.5	0–15
CC 21–1M	0–1	0–21
CC 40–0.5M	0–0.5	0–40
CC 72–0.3M	0–0.3	0–72
CC 100–0.2M	0–0.2	0–100

PRICE: $209.00

OPS-BTA

OPERATIONAL POWER

The OPS modules, with the suffix BTA are equipped with an operational patch panel for summing and feedback components. Gain is in excess of 0.5×10^6 V/V with an offset voltage coefficient $<20\,\mu V/^{\circ}C$. The fast-slewing unipolar amplifier is perfect for digital control or any rapid-fire programmed testing.

MODEL	VOLTS	AMPS
OPS 7–2BTA	0–7	0–2
OPS 15–1.5BTA	0–15	0–1.5
OPS 21–1BTA	0–21	0–1
OPS 40–0.5BTA	0–40	0–0.5
OPS 72–0.3BTA	0–72	0–0.3
OPS 100–0.2BTA	0–100	0–0.2

PRICE: $192.00

PCX-MAT

VOLTAGE REGULATORS

The PCX module, with the suffix MAT, sports a metered front panel with a 10-turn, high resolution voltage control. The low-noise integrated control amplifier regulates the output to better than 0.0005% for line, 0.005% for load. A multiterminal rear barrier-strip, interfaced with the printed circuit plug, provides access for remote control facilities.

MODEL	VOLTS	AMPS
PCX 7–2MAT	0–7	0–2
PCX 15–1.5MAT	0–15	0–1.5
PCX 21–1MAT	0–21	0–1
PCX 40–0.5MAT	0–40	0–0.5
PCX 72–0.3MAT	0–72	0–0.3
PCX 100–0.2MAT	0–100	0–0.2

PRICE: $180.00

For complete specifications and application notes — Write Dept. DH–12.

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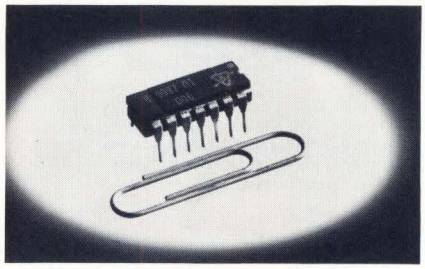
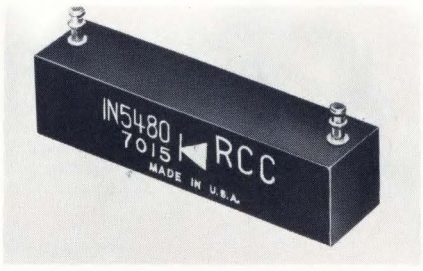
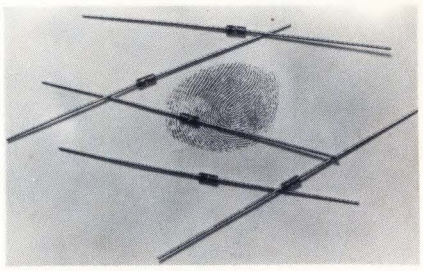
CIRCLE NO. 44



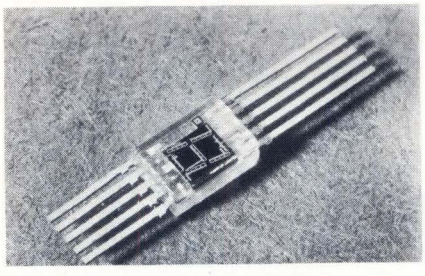
TTL integrated circuit Series 7400N has been added to the company's line of products. The series consists of 14 circuits that include NAND and AND-OR-INVERT gating functions as well as dual "D" and J-K flip flops. Sylvania Electric Products Inc., 1100 Main St., Buffadio, NY 14209. **369**



High-voltage rectifier Series 1N5477-81 features an output current of 1A at 25°C, 80A peak single cycle surge and voltage ratings of 5, 6, 7, 8 and 10 kV respectively. Units meet MIL-S-19500/418 and are packaged in a 3/4- by 3/4- by 3-in case. Rectifier Components Corp., 124 Albany Ave., Freeport, NY 11520. **372**

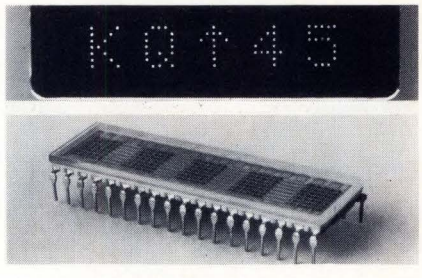


Zener diodes in the double plug DO-35 package feature zener voltages from 6.2 to 47V and meet the 1N710-730, 1N754-759 and 1N957-977 specifications. Tolerances are 20, 10 and 5 percent with 1 percent available on special request. American Power Devices, Inc., 7 Andover St., Andover, MA 01810. **375**

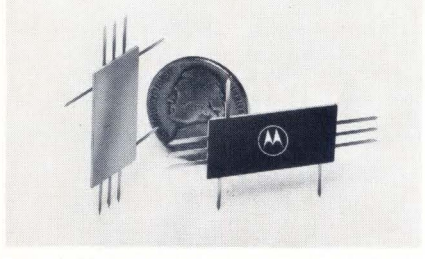


Monolithic light-emitting diode alphanumeric readout MAN-3 is a seven-segment display that is a totally monolithic semiconductor device formed by zinc diffusion into n-type gallium arsenide phosphide wafers. Units emit light in the range of 6300 to 7000Å (red), output is more than 200 fL from only 8 mW (1.6V at 5 mA) power input/segment. The price is $12.45 each in lots of 1 to 9. Monsanto Electronics Special Products, 10131 Bubb Rd., Cupertino, CA 95014. **370**

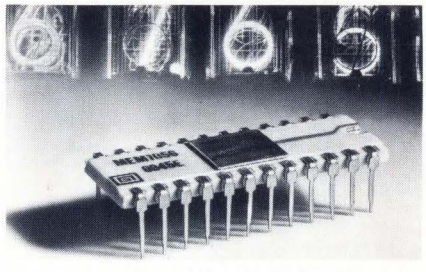
Bridge rectifiers for low-voltage applications (FWL-15, -25, -40V) are 1A units with a 35A one-cycle surge rating. Leads are spaced on 150-mil centers for plugging directly into PC boards. In 1000 lot quantities price is $0.20 each for the FWL-15, $0.25 each for the FWL-25 and $0.30 each for the FWL-40. Higher voltage bridge rectifiers also are available with 50 through 1000V ratings. Semicon, Inc., 10 North Ave., Burlington, MA 01803. **373**



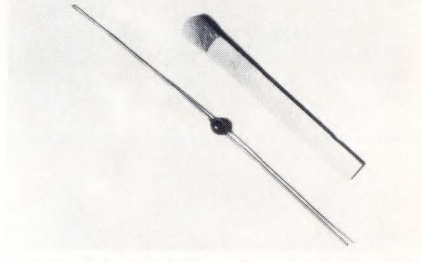
Light-emitting diodes in 5 by 7 dot patterns display letters of the entire alphabet and other symbols in addition to numbers. Gallium arsenide phosphide diodes used in the HP 5082-7100, 01, 02 alphanumeric displays require only 1.6V max. Characters are 1/4 in high on 1/3-in spacings. Units are packaged in clusters of three, four and five characters and price is $30/character in 1000 quantities. Inquiries Manager, Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, CA 94304. **376**



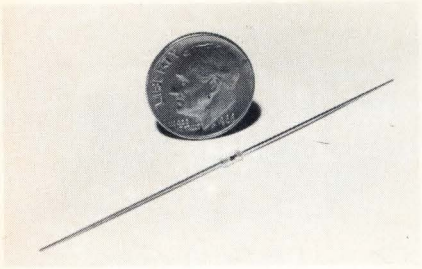
Duplexer MCH5890 operates at frequencies between 400 and 500 MHz with up to 40W input. It features a typical 0.1 dB transmit-mode insertion loss, a typical 25 dB transmit-mode isolation figure. Although primarily a transmit/receive switch, the unit finds use as a monitor network in transmitter circuits or as the sampling unit in AFC or AGC circuits. Motorola Semiconductor Products Inc., Box 20912, Phoenix, AZ 85036. **371**



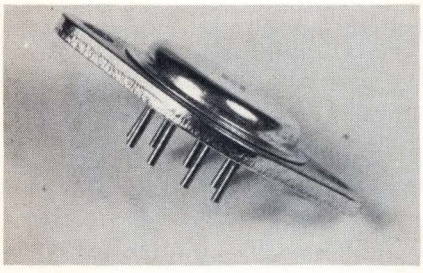
Monolithic IC MEM 1056 BCD counter/display driver is designed primarily to operate in conjunction with a seven-segment numeric indicator. It contains a one decade up-down BCD counter, a storage register, a BCD to seven segment decoding matrix and display drivers. Packaged in the 24-lead dual in-line container, the 100-quantity price is $20 each. General Instrument Corp., 600 W. John St., Hicksville, NY 11802. **374**



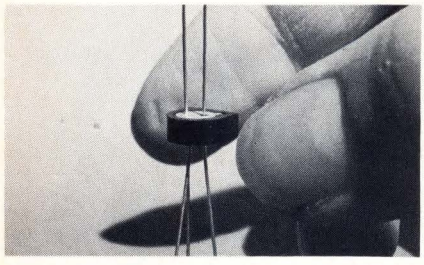
Micro silicon thermistor Dμ 125 Series is available in standard resistances from 10 through 10,000Ω. In its package size of 0.1-in sphere it is the smallest device of its type available. Characteristics include a thermal TC of 10s in still air and 2s in agitated fluid. Maximum operating temperature is 150°C and TC is 0.7 percent/°C nominal. Sensitron Inc., 225 Paularino Ave., Costa Mesa, CA 92626. **377**



Thermistor pellets hermetically sealed in glass-diode type enclosures are low-cost units available in resistance values of 2, 5, 10, 20, 50, 100, 200, 500, and 1 MΩ. Other values are available on special order. Fenwal Electronics Inc., Div. of Walter Kidde & Co., Inc., 63 Fountain St., Framingham, MA 01701. **378**

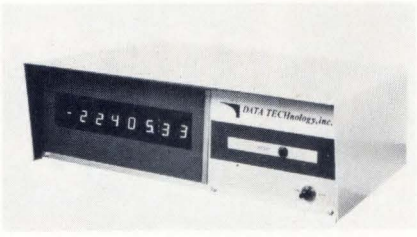


Series voltage regulators include positive circuits (HCCA 100, 103, 105) and negative circuits (HCCA 102, 104, 106). Regulation of 0.5 percent max, 0.05 percent typical, no load to 1A load and a voltage range from 8 to 50V with maximum output current of 3A are featured. They are capable of 40W dissipation at 25°C with heat sink and a temperature coefficient <0.005 percent/°C. Solitron Devices, Inc., 1177 Blue Heron Blvd., Riviera Beach, FL 33404. **379**



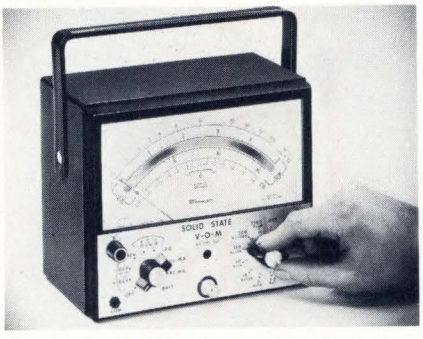
Photon couplers include the PC4-73, a high efficiency unit that combines a gallium arsenide solid-state LED and a photo Darlington amplifier. Its ratio of detector/lamp current is 100 percent or better. A second and faster switching unit is the PC15-26 which couples a similar solid state lamp with a photo transistor and produces a transfer ratio of about 35 percent. General Electric Co., Nela Park, Cleveland, OH 44112. **380**

Multiplexed A/D converter, Model MADC-15, operates at a throughput rate of 100 kHz with 15-bit resolution. Included are an A/D converter, high-performance sample-and-hold amplifier and 8 to 64 channels of multiplexing. Prices start at $4095 for an eight-channel version. Raytheon Co., 2700 S. Fairview St., Santa Ana, CA 92704. **385**



Up/down display counter, Model CMA, is available in single, dual or triple-axis configurations. Featured are MOS/TTL circuitry, up/down counting at up to 125 kHz and ±5 to 7 decades/axis. Prices start at $650 for a 5-decade unit or $870 for digital readout versions. Data Technology, Inc., 65 Grove St., Watertown, MA 02172. **388**

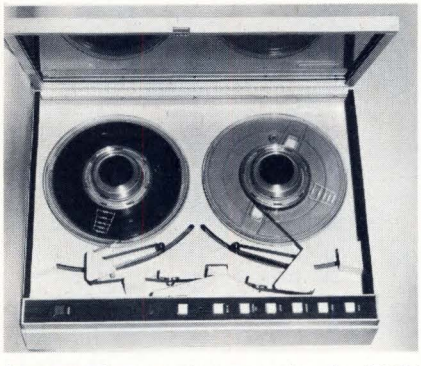
A 3-1/2 digit DVM, Model VT 300, measures 17 ranges of dc and ac volts, dc and ac amps. Range change is accomplished with interchangeable, plug-in cards. Features include automatic zero, overrange indicator, BCD output, and provision for optional extended range. Price is $199. Dixson, Inc., Box 1449, Dept. 212, Grand Junction, CO 81501. **391**



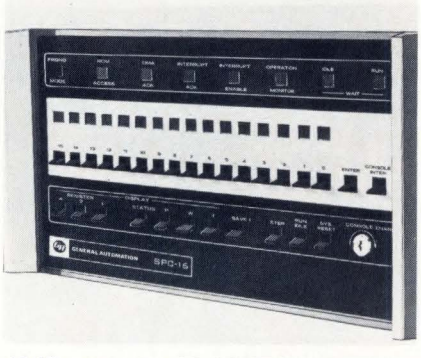
Laboratory V-O-M, Model 801, is battery operated and features low-power ohms for ICs, 5 mV sensitivity and 10 MΩ input resistance. An 8-in taut-band meter is used. One switchable probe covers all functions. Price is $200. Triplett Corp., Bluffton, OH 45817. **386**

Teletype acoustic enclosure has five layers of sound absorbing material that reduce Teletype noise up to 90 percent. Price is $139.50 and models are available for ASR and KSR 32 and 33, as well as Bell/TWX. Data Terminals Co., Box 5583, San Jose, CA 95150. **389**

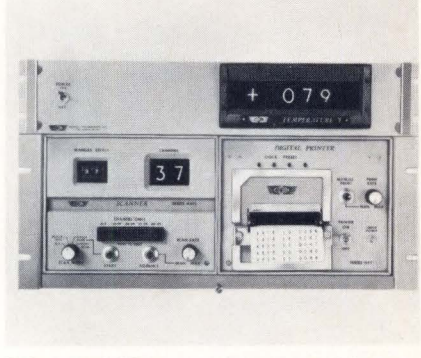
Ultrasonic generator is tunable from 9 to 100 kHz and provides 1000W output. Output is continuously variable from 0 to 1000W and output impedance is selectable from 3 to 1000Ω in nine steps. The "SoniKW-1" is priced at $995. RP Industries, Box 203, West Somerville, MA 02144. **392**



Low-speed magnetic tape units, the 2870/2890 Series, offer seven-track recording at 556 or 800 BPI and nine-track capability at a data density of 800 BPI, 1600 BPI phase encoding or 800/1600 dual density. The units operate at 25 ips without program restrictions. Price for both seven- and nine- channel units is $4110 in single lots. Data Action, 4575 West 77th St., Minneapolis, MN 55435. **387**



16-bit computer, Model SPC-16, provides both on-line and off-line operation with up to 64 hardware priority interrupts. It incorporates completely interchangeable read-only and read/write memories, as well as 16 general-purpose registers. Basic 4K core memory is field expandable to 32K in 4K increments. General Automation, Inc., 706 W. Katella Ave., Orange, CA 92667. **390**



Data acquisition instruments, Model H491 printer and Model H492 scanner, can be combined with H500 digital indicator to form a 50-channel digital data system with permanent printout of temperature, pressure, load, thrust, voltage, resistance or rpm. Units are both compact and portable. Howell Instruments, Inc., 3479 W. Vickery Blvd., Fort Worth, TX 76107. **393**

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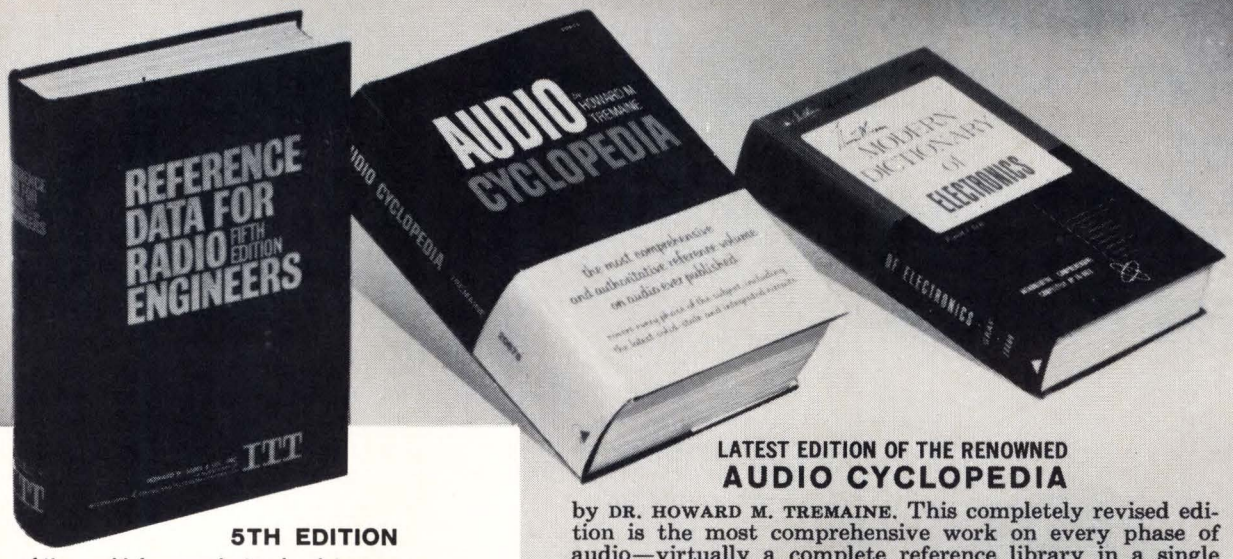

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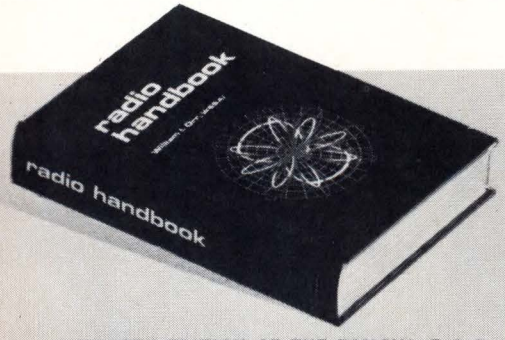

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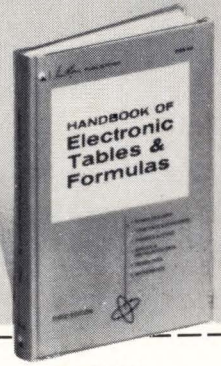

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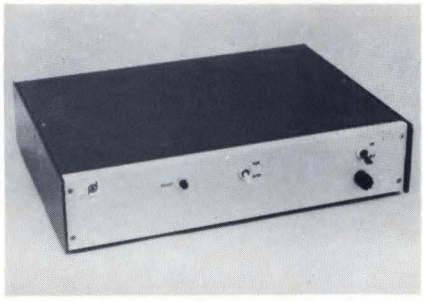
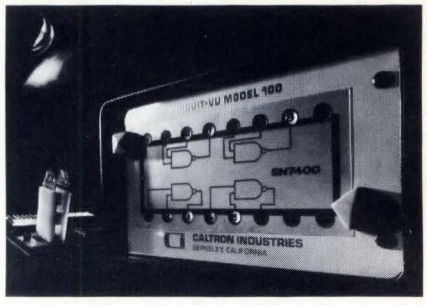
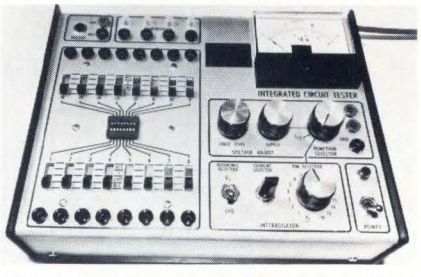


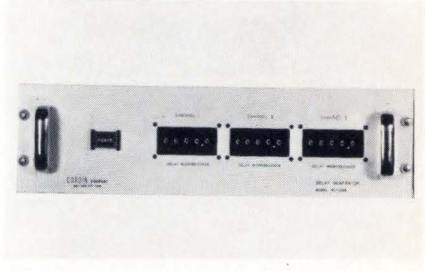
Electronic coupler for mating digital instruments to recording devices, the Dijitscan 1000, accepts low level BCD inputs in parallel and provides them sequentially at the output. Price is $420. Pivan Data Systems, Inc., 6955 N. Hamlin Ave., Lincolnwood, IL 60645. **397**



In-circuit IC analyzer displays input and output status through a schematic overlay of the logic element under test. The Model 100 uses a spring loaded clip for connection to 14- or 16-lead DIP packages. Price is $229. Caltron Industries, 2015 Second St., Berkeley, CA 94710. **300**



IC tester performs both dc and functional tests. Features include a 4 by 16 matrix for selection of V_{cc}, logic level "1", ground or "no connection" at each pin and a push-button square wave pulser for testing gates, counters and flip flops. Model 101A tests both TO-5's and flat packs as well as 14- and 16-pin dual in-lines and is priced at $315. Spectrum Dynamics, Box 23699, Fort Lauderdale, FL 33307. **398**



Digital time delay generator produces three independent delay output pulses from 1 to 9999.9 μs in steps of 0.1 μs. Input pulse sensitivity of the Model 413 can be varied from +10 to +1200V and the generator produces a pulse of +100V into 50Ω with rise time of 100 ns and duration of 100 μs. The unit can handle a frequency of pulses up to 30/s. Cordin Co., 2230 South 3270 West, Salt Lake City, UT 84119. **301**

FET input multimeter has 68 ranges that cover ac and dc voltage and current, low-power resistance, capacitance, temperature and output. The Model 2795 is temperature compensated from 0 to 50°C and has rated accuracy of ±1 percent for both ac and dc. Price is $230. Simpson Electric Co., 5200 W. Kinzie St., Chicago, IL 60644. **399**

Portable recorder, Model 806, uses standard cassettes. Recording is incremental by character, entered one keystroke/character. Data is recorded in BCD, EBCDIC or ASCII format, even parity, 32 characters/in. Cassette capacity is approximately 200,000 characters. Electronic Laboratories, Inc., 3726 Dacoma St., Houston, TX 77018. **302**

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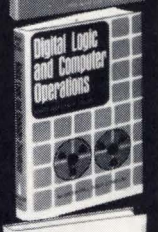

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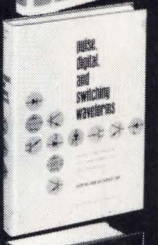

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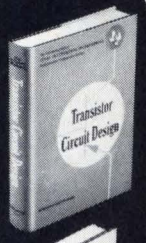

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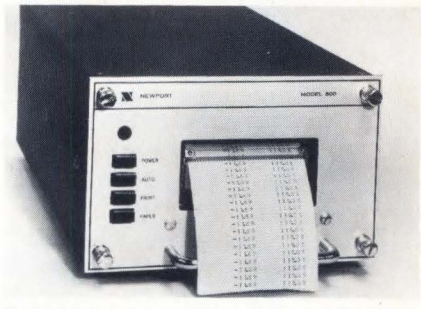
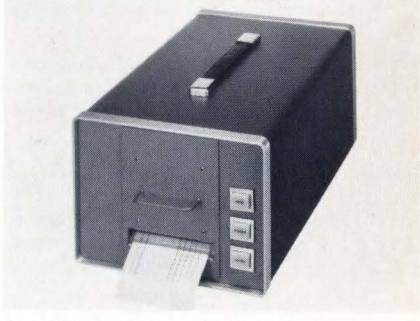
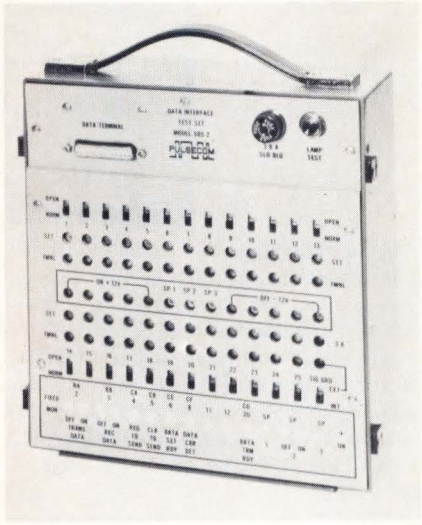
Digital cassette recorder for field service interfaces with most data communication systems. The unit accepts a wide range of digital and audio signals including direct interface with RS232 connectors. A self-contained loop supply allows recording from, and operation of, teleprinters directly. Price of the Model UDT-100 is $650. Dataprobe, Inc., 290 Huyler St., South Hackensack, N J 07606. **306**



Digital data printer, Model 800, can print a line of data every 360 ms and handles up to 21 columns of BCD input data with two-color printing. Inputs are compatible with standard DTL and T²L logic levels. Price is $895. Newport Laboratories, Inc., 630 E. Young St., Santa Ana, CA 92705. **307**

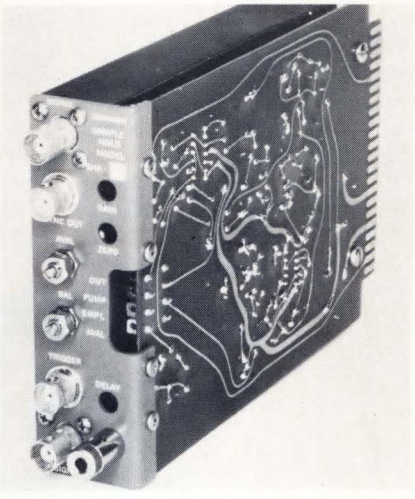


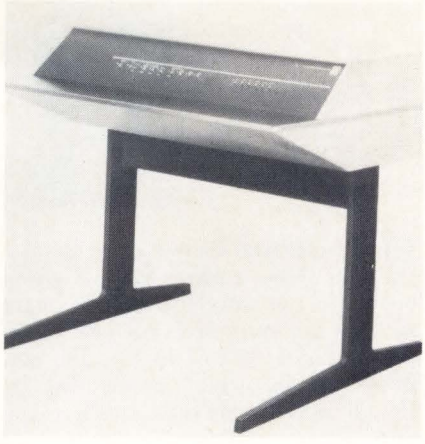
Digital printer has floating decimal point and handles up to 20 columns of data. Data storage is available as an option. Printing rate is 60 lines/min. The Model 2020 will accept data of different fiducial states and voltage levels from several sources simultaneously. Digitron Corp., 2544 W. Main St., Norristown, PA 19401. **308**



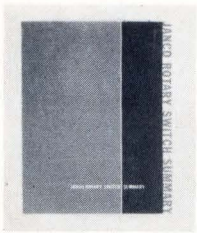
Test set allows data terminal users to localize trouble to either the terminal or its data set. The Model 505-2 provides both access and control at all leads of the RS-232 interface connector. Selling price is under $400. Pulse Communications, Inc., 5714 Columbia Pike, Baileys Crossroads, VA 22041. **394**

Sample and hold amplifier has 1 ns aperture and long data hold capability. The high accuracy model SHA-1 samples and holds the amplitude of either a recurrent or single transient signal. It operates as a feed-through sampler, thus imposing minimal signal loading. Gralex Industries, Inc., 155 Marine St., Farmingdale, NY 11735. **395**

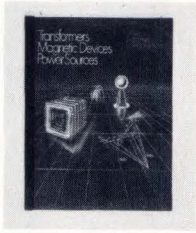




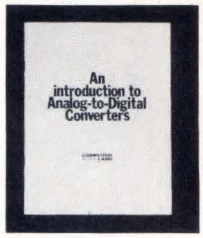
Remote batch terminal is programmable for interfacing with many different types of central processors and for off-line data processing. Standard features of the basic $20,900 model include auto-answering for dial-up lines, automatic turnaround, multiple record transmission, horizontal format control, EBCDIC transparency and multipoint line control. M&M Computer Industries, Inc., 770 N. Main St., Orange, CA 92667. **396**



Rotary switch wall chart No. 124 contains complete specs on the company's micro-miniature, miniature, standard rotary switches and space-saver push-button totally enclosed rotary switches. The new wall chart features a simple diagram showing how to order these rotary switches according to the specific needs of an engineer. Janco Corp., 3111 Winona Ave., Burbank, CA 91504. **309**

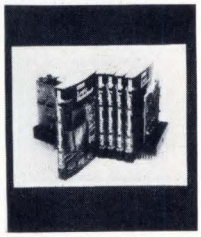


Transformers, magnetic devices and power sources are covered in this catalog. Described are such items as filament heater transformers, voltage regulating filament transformers, audio frequency transformers, saturable reactors and light transformers covering the range from 1 to 500 kVA, up to 300 kV. Light Electric Corp., 214 Lackawanna Ave., Newark, N J 07103. **313**

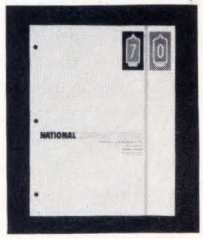


"An Introduction to Analog-to-Digital Converters" is the title of this 24-page "primer" on the A/D conversion process. After a first section that deals with the basics of A/D converters and a discussion of the binary numbering system, other sections cover various errors that can occur in typical applications. Computer Labs, 1109 S. Chapman St., Greensboro, NC 27403. **317**

Power transistor chips are the subject of short form catalog PG-115. Units are available from 0.5A to 30A with both npn and pnp units available. Pirgo Electronics Inc., 130 Central Ave., Farmingdale, NY 11735. **310**



"1970 Logic Handbook" contains 448 pages that include an introduction to solid state logic, application notes, descriptions and prices of more than 200 standard logic items. Dept. P, Digital Equipment Corp., Maynard, MA 01754. **314**

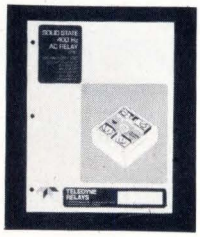


Readout tube quick reference catalog, SB-26, gives complete technical data for readout tubes with displayed character size ranging from 0.31 in to 2 in. National Electronics, Inc., Geneva, IL 60134. **318**

Thick-film hybrid circuit design is the subject of a new guide that contains hybrid design guidelines, packaging information and data on active devices, substrate materials, capacitors and commercially available inks. Guide opens to 15 by 22 in for mounting on wall or desk top. Sylvania Electric Products Inc., 1100 Main St., Buffalo, NY 14902. **311**

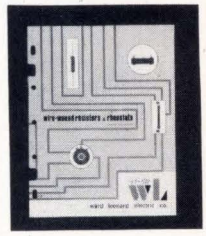
Power Supply catalog and engineering manual has 32 pages with detailed information on 11 separate lines of standard power supplies including modular types, system supplies, laboratory units and special purpose types for op amps and ICs. Deltron, Inc., Power Div., Wissahickon Ave., North Wales, PA 19454. **315**

Thyristor Catalog, Publication No. THC-500 contains 24 pages that cover more than 180 different types of SCRs, diacs and triacs. Introductory material includes a brief explanation of triac firing modes. RCA Electronic Components, Commercial Engineering, Harrison, N J 07029. **319**



Solid-state 400 Hz ac relay now is available in six models for many applications including TTL logic systems. The Series 6 relay is maintenance free and can withstand overloads as much as 1000% over its 20A, 280V ac rating. Eight graphs included in this brochure show operating characteristics of the Series 6 relays. Teledyne Relays, a Teledyne Co., 3155 W. El Segundo Blvd., Hawthorne, CA 90250. **312**

Immersion-proof rectilinear cermet trimmers series 195 are described in Data Sheet 3195A. The new 1-1/4 in trimmer design is available in three lead configurations and is rated 0.75W at 85°C. Other features include low TC, clutch stops, a cermet element and 23 turns. Resistance range is from 50Ω through 500K. CTS of Berne, Inc., Berne, IN 46711. **316**



"Wire-Wound Resistors and Rheostats" is the title of 18-page catalog ww/w1/270. Included in addition to the company's line of resistors is technical information on factors that influence resistor selection and a new dual power rating system that the company hopes will become an industry standard. Ward Leonard Electric Co., subsidiary of Riker-Maxson Corp., 31 South St., Mount Vernon, NY 10550. **320**

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PATTON: ORDEAL AND TRIUMPH *by Ladislas Farrago.* The best-selling, definitive biography, and now a hit movie, of the controversial, colorful General George S. Patton. Could the War in Europe have ended 10 months earlier? Who wanted to fire Patton on the eve of D-Day? Why was the German army allowed to escape from the Falaise Gap? Who prevented Patton from taking Prague? Who forced Patton's troops into a near-suicide landing in Sicily? These questions and many more posed by history are answered in this widely-acclaimed work. maps. index. $12.50

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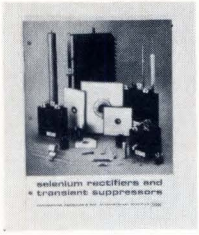
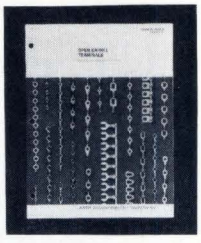
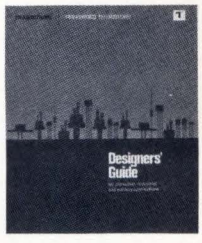


"Selenium Rectifiers and Transient Suppressors" is the title of 40-page brochure B-108. Included are contact protectors, stack assemblies and cartridge rectifiers. International Rectifier, Semiconductor Div., Dept. 781, 233 Kansas St., El Segundo, CA 90245. **275**



"Open Barrel Terminals" is a 32-page catalog that contains descriptions for over 825 terminal types. These terminals are intended for high-speed installation (some up to 22,800/hour) with associated automatic and semiautomatic machinery also described. AMP Inc., Harrisburg, PA 17105. **278**



Designers' Guide has 20 pages that cover triacs, SCRs, GTOs, photo sensitive devices, chips, thyristor symbology and definitions, application suggestions and packaging considerations. Transitron Electronic Corp., 168 Albion St., Wakefield, MA 01880. **281**

1970 instrumentation handbook is a 276-page hard-cover catalog that includes technical information and application notes on such products as oscillograph recorders, tape recorders, X-Y recorders, digital voltmeters, signal-conditioning equipment, transducers, amplifiers, monitor scopes and data-acquisition systems. For information on how to obtain the handbook contact C. F. Creswell, Honeywell Test Instruments Div., Box 5227, Denver, CO 80217.

Magnetic component selection is the subject of this unique double-ring binder encyclopedia of capabilities. The binder is separated into an applications division and a configuration division. The user can open to any application's page and to any configuration's page simultaneously. Such headings as "SCR Triggers", "Sine Wave Demodulator" and "Pulse Gates" are found in the applications section. Aladdin Electronics, 703 Murfreesboro Rd., Nashville, TN 37210. **279**

"Hybrid Microcircuit Design Manual for the '70s" is the title of this 28-page publication. Included are a comprehensive survey of equipment and facilities, organization and procedures to produce microcircuits properly, tips for designers, listings of standard components, typical circuits and a variety of packaging configurations. The design manual is available by letterhead request only from Circuit Technology Inc., 160 Smith St., Farmingdale, NY 11735.

Electromagnetic delay lines for digital circuitry applications are described in an eight-page brochure. Fourteen standard models are included with delay ranging from 7 to 1000 ns. The smallest unit is 0.49 by 0.49 by 0.37 inch. Impedance is approximately 100Ω. ESC Electronics, 534 Bergen Blvd., Palisades Park, N J 07650. **277**

"Standardized Modular Power Units" is the title of this 12-page, two-color catalog that covers a line of shelf power supplies. The line consists of six package sizes at seven different voltage levels ranging from 3.6V dc up to 28V dc at current ratings from 0.35A to 85A. North Electric, Electronetics Div., Galion, OH 44833. **280**

Semiconductor specifications for a complete line of power transistors, power rectifiers, rectifier assemblies, zener and reference diodes, triacs and SCRs are offered in this new 80-page catalog. Different colored individual booklets separate the catalog into various product families. Sensitron Semiconductor, 211 W. Industry Ct., Deer Park, NY 11729. **282**

Literature

Keyboard 51SW5-2 is an MOS encoded solid-state unit that features an electronic two-key rollover system that allows the operator to roll keys during burst speed typing of familiar words without entering an erroneous code. Also, a one-character storage feature holds the data bits at the output until the next key is depressed. It is encoded with the 8-bit EBCDIC code plus odd parity, and there are four modes of operation. This four-page product sheet describes dimensions, electrical data, code assignment and ordering information. Micro Switch, a Div. of Honeywell Inc., 11 W. Spring St., Freeport, IL 61032. **283**

DC power supplies include 9 new lines that are introduced in catalog supplement L-5. Described is new LV series of high efficiency, low ripple power modules designed to power IC logic circuits. The new series offers 0.015% regulation and ripple as low as 10 mV rms. An LW series is designed to power transistor circuitry, relays, motors, lamps and solenoids. Other products include a dual output tracking power supply LXD-3-152, a new modular power supply LCS-A with 19 fixed voltage models to 150 Vdc and up to 3A, and 5 wide range models to 120 Vdc up to 2A. Lambda Electronics Corp., Rte. 110, Melville, NY 11746 **284**

Miners vs Farmers

Gentlemen:
There are two ways to employ engineers: the farming method and the mining method. One can place the new seed in fertile ground, give it a chance to grow, weed out the unfit early, and continually allow renewal with continuing education and challenging assignments. That is farming.

Most employers (users) of engineers prefer mining. Use the experience of education at the employees or society's expense and dredge out the ability and new methods he has learned. Use his youthful hope and enthusiasm to quickly expand his work experience to fit his academic experience in some manner which optimizes his immediate output to his employer. But don't renew the general academic abilities as part of the cost of doing engineering.

If he shows the ability to quickly learn the ability to do the same with those that come after him, then make him a manager. He has outlived his engineering life. His engineering knowledge has been mined. If, in the mining of his intellect he is so foolish as to want to continue in engineering tasks, then put him on the surplus list. Perhaps his second career running a franchised hamburg stand will be rewarding financially.

Our youth are smarter than we were. Their vision is clearer, and they will not be exploited in the new coal mines of engineering employment.

Name withheld

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Archaic Pensions

Gentlemen:
I fully support the letters in your magazine of 1 April 1970, p. 84. There are many problems and ideas mentioned there and for each of them a separate study could be written.

Here, I want to mention only one very important problem: the pension plan which is in this country the most archaic one. Almost all of the civilized and technically advanced countries in Central and Western Europe have a pension fund for their non-governmental employees working in the private enterprises. Every such employee must be a member, and his contribution to this fund is deducted from his salary. The same amount is matched by his employer.

If he changes his job, he and his new employer both continue to pay to the same pension fund. During his lifetime, he can change his jobs as many times as he wishes, or as he is forced to do, but he does not lose his pension plan. If after 30 or 35 years he retires, his monthly pension is 60 to 80% of his last salary.

Such a pension fund organization is a private enterprise and there is only one for each country. They are highly profitable. In Czechoslovakia where I lived and worked before the Second World War, this pension institute was so prosperous that even the Government of Czechoslovakia borrowed money from it sometimes and paid the official interest on that loan.

We claim to be technically the most advanced country in this world, and yet we are so far behind other civilized countries which can assure decent retirement for those who were working hard and well throughout their whole life. The above mentioned plan is not "socialism" but it is a well organized private insurance system which pays the highest possible return to its members on their investments!

Our country is losing countless millions of dollars because those retired persons who cannot afford to have a decent living in USA live in Mexico and in various countries in Europe. This sad fact has a far-reaching adverse effect on our national economy.

Ladislav E. Macko
Sr. MSEE

Engineers/Councilman

Gentlemen:
Mr. Montgomery's article on Engineers in Local Government (February 1970) was of extreme interest to me as I now serve on the Borough Council of South Plainfield, NJ. This council consists of three engineers, two accountants, and a building contractor. Therefore, I feel that engineers in our town do get involved.

I do disagree with the premise of the article which implies that local government is to blame for the slow introduction of technology into municipal operations. If local governments are that influential in technical areas, then they could take credit for the airline system, power networks, communication systems, and many other utilities which serve the public as much as solid waste disposal, water purification, traffic control, etc. I would rather put the largest share of the responsibility on the industries which can solve these problems. No city ever contracted Boeing to build a plane for its airport. No county ever asked Detroit to design an auto to fit their particular road conditions. Instead, local governments respond to two main progressive stimuli, i.e.—the people's wishes and the economically available tools to carry them out.

If these industries professing to be involved with people problems would not just sit back waiting for part time councilmen, etc. to beat a path to their door but aggressively pursue these markets as much as they do their retail and industrial markets, they would probably be quite surprised that local government is usually more than glad to utilize any system which can serve the town at lower cost and increased efficiency. Like any other commercial venture, though, it takes a selling job. In my short experience in government I find little salesmanship or marketing and we are left to ourselves to guess what's available and perhaps take great chances with tax moneys if we spend without sufficient examination of the product or service. Therefore, many of us look like we are the bottlenecks. Industry must stop treating local governments like the federal government. We must justify our costs more than the federal government and usually more than most private enterprises.

As you can see, my comments are concerned with problems, their possible solutions, and the available components to solve them. This, perhaps, comes from my engineering background. My search for technological tools of government to come from industrial R&D is little different than the way I handle my company's projects. I just wish that the companies interested in government applications were as aggressive and responsive as the various electronic component and system firms serving my discipline.

There is one other thing industry could do, and with this I think Mr. Montgomery would agree. Companies must make a positive effort to motivate engineers toward serving in local governments. Engineers will respond in areas where their management wishes them. If industrial management wishes to learn about local government markets they could do no better than to have their technical staff serve. Engineers are sent to and run seminars and courses and training programs in any other area of corporate interest, why not government? Anyone having the ability to serve their community should be greatly encouraged and helped by his firm. Only in this way can industry honestly say they are seriously interested.

Henry A. Seesselberg
Supervisor
Physics & Electronics R&D
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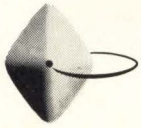

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Broadcast over Design Dateline—reference suggestions and information.

1969 NEREM Record

Published by the IEEE, Boston Section, 31 Channing St., Newton, MA 02158; $8 in the US; $9 elsewhere.

This record condenses 109 papers that were presented at Northeast Electronics Research and Engineering Meeting (NEREM) in Boston, Nov. 5-7, 1969.

Some of the sessions were: optoelectronics, computer-aided design, small computers, monolithic memories, recent FET developments, air traffic control, radiation hardening, bioelectronics and computerized testing techniques.

Tele-Communications And the Computer

By James Martin; Prentice-Hall, Inc., Englewood Cliffs, N J; 1969; 470 pages; $14.

This presentation discusses one of the most exciting developments in computer technology—combining telecommunication with computer systems. The two techniques complement each other and combined, they add power to each other.

Information on computer hardware is readily available, but it is relatively difficult to obtain comparable information on common-carrier systems. For this reason, common-carrier equipment is emphasized in this text and attention is given to modems that are associated with the carrier's line.

Outstanding features include: simplified description of telecommunication; discussion on how computers use telecommunication; detailed description of available equipment; and a discussion of new developments and what is expected in the future. For more information about this book, Circle **402**.

Harry Howard

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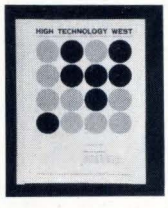
Now available: IEEE REFLECS (Retrieval From the Literature on Electronics and Computer Sciences)—magnetic tapes that contain indexing and abstracts of papers on electronics, computers and control, and applied physics. These tapes, available on a monthly basis, use a variety of character codes and tape formats to suit a variety of customer requirements. Subscribers also may select their areas of interest from eight subject categories, such as "Electron Devices and Materials" and "Computer Science and Technology".

Working with the IEE of London, IEEE surveys more than 1200 journals, conferences, patents and books to produce an estimated total coverage of 66,000 scientific and technical papers for 1970.

Coming: the IEEE Annual Index Tapes. This tape service also will be produced and delivered in 1970. Two tapes will contain cumulative indexing of IEEE's publications for 1968 and 1969 and will cover about 16,000 papers.

Inquiries about these two tape services may be directed to Thomas H. Hogan, Information Services, IEEE, 345 E. 47 St., New York, NY 10017.

Data Communications



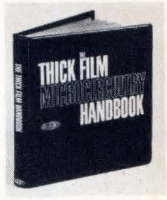
Published as the December 1969 issue of "High Technology West" (a monthly research service) by California Corporate Research, Inc., 1060 Crenshaw Blvd., Los Angeles, CA 90019; $250 per copy or $1200 with annual (12-issue) subscription.

This 60-page report on the interactive data terminals industry covers 98 manufacturers and analyzes the four main aspects of the industry—markets, technology, products, and companies.

The study predicts this market's projected growth from $200 million in 1969 to $860 million in 1972. It also explains how the terminal population will become 15 times greater by 1975.

The report permits a rapid evaluation of competitive products, annual shipments, unit price changes and timing of the expected industry shakeout.

Thick Films



During 1970 Du Pont is issuing a completely new version of its "Thick Film Microcircuitry Handbook" in a series of quarterly supplements. The first supplement was published in March.

The new edition contains special sections on hybrid microcircuit manufacture, design considerations and applications for thick film microcircuits. The design section, written for electronic designers who have worked previously with discrete components and now need to design thick film circuits, includes more than 60 pages of design information.

Several electronics experts have written exclusive articles for this 1970 handbook.

It may be ordered from the Du Pont Co., Room 2507 Nemours Bldg., Wilmington, DE 19898; subscription for the four supplements is $50.

ROM Databank

For more information about "'U' Cores Speed ROM Quick Change", p. 55, see "An Engineering Guide to Read-Only Memory Systems". This how-to guide includes the theories behind the technology, specific applications and an economic breakdown of ROMs in microprogram control.

For your copy, write to Paul Rosenbaum, Memory Technology, Inc., 83 Boston Post Rd., Sudbury, MA 01766.

Transistor Manual

Solitron recently published a new manual in which it presents the state-of-the-art capability of its Semiconductor Div. in manufacturing neutron-hardened silicon-power transistors. The booklet also outlines information on neutron irradiation effects relative to each family of Solitron's transistors.

Contained are engineering data sheets for several series, design parameters and processing techniques, analysis of post-radiation data, photographs, curves and specification charts.

To order this manual or to find out more about these devices, contact Solitron Devices, Inc., 1177 Blue Heron Blvd., Riviera Beach, FL 33404. Manual price: $3.95.

Corning buys exposure to their target audiences

"What I'm looking for is maximum reach (readership) among our target audiences at minimum cost. I buy exposure to our target audiences", comments Ted Brown, Manager of Marketing Communications, Electronic Products Division of Corning Glass Works.

Corning's advertising agency, Warner, Bicking & Fenwick, Inc., recently conducted one of the most significant independent readership studies on the electronics field that has been done in years. Purpose of the study was to measure magazine readership among Corning's audience of electronic design engineers who specify the purchase of capacitors and/or resistors.

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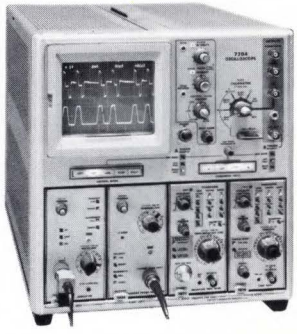

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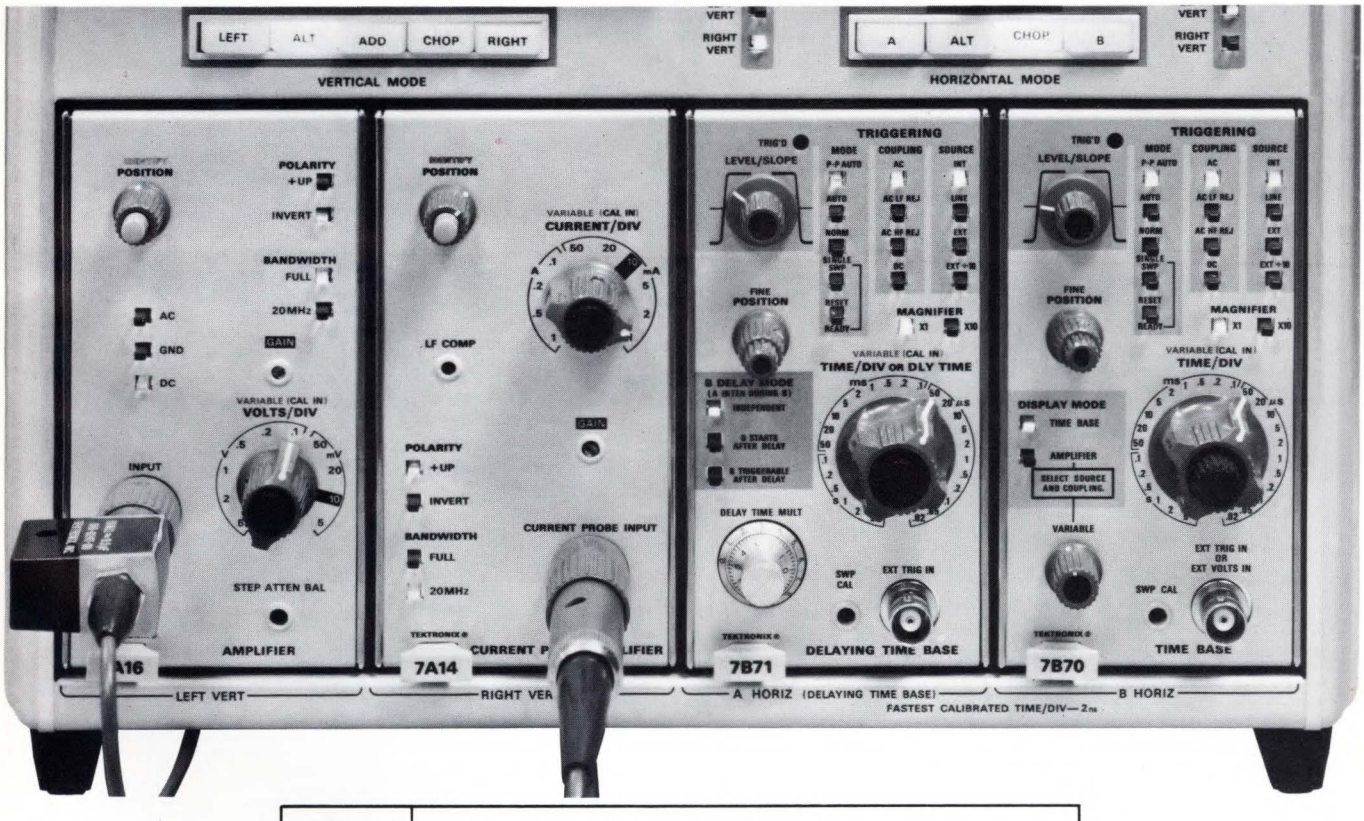

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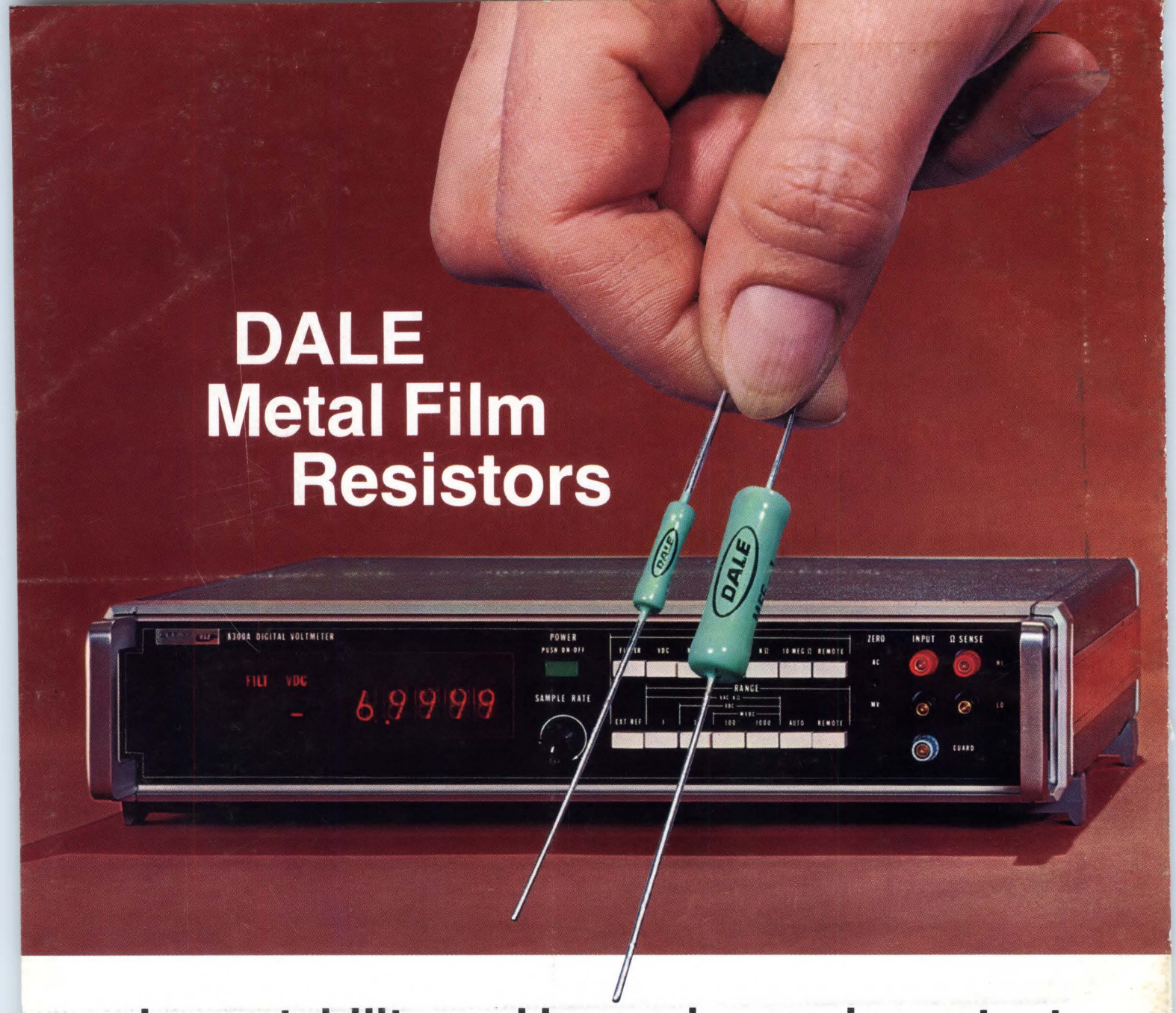

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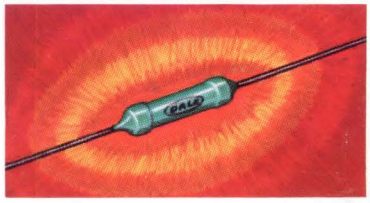

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