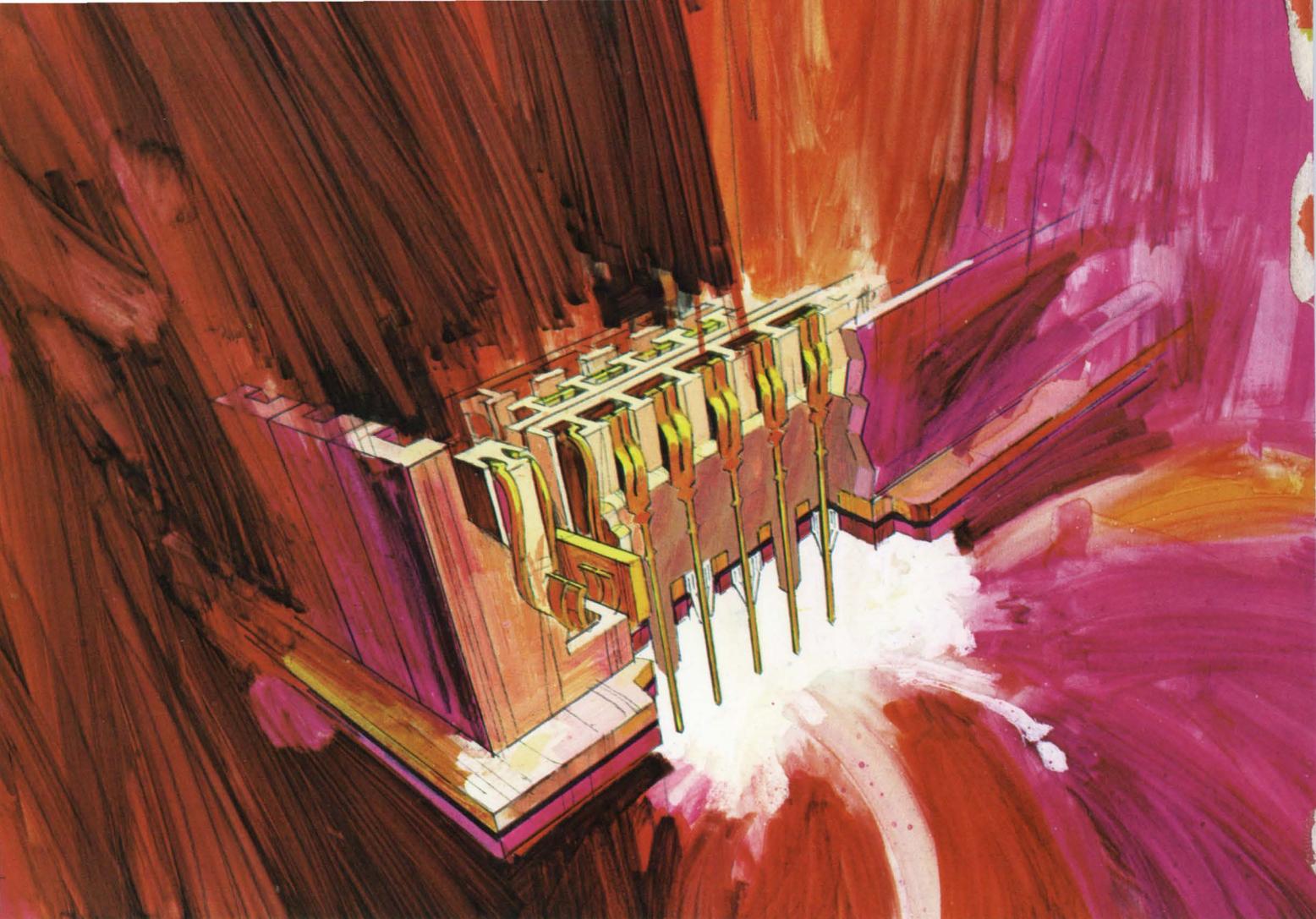


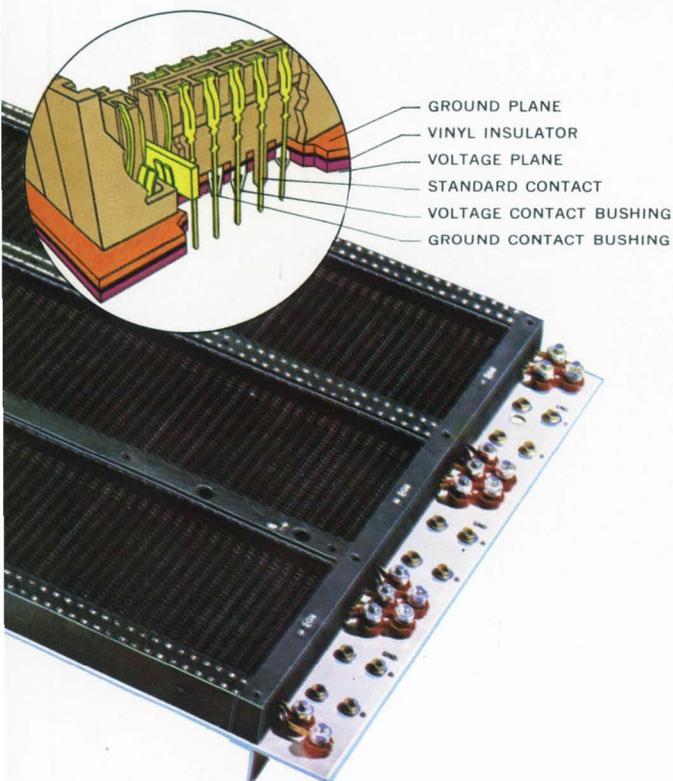
Minicomputers: The new success story of the industry. Low cost, small size, rugged construction and adaptability are the reasons behind the sudden burst of new applications. Automatic test lines, laboratory data logging, hospital care and scientific computations are just a few. For details, see this report starting on page C6.





IMITATED—BUT NOT EQUALLED.

CINCH BACK PLANE CONNECTOR SYSTEM



GROUND PLANE
 VINYL INSULATOR
 VOLTAGE PLANE
 STANDARD CONTACT
 VOLTAGE CONTACT BUSHING
 GROUND CONTACT BUSHING

Today, most back plane connector systems are being modified to include features first developed by Cinch. But only the Cinch back plane was designed to incorporate these innovations as basic design considerations, not modifications of already existing devices.

Cinch design leadership produced the *first* back plane connector system with these important features:

1. Replaceable buss bars that permit removal and replacement of bussing contacts.
2. Easily replaceable voltage plane and ground contacts, including bussing.
3. Precision monoblock insulators that eliminate modular construction.
4. Cantilevered, preloaded contacts.

Cinch didn't stop with the product. Special design molded styrofoam carriers completely eliminated damage during transit.

Combined with cost reducing techniques of selective gold plating, simultaneous insertion of contact rows and a unique method of terminal positioning, these features result in the most efficient and most economical back plane connectors system you can buy.

For information on this or other Cinch interconnection devices, contact your local Cinch Electronics Group office or write to Cinch Manufacturing Company, 1501 Morse Avenue, Elk Grove Village, Illinois 60007.

C-6914



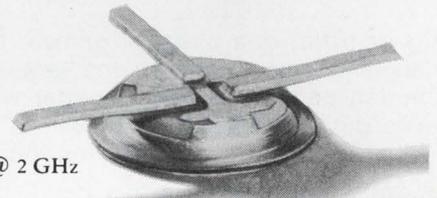
INFORMATION RETRIEVAL NUMBER 242

Microwave transistors, \$49 and less.

They're as good as anything twice the price.

Typical 35803 B/E performance:

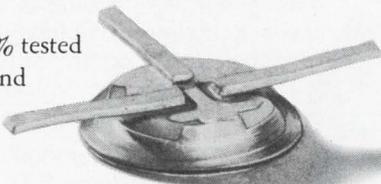
as oscillator: 100 mW @ 4 GHz
as amplifier: 50 mW output
8 dB gain
4.5 dB noise figure } @ 2 GHz



For all you designers who've been paying \$90 and up to \$150 for *high quality* transistors, Hewlett-Packard has good news: volume microwave transistors at low prices. The prices are so low because we make more of these devices than anybody else in the world (we use them ourselves in the instrumentation we sell).

All transistors are 100% tested at microwave frequencies and HP process control assures high uniformity from device to device.

With such consistent quality, you can design your circuits around their performance with confidence.



Typical 35806 B/E performance:

as oscillator: 40 mW @ 4 GHz
as amplifier: 50 mW output
9.5 dB gain
5.2 dB noise figure } @ 2 GHz

Evaluate HP's microwave transistors. In 1 to 99 quantities, they'll cost you \$49 each for some types and just \$45 for the others. Or if you want fully RF tested chips instead of packages, they're \$15 each. Compare their performance to anything else you can buy. They're as good as anything twice the price.

Let your local HP field engineer fill you in on all the specs on all our microwave transistors. Or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT  PACKARD

04009

INFORMATION RETRIEVAL NUMBER 2

Datapulse is making waves.

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

The little beauty on top, the Datapulse Model 401, sells for only \$395 and gives you a dial accuracy of one percent (that's about twice as good as the competition). Frequency is 0.02 Hz to 2 MHz, and sine distortion is only 0.25 percent in the audio range. Square-wave rise time is a

fast 40 nanoseconds. To handle low levels, we give you 80 db dynamic amplitude range.

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

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

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

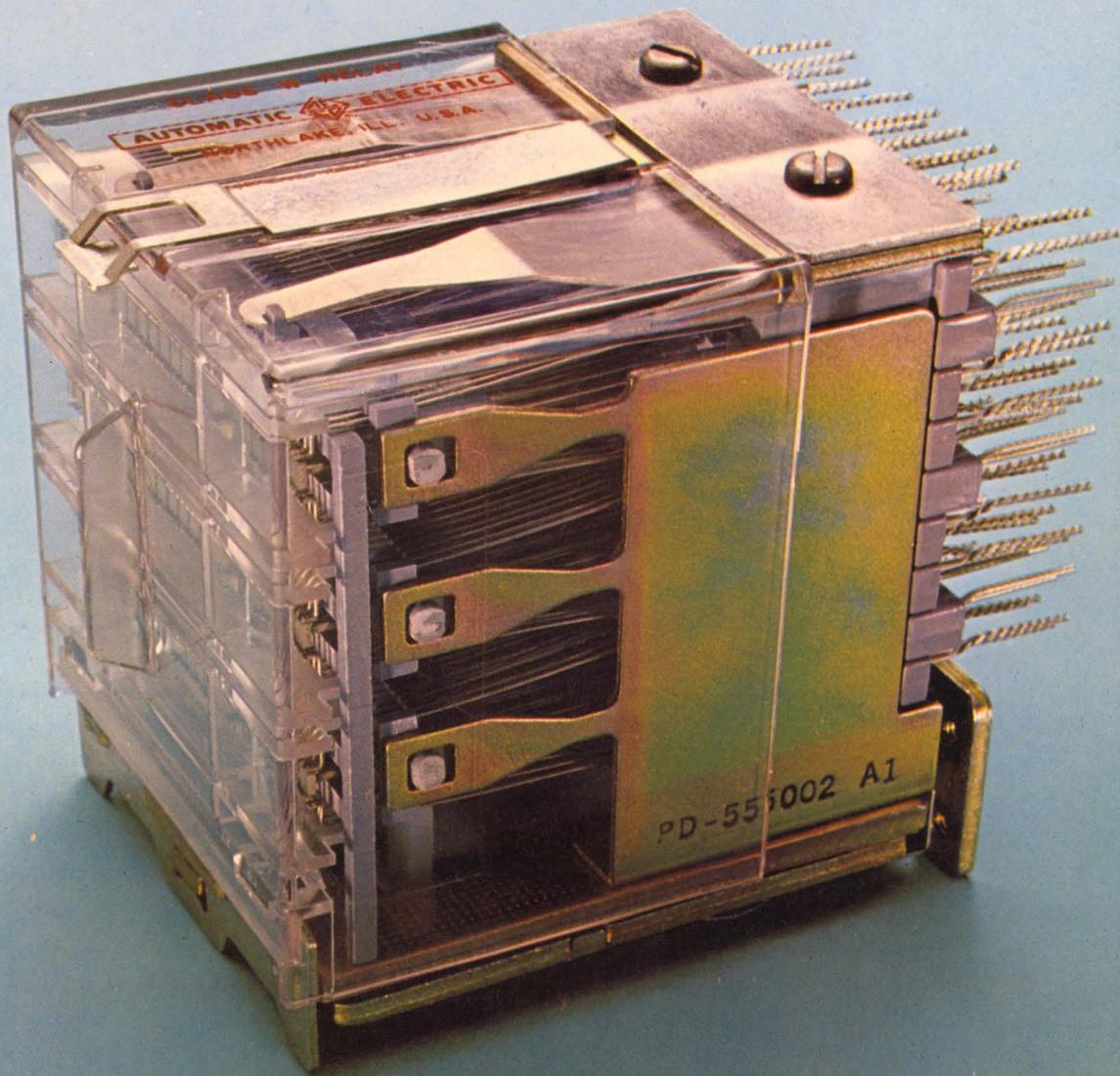
To arrange a demonstration or obtain more data, contact your local S-D man. Or address Datapulse Division, Systron-Donner Corporation, 10150 W. Jefferson Blvd., Culver City, California 90230. Phone (213) 836-6100.



DATAPULSE
DIVISION

SYSTRON  DONNER

Reliability is staggered steps and a hunk of DAP.



Expect over a billion operations.

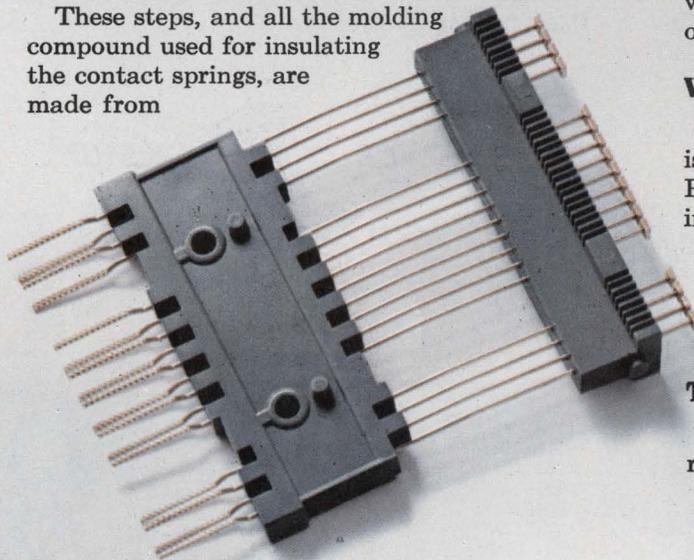
Our Class W wire-spring relay is different. In fact, there's nothing like it in the entire industry. Where else can you find a relay with lots of contacts and a mechanical life of more than a billion operations! That's about two and a half times the life of the best conventional relay around.

Another nice thing about our Class W is that it takes up a lot less space and costs less than using a bunch of other relays. That's because we build our Class W relay with one, two or three levels of contact assemblies, with 17 form C combinations per level. By the way, they're available with gold contacts for low-level switching.

Making it tough on creepage.

All those staggered steps you see on the side were put in to raise the breakdown voltage between terminals. These molded steps add extra creepage distance between the terminals. This really counts for high voltage testing, or when using our Class W in unfavorable ambient conditions.

These steps, and all the molding compound used for insulating the contact springs, are made from



diallyl phthalate. (They call it DAP for short.) It has great insulating properties and it wears like iron. Even if the humidity is high, you have excellent protection.

Redundancy—two springs are better than one.

Each of our long wire-spring contacts has an independent twin with the same function. One tiny particle of dust could prevent contact on other relays. Not with our Class W. You can be sure one of the twins will function. That's back-up reliability.

The twin contacts are twisted together at the terminal end. Then we give them a spanking (you might call it swedging) to provide solderless wrap.



We're for independence.

Our springs are longer, because the longer the spring, the more independent they get. And the better contact they make. Don't forget, the wire-spring relay is the most reliable way to get a permissive make or break contact. You can rely on it.

The middle contact springs have to be stationary. To make sure they stay that way forever, we actually mold them between two thick pieces of DAP on both ends. Just try to move one.

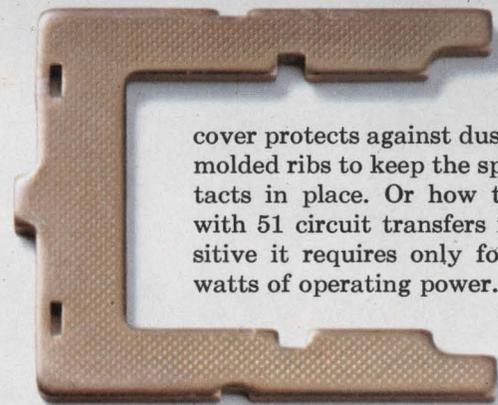
When we say flat, it's flat.

Each frame, banged out by a gigantic machine is extra thick and extra flat. Then they're planished. Planishing is another step we go through in forming the frame to add strength and stability by relieving surface strain.

We've made our spring-loaded pile-up clamp extra thick, too. Once it's tightened down, the whole pile-up is nice and tight, and stays tight.

There's more.

We could tell you a lot more about our Class W relays. Like how the tough high-temp molded



cover protects against dust and has molded ribs to keep the spring contacts in place. Or how this relay with 51 circuit transfers is so sensitive it requires only four to six watts of operating power.

But why don't you let us prove how much reliability we put into our Class W? We'll be waiting to hear from you. Industrial Sales Division, Automatic Electric Company, Northlake, Ill. 60164.

AUTOMATIC ELECTRIC
GENERAL TELEPHONE & ELECTRONICS

Here's One Place Where Your Dollar Is Worth A Dollar

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

Both oscillators offer improvements that assure you of a consistent signal—test after test—time after time... whether you are testing on a production line, researching in a design lab, or instructing future engineers.

Portable, line or battery powered. The 204C is a clean, inexpensive oscillator with a frequency range of 5 Hz to 1.2 MHz. Output is 2.5 Vrms into 600 Ω , 5 Vrms into open circuit. Choose interchangeable power packs—line, rechargeable or mercury battery. Price HP 204C, \$250 to \$285.

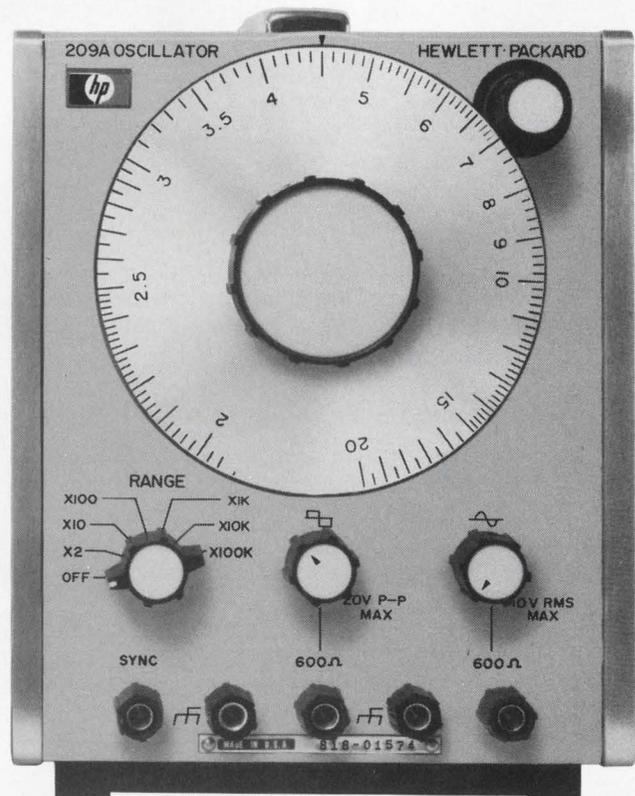
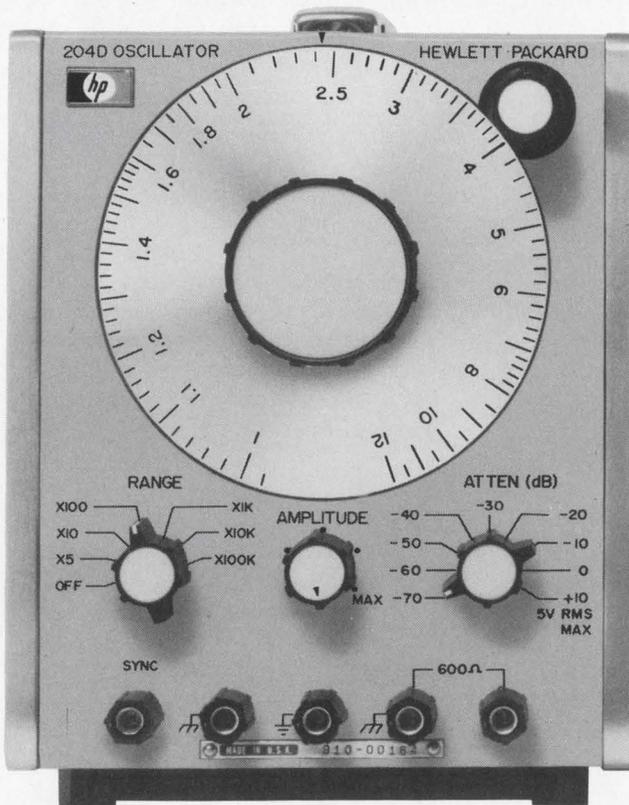
The 204D has the added convenience of a built-in 80 db attenuator. Eliminates using an outside attenuator when you need clean low-level signals. Price: HP 204D, \$325.

High power output, sine or square wave. The 209A generates simultaneous sine and square wave outputs over a frequency range of 4 Hz to 2 MHz. Amplitudes are independently adjustable. Voltage output for a sine wave is double that of the 204—5 Vrms into 600 Ω , 10 Vrms into open circuit. Square wave output is 20 V peak-to-peak. Price HP 209A, \$345.

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

099/2 A

HEWLETT  PACKARD
SIGNAL SOURCES





ERIE

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

Symbolic electronic signal undistorted by EMI —
photographed by Howard Sochurek

bring ERIE in early.

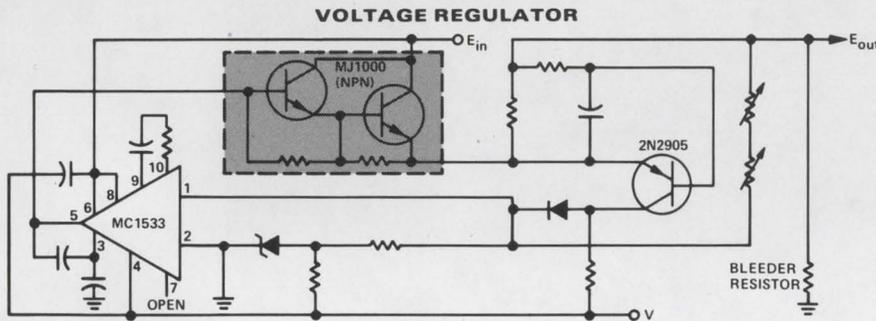
31,000 feet... heavy traffic... ugly weather over the Plains. This isn't the time for "noise" in the radar. But, no sweat! RCA's exciting new AVQ-30X Weather Radar is up front, sweeping the sky... protected from EMI by 39 special ERIE filters. No other airborne radar has ever approached the single or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

INFORMATION RETRIEVAL NUMBER 6

ERIE TECHNOLOGICAL PRODUCTS, INC.

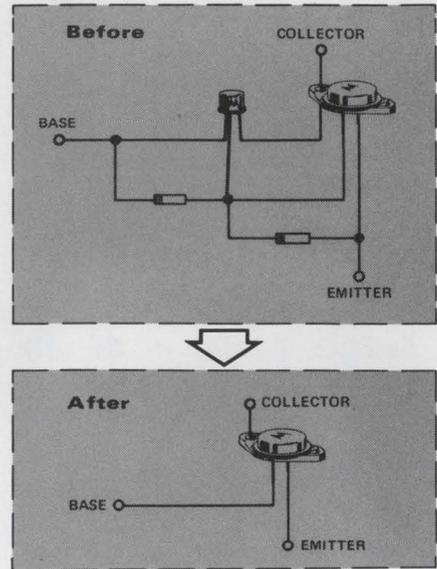
644 West 12th Street, Erie, Pennsylvania 16512
(814) 456-8592

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.



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.

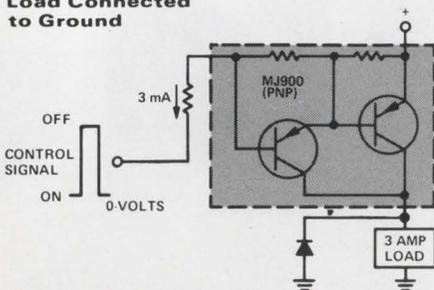
DARLINGTONS SIMPLIFY!



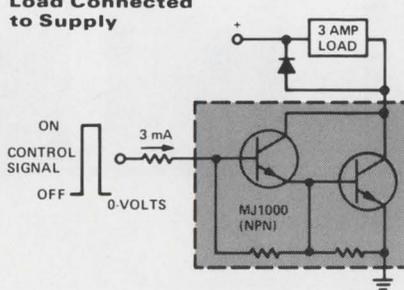
Power Darlington

DC STATIC SWITCHES

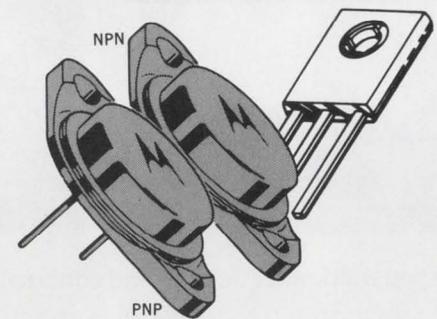
Load Connected to Ground



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.

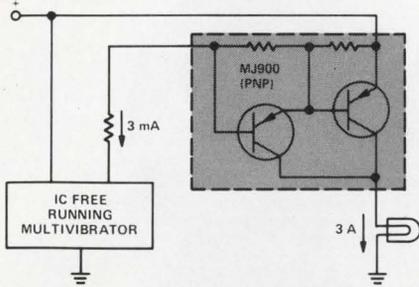


Perform With Package Variety. Besides the 5 A, TO-3 darlington, you'll soon have your choice of Thermopad plastic packages 77 and 90 — two sizes of case economy that will further reduce design costs.

— where the priceless ingredient is care!

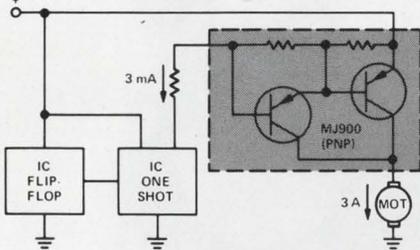


LAMP FLASHER



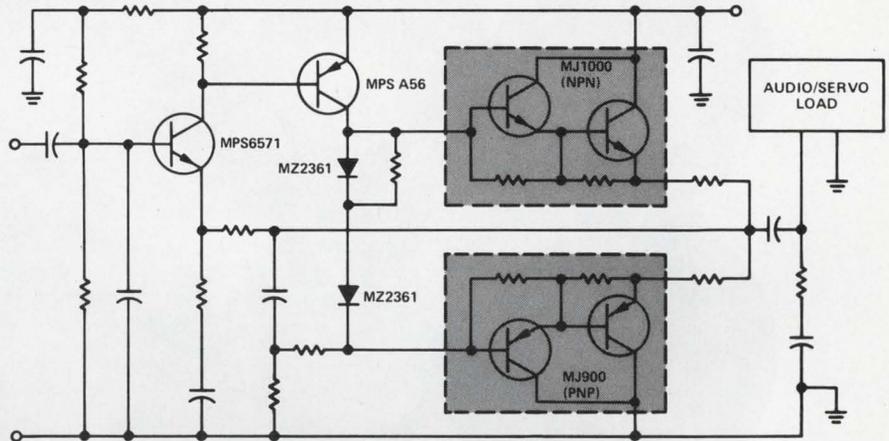
Innovate With I/C's. Drive the 3 A darlington with power levels derived from integrated circuit logic gates. Go from milliamperes to amperes directly, compatibly, easily.

DC MOTOR SPEED CONTROL



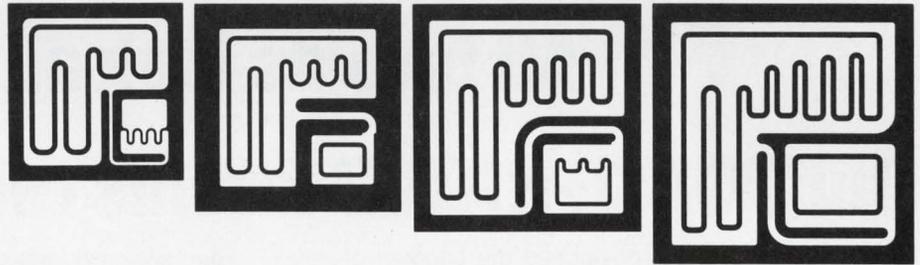
Obtain 1,000 dc gain. Yesterday, 25 minimum beta was great — today, Motorola power darlington's give you a minimum of 1,000 . . . an unheard-of, commercial/industrial state-of-the-art first!

30-W AMPLIFIER USING COMPLEMENTARY SYMMETRY



Revolutionize Today

Revolutionize Right Now. Introduce your relay or solenoid drivers, audio amplifiers, power supply regulators, servo amplifiers and series pass regulators to today's world of silicon power darlington systems — contact your franchised Motorola distributor for evaluation units or, for complete data, Box 20912, Phoenix, 85251 . . . the place it all begins.



Power Darlington		I_C A (Cont)	V_{CE0} (sus) V	h_{FE} @ I_C (min)	P_D W	I_{CB0} @ V_{CB} mA	SOA	Price 100 Up	
PNP	NPN							PNP	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.

The circuitry shown external to Motorola products is for illustrative purposes only, and Motorola does not assume any responsibility for its use or warrant its performance or that it is free from patent infringement.

MOTOROLA Silicon Power Transistors



All toroids look alike.

Our PULSE-RATEDTM toroids really are alike.

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

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

Specifications provided for every *pulse-rated* toroid include pulse in-

ductance, volt-microsecond product, and temperature behavior under pulse conditions.

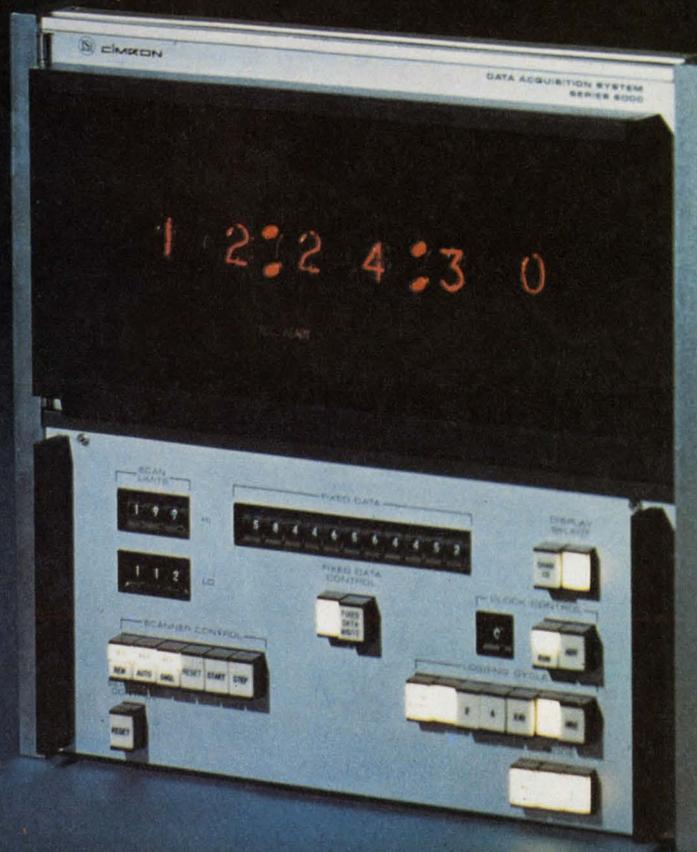
Parylene-coated *pulse-rated* toroids in sizes and specifications to suit your design requirements are now available for off-the-shelf delivery. Want some? We welcome the opportunity to send you samples. And hot-off-the-press spec sheets. And to consult with you about your design problems. Write Indiana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

indiana general 

a division of Electronic Memories & Magnetics Corporation

INFORMATION RETRIEVAL NUMBER 8

INTRODUCING



The instrument that obsoletes systems.

Simple idea. But someone had to think of it first. We did. We took all the elements of a digital data acquisition system and designed them as plug-in modules. Then we put them all in a box—*one box*. Result: the system became a single instrument.

So what? Cimron's new 8000 Series Digital Data Acquisition System is the first major departure in design concept since the advent of analog-to-digital converters. This new instrument optimizes the digital system. It offers the greatest

range of inputs, speed, and recording capability obtainable—*all at a price no system can match*. Cimron's measuring instruments will meet any accuracy and resolution requirement.

Modules in the single small 50-lb box include scanners, comparators, programmers, serializers, digital clock. No cables. No redundant components. Eliminates noisy ground loop problems. The housing contains a time shared readout, common power supply, and front panel con-

trols. The DAS 8000 is easily expandable and computer compatible.

Cimron *customer concern* again brings you a new instrument for solving the most stringent and complex measurement problems at the lowest cost per channel. For details on the DAS 8000, write: Cimron, Dept. D-137, 1152 Morena, San Diego, California 92110.

CIMRON



LEAR SIEGLER, INC.

CIMRON DIVISION



Bodine helps copiers/duplicators stay sharp, quick, reliable

Small. Quiet. Run reliably in long, hard, heavy-duty usage. Bodine fractional horsepower drive systems meet the needs of copier-duplicator operations. Bodine designs and builds exceptional performance and service-life into every drive and control unit. For they have a reputation to live up to: *Yours!* This means fewer callbacks. Fewer field service problems. Power that meets the dependability standards you've engineered into your product.

Whatever your product—copier, duplicator, business machine, instrumentation—specify Bodine fhp drives and controls. Over 3,500 standard specifications to choose from. Bodine also builds custom fhp drives and controls to meet design requirements. Our engineers will gladly help pinpoint the right one for your application. Write for bulletin. Bodine Electric Company, 2500 W. Bradley Place, Chicago, Ill. 60618.

Bodine Motors Wear Out—It Just Takes Longer



**BODINE MOTORS/GEARMOTORS
SPEED CONTROLS**

Designer's Calendar

MAY 1970						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

For further information on meetings, use Information Retrieval Card.

May 11-14

International Microwave Symposium (Newport Beach, Calif.)
Sponsor: IEEE. R. H. DuHamel, Granger Assoc., 1601 California Ave., Palo Alto, Calif. 94304.

CIRCLE NO. 317

May 13-15

Electronic Components Conference (Washington, D. C.)
Sponsors: IEEE, EIA. Darnall Burks, Sprague Electric Co., Marshall St., N. Adams, Mass. 01247.

CIRCLE NO. 318

May 18-20

Aerospace Electronics Conference (NAECON), (Dayton, Ohio)
Sponsor: IEEE. IEEE Dayton Office, 124 E. Monument Ave., Dayton, Ohio 45402.

CIRCLE NO. 319

May 19-21

Power Sources Symposium (Atlantic City, N. J.)
Sponsors: U. S. Army Electronics Command, et al. Power Sources Division, U. S. Army Electronics Command, Fort Monmouth, N. J. 07703.

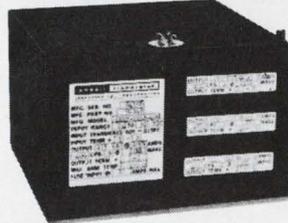
CIRCLE NO. 320

May 26-28

Society for Information Display Symposium (New York City)
Sponsor: Society for Information Display. Bernard J. Lechner, RCA Laboratories, Princeton, N. J. 08540.

CIRCLE NO. 321

How To Solve Your Power Supply Problem—



28 VDC to 400 Δ 3 ϕ
Model Q10D-115A-400Y
Size 6" x 6" x 4" — Wt. 8.3 lbs.
Output 100 volt amps



400 Δ to DC (Reg)
Model T3D-48.6A
Size 2 $\frac{3}{4}$ " x 3" x 3 $\frac{1}{4}$ " — Wt. 2.3 lbs.
Output 48 VDC at 618 ma



60 Δ to DC (Reg)
Model V6D-27.6A
Size 4 $\frac{1}{2}$ " x 6" x 4" — Wt. 10.3 lbs
Output 28 VDC at 2.1 amps



28 VDC to DC (Reg)
Model AK1D-1970A
Size 1 $\frac{1}{2}$ " x 2 $\frac{3}{4}$ " x 3" — Wt. 1 lb.
Output 2000 VDC at 5 ma

NEW! Mil-Spec Quality Power Supply Modules for All Types of Power Conversion

Abbott has a new line of power supply modules. They are built to meet military environment-MIL-E-5272C. All types are available with *any output voltage you need from 5 volts to 10,000 volts DC* — and DC to 400 Δ inverters with either 1 ϕ or 3 ϕ outputs.

DC to 400 Δ , 3 ϕ — This new inverter changes 28 VDC battery voltage to three phase power with outputs of 33, 66, and 100 volt amps, 400 cycles or 800 cycles, as well as output voltages of 115 VAC or 27 VAC. All three phases are independently regulated at 1%. Also, 1 ϕ output units are available with powers of 30, 60, 120 and 180 volt amps, 400 cycles or 800 cycles, at 115 VAC or 27 VAC. All of these solid state inverters are completely described on Pages 54 thru 59 of our new catalog.

60 Δ to DC — These modules are the smallest, lightest weight 60 Δ to DC power supplies we have seen. They are well regulated for line and load changes. Hermetically sealed for military environment they will operate to 160°F heat sink temperatures. They are available in *any output voltage you need — 5 volts to 10,000 volts,*

with power outputs of 5, 10, 20, 30, 60, 120, and 240 watt sizes as standard catalog listings. You will find them completely described with prices on Pages 2 thru 13 of our new catalog.

400 Δ to DC (Reg) — Designed especially for 400 Δ input power, this line of converters is available with any output voltage you want — 5 volts to 10,000 volts DC. Power outputs of 5, 10, 20, 30, 60, 120, and 240 watt sizes are standard. Well-regulated and hermetically sealed, these units are described on Pages 19 thru 33 of our new catalog.

DC to DC (Reg) — Some of these DC to DC converters are as small as a package of cigarettes and weigh less than a pound. Output voltages from 5 volts to 10,000 volts are all listed as standard models in our new catalog. Power outputs come in standard sizes from 5 to 240 watts. These converter modules feature close regulation, short circuit protection and hermetic sealing for rugged applications found in military environment. They are listed in order of increasing output voltage on Pages 37 thru 51 of our new catalog.

If you need a power supply module in a hurry please check pages 1834-1851 in your EEM (1969-1970 ELECTRONIC ENGINEERS MASTER Directory). Most of the above units are listed there. Or, for a complete list of our power supply line please send for your FREE catalog.

abbott transistor

LABORATORIES, INCORPORATED
5200 W. Jefferson Blvd. • Los Angeles 90016
Area Code 213 • WEBster 6-8185

TO: Abbott Transistor Labs, Inc., Dept. 41
5200 W. Jefferson Blvd.
Los Angeles, California 90016

Sir:
Please send me your latest catalog on power supply modules:

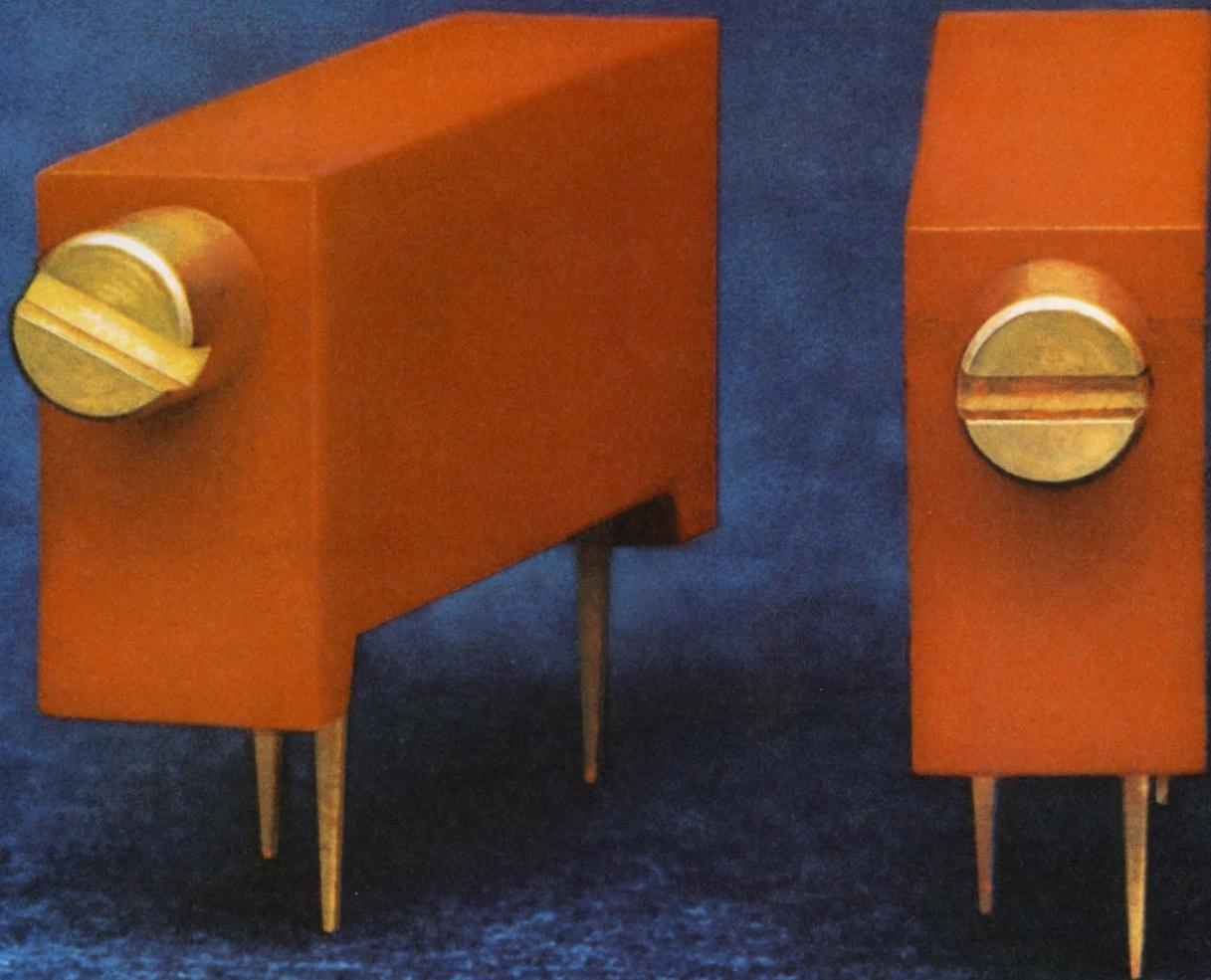
NAME _____ DEPT. _____

COMPANY _____

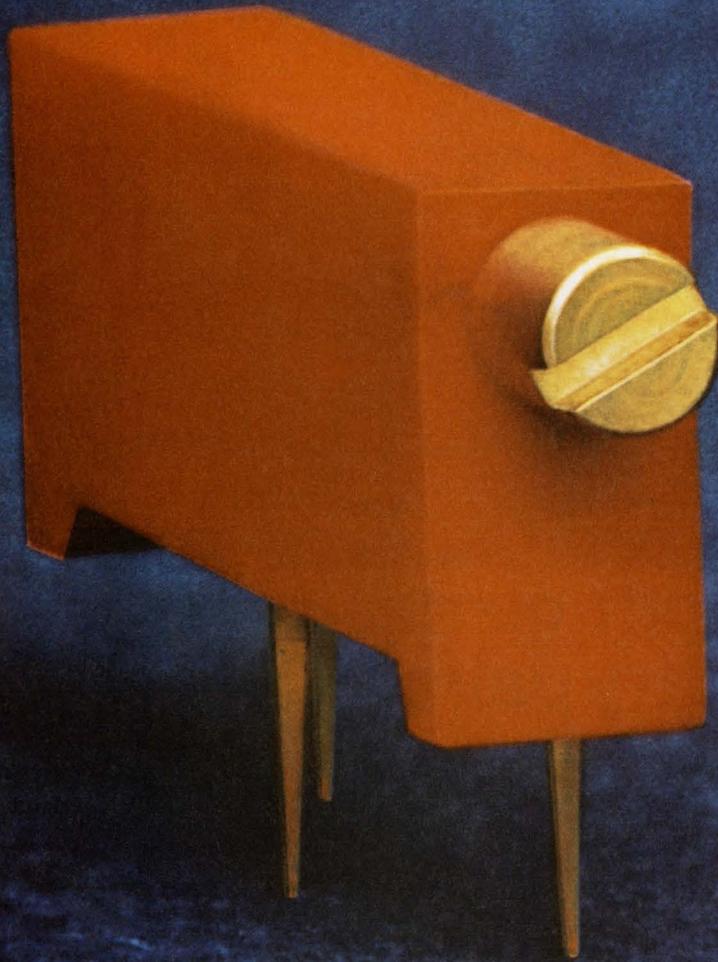
ADDRESS _____

CITY & STATE _____

Film-Mets? Wirewounds? Or Cermet?



What our extra choice means to you.



It ends circuit design compromise.

Because now you can get the perfect match between design needs and trimmer performance.

Suppose you need infinite resolution, lowest noise characteristics and maximum contact setability. Then Film-Met™ would be your best choice.

But if it's infinite resolution and the widest resistance ranges you're after, then cermets would be best.

And of course, good old wirewounds still reign

supreme in lowest temperature coefficient of resistance and lowest contact resistance variation.

Only Amphenol has all three types—and in all the popular military and commercial sizes.

But you'll need more specs than this to determine the best trimmer for your application.

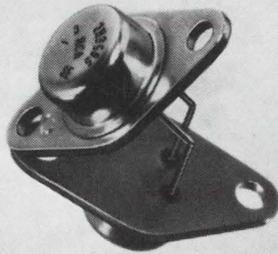
So send today for your free catalog. Or call your nearest Amphenol distributor. Amphenol Controls Division, Janesville, Wisconsin 53545.



AMPHENOL
THE BUNKER-RAMO CORPORATION

INFORMATION RETRIEVAL NUMBER 12

Have symmetry reflected
Have symmetry reflected



in your high-voltage designs with complementary pairs from RCA

Here's news for designers who have been waiting for high-voltage complements. RCA announces the TA7410, a new high-voltage silicon power transistor which extends the capability of RCA's whole new generation of p-n-p/n-p-n devices.

Featuring high-breakdown voltages and fast-switching, the TA7410 will be one of the most important transistors in a wide range of commercial, industrial, and military circuits...especially those using complementary pairs.

With new advantages from complementary high-voltage pairs you can:

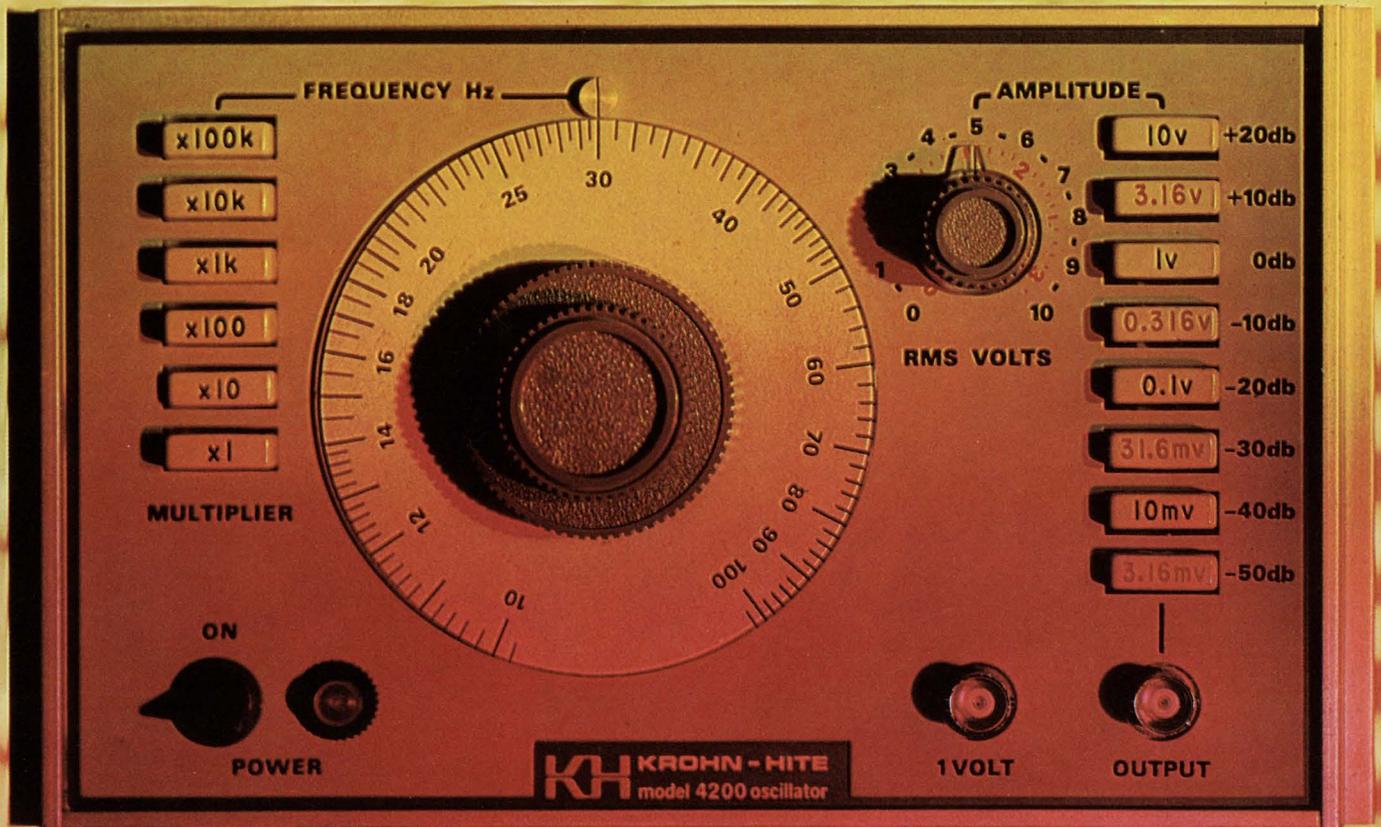
- Obtain low output impedance at both + and - terminals with symmetrical series regulators
- Eliminate the destructive effects of leakage inductance in push-pull inverters
- Design line-operated, complementary linear amplifiers
- Create new complementary high-voltage switching inverters.

TA7410 is a p-n-p complement of the well-accepted 2N3585. Its companion type, TA7719, is a complement to 2N3584. TA7410 features a V_{CEO} of -300 V while TA7719 has a V_{CEO} of -250 V. Both are realistically specified for minimum betas of 20 at 1 A, and feature rise and fall times of 0.6 μ s maximum.

Let TA7410 and TA7719 complement your designs with their compact hermetically-sealed TO-66 packages. They represent the newest in a series of high-voltage complementary pairs that started with the 2N3440/2N5415—the industry's first such units (in hermetic TO-5 packages).

For more information, consult your local RCA Representative or your RCA Distributor. For technical data, write: RCA Electronic Components, Commercial Engineering, Section IG4-2/UT9, Harrison, N.J. 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

RCA



THE WAVEMAKERS

in every sense of the word

and we'll prove it!

We're challenging you to use our amazing new Model 4200 Test Oscillator in your own lab, on your own projects for 10 days without obligation. We're sure you'll be quick to recognize its superior performance, ease of operation, reliable accuracy, and unmatched value. The consistent half watt power output over the 10 Hz to 10 MHz range plus an internal impedance of 50 ohms means you can drive loads without overloading. Add excellent frequency response of 0.025 db and a distortion factor of 0.1% and you've got a versatile, high performance test oscillator that can't be beat.

Yes, Krohn-Hite, innovators in oscillator design for over twenty years, is making waves again!



First Class
Permit No.
30358
Boston, Mass.

Business Reply Mail

Krohn-Hite Corporation
580 Massachusetts Avenue,
Cambridge, Massachusetts 02139

KROHN-HITE MODEL 4200, 10 Hz TO 10MHz, TEST OSCILLATOR

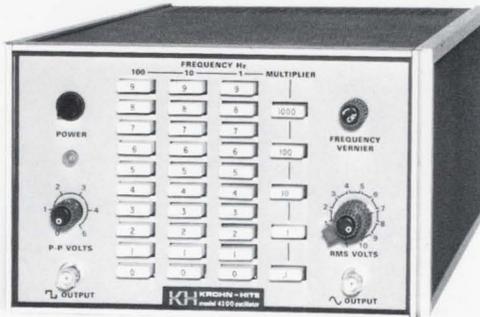
- Frequency Range: 10 Hz to 10 MHz
- Power Output: 1/2 watt
- Maximum Output: 10 volts rms
- Frequency Response: 0.025 db
- Harmonic Distortion: 0.1%
- Frequency Accuracy: 2%
- Internal Impedance: 50 ohms
- Auxiliary Output
- External Synchronization
- Amplitude Stability: 0.02%



A low priced, solid state laboratory or production signal source featuring unusual flatness and ease of operation normally found in instruments selling at twice the price. The high power output signal of the Model 4200 delivers full voltage to the load over the entire frequency range. An infinite resolution dial and push-button multiplier provide rapid and continuous frequency tuning. In short, the Model 4200 is a broad range, versatile test oscillator destined to set new standards in performance and value.

KROHN-HITE MODEL 4100A, 0.01 Hz TO 1 MHz PUSH-BUTTON OSCILLATOR

- Frequency Range: 0.01 Hz to 1 MHz
- Power Output: 1/2 watt
- Harmonic Distortion: 0.02%
- Frequency Accuracy: 0.5%
- Amplitude Stability: 0.002%
- Frequency Response: ±0.05 db
- Internal Impedance: 50 ohms
- Square Wave Risetime: 20 ns
- External Synchronization



A medium priced, solid state, general purpose Oscillator that produces sine and square waves simultaneously from 0.01 Hz to 1 MHz with 1/2 watt of power into 50 ohms. Frequency calibration is within ±0.5% and push-button tuning permits ±0.1% frequency repeatability. 50 ohm internal impedance minimizes output voltage drop due to loading, specifically at higher frequencies where unavoidable capacitive loading limits the usefulness of higher impedance oscillators. The Model 4100A is an ideal laboratory and production instrument for a variety of applications where outstanding performance offers increased measurement speed and accuracy.

Yes, Krohn-Hite, the leader in variable filters, is fast becoming a leader in oscillators. Krohn-Hite has designed and manufactured a complete line of signal generating equipment to meet and, in many cases, exceed your project requirements. Each offers high performance features that you'd normally expect to cost a great deal more. Here's a brief rundown of the soon-to-be famous, never-to-be forgotten Krohn-Hite line. For further information on any of the instruments or complete details on our challenging Free Trial offer, simply fill in the attached postpaid reply card. We guarantee an answer by return mail.

OSCILLATORS

Frequency Range	Osc. Model*	Freq. Acc. %	Power (mw)	Impedance (ohms)	V RMS (Open Circuit)	Quad. Output	Add'l. Wave-Forms	Freq. Resp. (db)	Dist. %	Approx. Ship. Wt. lbs/kgs	Price
0.001 Hz to 100 kHz	4024	0.5	125	200/600	10	Yes	□ □	0.01	0.01	24/11	\$1200
0.001 Hz to 100 kHz	4025	0.1	125	200/600	10	Yes	□ □	0.01	0.01	24/11	\$1950
0.01 Hz to 1 MHz	4100A	0.5	500	50	10		□ □	0.05	0.02	21/10	\$ 550
0.1 Hz to 100 kHz	4000	0.5	125	200/600	10	Yes	□ □	0.01	0.01	18/9	\$ 850
0.1 Hz to 100 kHz	4001	0.1	125	200/600	10	Yes	□ □	0.01	0.01	18/9	\$1450
10 Hz to 10 MHz	4200	2	500	50	10		~ (FIXED)	0.025	0.1	21/10	\$ 350

*Add suffix "R" for rack mounting.

PROGRAMMABLE OSCILLATORS

Frequency Range	Osc. Model	Freq. Acc. %	Max. Volts	Output Impedance	Dist.	Square Wave	Prog. Amp.	Approx. Ship. Wt. lbs/kgs	Price
0.1 Hz to 100 kHz	4030R	0.5	10 RMS	200/600	0.01%	optional	optional	27/13	\$1495
0.1 Hz to 100 kHz	4031R	0.1	10 RMS	200/600	0.01%	optional	optional	27/13	\$2145
0.1 Hz to 1 MHz	4131R	0.1	10 RMS	50	0.02%	yes	yes	30/15	\$1375
0.1 Hz to 1 MHz	4141R	0.1	10 RMS	50	0.02%	yes	yes	30/15	\$1585
1 Hz to 1 MHz	4130R	0.5	10 RMS	50	0.02%	yes	no	27/13	\$1075
1 Hz to 1 MHz	4140R	0.5	10 RMS	50	0.02%	yes	yes	27/13	\$1285

- Yes, I accept your challenge to try the fabulous Model 4200 Test Oscillator. Send me complete details at once.
- Send me complete specifications on Model(s): _____
- Send me a copy of the complete K-H Catalog.
- Wow! You've aroused my interest and I can't wait. Please have your representative call me for an appointment.

NAME _____ TITLE _____

COMPANY _____

DIVISION _____ PHONE _____

STREET _____

CITY _____ STATE _____ ZIP _____

Here's your chance to put Krohn-Hite, the Wave-makers, to work for you. Accept our challenge and you'll never settle for less. Just fill in the attached post-paid card and we'll see that you get all the details on the Krohn-Hite Free Trial Offer by return mail. Then, you too can be a wavemaker.



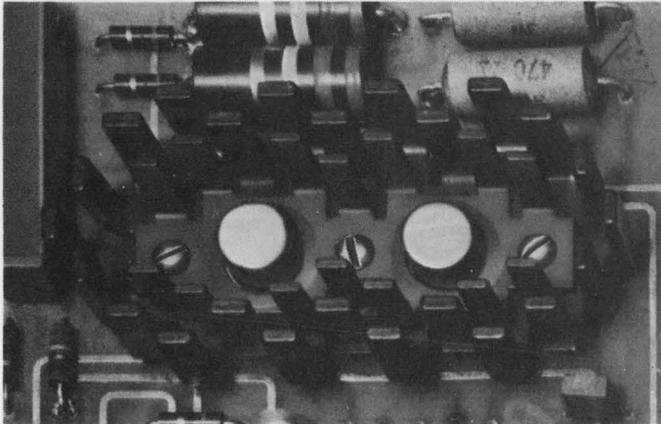
KROHN-HITE CORPORATION

580 Massachusetts Ave., Cambridge, Mass. 02139
Telephone: 617/491-3211 TWX: 710-320-6583

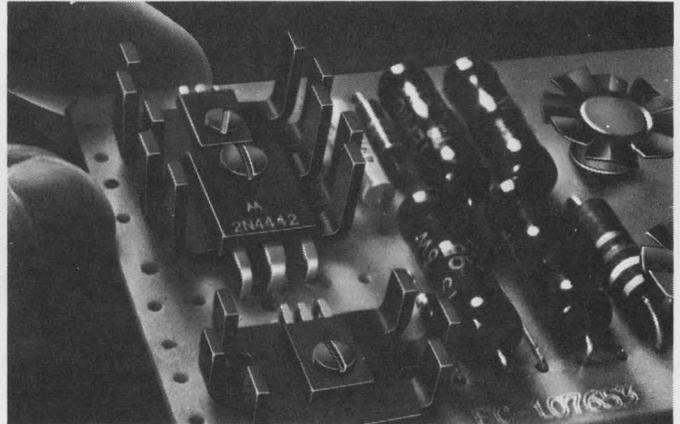
OVERSEAS SALES OFFICES: BELGIUM, C. N. Rood s. a. DENMARK, SC Metric A/S; FRANCE, Antares; GERMANY, Nucletron Vertriebs-GMBH; HOLLAND, C. N. Rood n. v.; ITALY, Dott. Ing. Mario Vianello; SWEDEN, Teleinstrument; ISRAEL, R. D. T. Elect. Eng. Ltd.; JAPAN, Shoshin Shoji Kaisha, Ltd.; AUSTRALIA, Sample Electronics (Vic.) Pty., Ltd.; G. B., B & K Inst. Ltd. Printed in U.S.A.

Tips on cooling off hot semiconductors

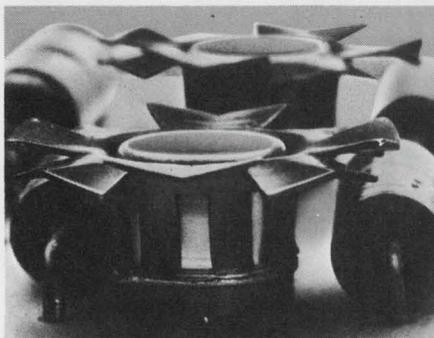
As power levels go up and up and package size shrinks, circuit designers are keeping semiconductors cool with IERC Heat Sinks/Dissipators. Reducing junction temperature gives many benefits: faster rise and fall times, faster switching speed and beta, fewer circuit loading effects and longer transistor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



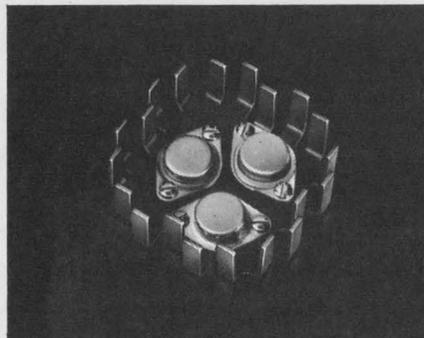
Thermal mating of matched transistors, such as these TO5's shown on a dual LP, maintains matched operating characteristics. The LP's unique multiple staggered-finger design (both single and dual models) maximizes radiation and convection cooling, results in a high efficiency-to-weight and -volume ratio.



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



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



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

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

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



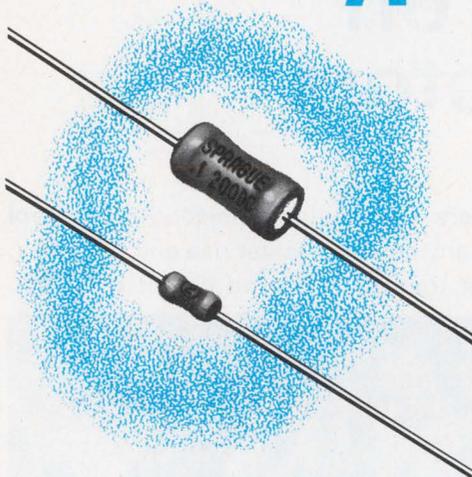
Heat Sinks/Dissipators

IERC



Now...new, lower capacitance values!

Type 192P PACER[®] FILMITE[®] 'E' CAPACITORS



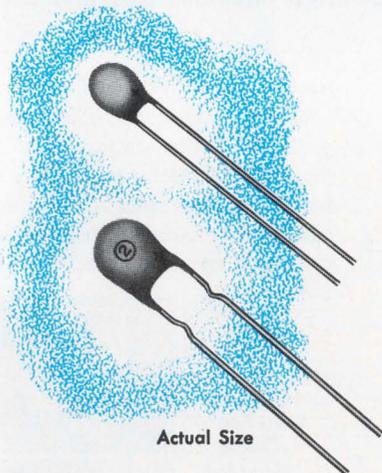
INFORMATION RETRIEVAL NO. 823

- Low-cost film capacitors with one-third the size of conventional tubulars
- Eight new low-capacitance values (100 pF thru 390 pF @ 200V) added to broad range of standard ratings
- Special construction—extended foil sections terminated in metal end caps, assuring positive contact with every turn of the electrodes
- End caps are also effective moisture barriers
- Entire assembly protected by special sleeve of high dielectric strength
- Request Engineering Bulletin 2066B

45C-0105R1

Newly broadened low-cost line!

Type 196D Dipped Solid-Electrolyte Tantalex[®] Capacitors



Actual Size

INFORMATION RETRIEVAL NO. 824

- Here's a capacitor design that admirably fills the need for low-cost yet dependable solid tantalum capacitors suitable for printed wiring boards
- Straight leads as well as crimped leads are readily available to meet your manufacturing needs
- Covering a broad range of capacitance values from .1 μ F to 330 μ F, with voltage ratings from 4 to 50 VDC, Type 196D Capacitors are protected by a tough insulating coating which is highly resistant to moisture and mechanical damage
- Request Engineering Bulletin 3545A.

45C-9124R1

For Engineering Bulletins as noted above, write to:
Technical Literature Service, Sprague Electric Co., 347
Marshall Street, North Adams, Massachusetts 01247.



'Sprague' and '®' are registered trademarks of the Sprague Electric Co.

THE BROAD-LINE PRODUCER OF ELECTRONIC PARTS

Highlighting

THE ISSUE

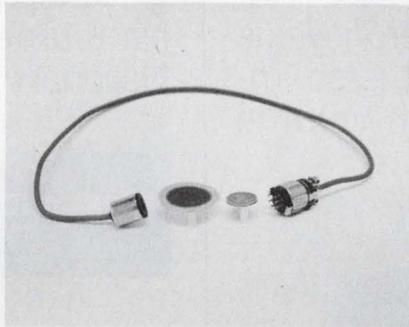


"The minicomputer industry is the fastest-growing segment of the fastest-growing business in the world."

This statement by the director of marketing of a minicomputer manufacturer—Allen Z. Kluchman of Data General Corp., Southboro, Mass.—sums up the impact of an idea that has been kicked around in the computer industry for six or seven years but only began to bear fruit two years ago.

The minicomputer's name comes from its small size, but its most significant feature is its relatively low cost. And the list of its applications is endless.

PAGE C6



A new incremental optical encoder with a remote reflective disc controls speed digitally without adding mass. It eliminates the need for shaft couplings and extra bearings.

The device consists of two separate parts: a thin reflective plastic count track disc and a small electro-optical pickup head. The user simply cements the disc on the rotating surface to be monitored.

PAGE 97



Not many people in the country have heard of Item 807 of the United States Tariff Code. But by summer it may be as common in the language as "Taft-Hartley" or "ABM."

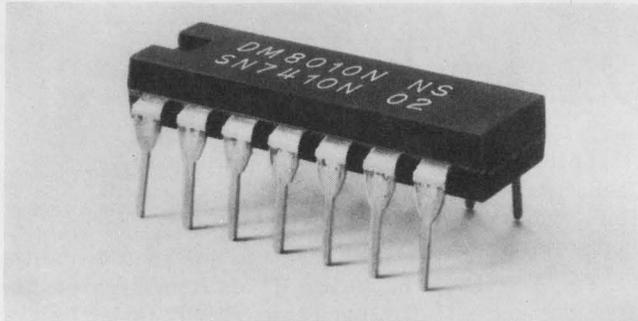
The Tariff Commission will open hearings in May at its Washington headquarters, and the inherent fireworks in these sessions will likely get them national attention. Labor wants the tariff item repealed; industry insists that it be retained.

What is Item 807? And why has it stirred such a fuss? Full details are contained in the story on

PAGE 24

Why National Semiconductor buys Teradyne J259's by the dozen

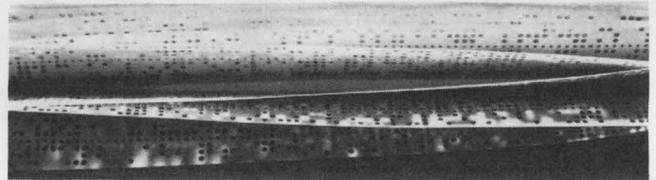
National Semiconductor can trace its considerable success as an IC manufacturer to many factors. One of the most important is the productivity of its testing facility, built around a lineup of 12 Teradyne J259 computer-operated test systems. "The Teradyne systems," according to Jeff Kalb, National's TTL product manager, "give us the economy of testing that is so important to profitable high-volume production."



National, along with most other major IC producers, has found that the J259 boosts productivity in many ways. No other test system, for example, gives its user as much multiplexing freedom as does the J259, which lets National leverage its investment by making each J259 support several test stations doing several different jobs.

Reliability is another all-important key to productivity. National experiences minimal downtime with its J259's. This is as it should be; we design and build our equipment to work shift after shift, year after year, in *industrial* use. Teradyne systems are right at home on production lines like National's, where the workload is heavy and continuous. And operation never has to be interrupted for calibration; the J259 has no calibration adjustments.

The J259's great versatility is also put to good use at National. The same systems that test wafers and packages also generate the distribution and end-of-life data that engineers need to control production processes and ensure high device reliability. Production, engineering, QC, and final test—all share simultaneously in the benefits from National's J259's.



A computer-operated system is only as good as its software, which in the case of the J259 is the best there is. National's J259's are orchestrated by Teradyne-supplied master operating programs for datalogging, classification, and evaluation. As Teradyne updates and improves its software, National is kept fully informed.



National's array of J259's handle the testing of its digital IC's smoothly and economically. For its linear-IC testing, National has turned to Teradyne's J263 computer-operated linear-IC test system.

Teradyne's J259 makes sense to National Semiconductor. If you're in the business of testing circuits—integrated or otherwise—it makes sense to find out more about the J259. Just use reader service card or write to Teradyne, 183 Essex St., Boston, Mass.

Teradyne makes sense.

U.S. technology stars at 20-nation Paris show

Paris

The biggest electronics show in the world—the Salon des Composants Electroniques, held in Paris, April 3 to 8—drew 784 companies from 20 countries, but it was American technology that dominated.

This was particularly apparent in the field of advanced semiconductors. Several European companies, however, have developed linear ICs, MOS memories and high-speed thyristors that look remarkably like their counterparts developed by General Electric, Texas Instruments and RCA.

The Soviet Union, Hungary and East Germany were on hand, and their presence stirred animated speculation about a huge potential electronics' market and supplier: Eastern Europe. The problem here is trade restrictions. One French executive for an American company put it this way: "Eastern Europe is like a beautiful woman who wants to get married, but one must first obtain a medical certificate to talk with her."

The Russian exhibits, which overshadowed those brought by Hungary and East Germany, included 40 types of ICs, some with 1340 MOS devices on a chip; DTL and RTL devices; FETs, linear ICs, hybrid LSI circuits, gallium arsenide light-emitting diodes and a rack full of passive components that the exhibitor described as "the best in the world."

Representatives of American companies at the show said that business is booming. Motorola reported it had grown 80% last year and looked for growth of 100% this year. Fairchild, Texas Instruments, RCA and General Instruments are also firmly established on the Continent.

The European giants at the show were Philips and Siemens. A

number of European concerns have added new lines of ICs, particularly for industrial and consumer markets. Among these are RTC and Sescosem in Paris and Ates Componenti Elettronici in Milan.

Missing at this year's exhibition was the wide range of instrumentation equipment that had been displayed in the past. Components and materials were spread over 65,000 square feet of the Hall Monumental of the Parc des Expositions, while instruments occupied hardly a tenth of that area. The reason given for the cutback in instrument displays was competition from other electronics shows: the Hanover Fair at the end of this month, the Mesapura Show in Paris late in May and the Electronica Show in Munich in November.

JOHN N. KESSLER

Israelis double electronics output

The electronics industry in Israel is growing at a phenomenal rate. In 1969 the output doubled over that of the previous two years, hitting \$71.4-million. And this did not include the output of enterprises belonging to the entertainment sector, such as television sets and radio receivers. Nor did it include those plants that belong directly to the defense establishment.

Israeli electronic products include radio transmitters for both civilian and military application, radar, control systems, electro-optical equipment, medical electronics, cables and wires, burglar and fire-alarm systems, computers and components.

Recently announced was production of microcircuits on silicon wafers by the engineering depart-

ment of the Technion, Israel's technical university.

A further boost to Israeli industry may come if the European Common Market gives Israel a 45 per cent preferential customs treatment that she is now requesting. Israel feels entitled to this because she is "such a good Common Market customer," a Government official explained.

Among the foreign concerns that have invested in the Israeli electronics industry in the last few years are Motorola, Monsanto, Zenith, American Electronics Laboratories, J. F. D. Electronics, General Telephone & Electronics, and the Vishay Corp.

\$71-million in computers ordered by Government

NASA and the Dept. of Defense have announced plans to spend upward of \$71-million for new computers.

NASA intends to spend \$63-million during the next fiscal year for data-processing equipment. Both large and small-scale machines are included, with the small machines to be used for real-time data acquisition in the testing of systems.

The Defense Dept. is buying over \$8-million in computer equipment from Honeywell. It is to be used in a digital communications system for the Defense Contract Administration.

Computers to sort mail at 210 post offices

Now that the American public has learned to address letters with ZIP codes—75% of the letters that enter U. S. post offices now bear them—the Post Office Department is going to install 210 computers and sorting machines in post offices in 136 cities.

Built by General American Transportation Corp., Niles, Ill., the 210 computers will cost \$11.4-million.

The system will enable a postal operator to sort mail merely by glancing at the zip code on a letter as it flashes by and pressing a ZIP-coded keyboard. The keyboard will feed the information to a computer, which will tell a 15-ton sort-

ing machine which of 277 destination bins the letter goes to. Twelve operators will be able to sort up to 36,000 letters an hour at an estimated savings of \$13.5-million a year in labor.

Study finds Omega flaws, but Navy isn't worried

A number of major design problems need to be solved before the Navy's Omega navigation system is ready for transoceanic use by civil airlines. This is the conclusion reached in a study made for the Federal Aviation Administration by the Radio Science Laboratory of Willow Run Laboratories.

The Willow Run Center, a unit of the University of Michigan's Institute of Science and Technology completed the study last fall, but the findings were released only recently.

Omega is a very-low-frequency navigation system that, with only eight ground stations, is designed to provide position information to Omega receivers anywhere in the world—in aircraft, ships or submarines. Civilian as well as military vehicles can use the system. Omega is a step beyond Loran-C because of its greater range, fewer number of ground stations and ability to be received in submarines.

The Navy, which began development of the worldwide network in 1958, doesn't share the apprehension expressed in the report. It says the design problems are all being solved.

"It's hard, of course, to demonstrate what the complete eight-station system will do, with only four stations in operation," Omega's project manager, Capt. James Burke, told ELECTRONIC DESIGN. "But, all in all, the system is working well."

The last station in the network is scheduled to be completed, at the latest, by early 1973.

A major problem, according to the Willow Run report, is position

ambiguity. The receiver may show an aircraft's exact position in relation to two position lanes—but without making it clear which two lanes in the vast grid system are being displayed.

Other problems include: lack of a fully automatic receiver to perform the complete coordinate transformation and lane-resolution functions, and the possibility of losing tracking capability during periods of precipitation static—noise made by the impact of small particles, particularly ice crystals, upon the surfaces of aircraft.

The Navy says the ambiguity problem has been partly cleared up by a receiver built by Northrup; it uses three frequencies instead of only one.

And the problem of precipitation static, the FAA says, may have been solved by abandoning an E-field antenna for a ferrite loop type developed by the Pickard and Burns Div. of Continental Electronics Manufacturing Co. in Dallas.

Electron beam transfers color video tape to film

Color images from video tape can now be transferred directly to film without going through tedious, expensive procedures, the 3M Co., St. Paul, Minn., announced at the National Association of Broadcasters Convention in Chicago on April 5.

Development of the new system, which 3M calls Chromabeam, means that high-quality video tape can now be mass-produced at low cost.

The technique dispenses with the kinescope, which requires color film; it uses, instead, less expensive slow-speed, fine-grain black-and-white film to produce three color separation negatives. The film, which is commercial grade, is exposed by electron beam.

Color registration is assured inherently because all images are recorded by the same beam on the same film. The film exposed to the beam is processed into a separation master. The final color print on color film is obtained from the master by using color filters and the color separation negatives.

Low-cost tape copying developed in Japan

A new method for duplicating video, as well as audio, tapes at high speed and low cost has been developed by Matsushita Electric Corp. of Kadoma, Japan. The company's two-inch video-tape printer eliminates the usual head-to-head method of tape duplication. It works with either color or black-and-white tape.

A conventional tape and a special master tape, their magnetic surfaces facing each other, are tightly wound together onto a single reel. A transfer electric field is applied to the reel for a few minutes. The tapes are then unwound onto their respective reels.

Matsushita reports this method provides excellent duplicate tapes without harm to the quality of the master tape, even after thousands of applications.

Besides its use as a video tape printer, the new unit can also duplicate audio and computer tapes, as well as the popular 1/4-inch cassette tapes.

2 new minicomputers to be shown at SJCC

At least two manufacturers of minicomputers have developed new models and plan to put them on public display for the first time at the Spring Joint Computer Conference in Atlantic City, N. J., May 5-7.

The two companies are Varian Data Machines, Irvine, Calif., and General Automation, Orange, Calif.

Varian's entry is the 620/f, a high-speed version of the company's line of 620 minicomputers. The 620/f has a cycle time of 750 ns, which qualifies it as one of the fastest minis. A typical speed today is 1000 ns.

The new General Automation model is the SPC-16, the company's first 16-bit-word minicomputer. With a cycle time of 960 ns, it joins the established 8-bit SPC-12.

This activity among minicomputer manufacturers is indicative of the current status of the computer industry. Sales of small machines are good; those of the larger ones are lagging.



Look what Acopian offers...

MIL-Tested DC Power Supplies in 3 Days

Count on Acopian for guaranteed 3-day shipment of MIL-spec DC plug-in power supply modules. In fact, we'll ship *any* of our 82,000 supplies—for MIL-spec or industrial applications—just 3 days after receipt of your order. That's our guarantee—and we've never failed to keep it.

Call in your requirements or order from our catalog. Acopian power supplies are available with single or dual regulated outputs for powering op amps, ICs, logic circuits and electronic measuring equipment; and with unregulated

APPLICABLE MIL SPECS

MIL-STD-810B: High Temperature
▪ Humidity ▪ Salt Fog ▪ Altitude ▪ Vibration ▪ Shock ▪ Fungus

MIL-E-5272C: Low Temperature

MIL-I-6181D: Radio Frequency Interference

Details in our catalog

outputs for lamps and relays. In addition, Acopian offers completely-wired

multi-output power supply systems—write for details.

For a copy of the latest Acopian catalog, write or call Acopian Corp., Easton, Pa. 18042. Telephone (215) 258-5441. And remember, every one of Acopian's 82,000 power supplies is shipped with this tag...



Not many people in the country have heard of Item 807 of the United States Tariff Code. But by summer "Item 807" may be as common in the language as "747 jumbo jet," "Taft-Hartley" or "ABM."

Item 807 is being extolled by major electronics companies as a boon to the industry and the national economy.

Item 807 is being denounced by organized labor as a threat to job security and a drain on the U.S. balance of payments.

The United States Tariff Commission, at the request of President Nixon, will open hearings May 5 at its headquarters in Washington on the merits and drawbacks of Item 807, and the inherent fireworks in these sessions will likely get them national attention. Labor wants the tariff item repealed; industry insists that it be retained. The President has called for recommendations by the Tariff Commission no later than Aug. 31.

An exemption in duty

What is Item 807 of the Tariff Code? And why has it stirred such a fuss?

Simply put, the Tariff Code item provides that when U. S. components are sent to a foreign country and assembled there by any company into a product, the product may be imported into the United States exempt from duty. Duty is paid only on the "value added" by foreign labor.

Both complete products—such as television sets—and parts of complete products—circuits, say—come under Item 807. Anything for which an assembly operation takes place can be imported under the tariff item. The only requirement is that the import contain American goods.

It need not even be 100% American goods in the import. A company abroad may, for example, build a television set or a circuit with 55% foreign goods and 45% American; it receives an 807 tariff break on the 45% of the import that is American-made.

Under Item 807, American electronics companies have sent components to assembly plants abroad, where labor is cheaper. They have

ITEM 807: A boon...OR



John N. Kessler
News Editor

had radios, television sets and other consumer products assembled there and have imported and sold the finished products in this country at considerable savings in labor.

Under Item 807, American semiconductor companies and other makers of electronic parts, have moved a portion of their operations overseas. By using part foreign goods and part American, they have assembled their circuits and other components, imported them into the United States and received an 807 tariff break.

Last year, the Tariff Commission reports, the average television set imported under Item 807 consisted of 60% foreign parts and 40% American. If that trend holds, the importer of such a set valued at \$200 will pay this year a tariff of only \$8.40, as opposed to \$14 for a comparable 100% foreign-made set—a neat saving if the company imports 100,000 units of only the

one finished product. A concern importing several such products and parts under Item 807 could save upward of a million dollars.

Besides such obvious gains for business, what other benefits does 807 yield? Supporters of the tariff item, including the Electronic Industries Association, cite these broad advantages:

- It helps stimulate the export of American components to foreign assembly plants.

- It's good for world trade and enables American companies to compete more successfully with cheaper foreign products.

- It protects American jobs in the long run, by encouraging U.S. companies to buy at least part of their components in this country. If 807 were repealed, the argument runs, U.S. companies might be tempted to buy all of their parts overseas.

But the AFL-CIO sees Item 807 this way:

BUST FOR ELECTRONICS?



- Technological knowledge, production and jobs are being exported overseas, and American labor is being hurt as a result.

- The item encourages the import of foreign goods, and thus is a negative factor in the balance-of-payments ledger.

- It forces the American electronics industry to become increasingly dependent on Government contracts and subsidies to survive in this country, and the Government is engaged in cutting back on this commitment at present.

In 1968—the last year for which complete figures are available—the total value of goods imported into the United States under Item 807 amounted to about \$1.4-billion, according to the Tariff Commission. Of this total, the value of consumer electronics, components, ferrite-core memories and other electrical equipment was \$269-million. This did not include scientific and technical instruments, such as oscilloscopes and voltmeters, which amounted to another \$13-million.

Of the \$268-million in electronics \$109-million represented U.S. components shipped out of the country and assembled overseas. Importers paid duty on the balance—\$159-million, which covered components purchased overseas and the labor costs of assembling the product.

Battle lines are drawn

Industry's view at the May 5 hearings on the controversial tariff item will be spearheaded by the special counsel to the EIA, Alfred R. McCauley of Graubard, Moskowitz & McCauley, Washington, D.C., and by Prof. Robert B. Stobaugh of the Harvard Business School. Nathaniel Goldfinger, director of the research department of the AFL-CIO, will probably lead the presentation of labor's position.

McCauley denies that U. S. workers are losing jobs heavily as a result of Item 807.

"Employment," he told ELEC-

TRONIC DESIGN, "is up each year in the electronics industry." And he cites EIA figures, based on U. S. Dept. of Labor statistics, as follows.

Year	Workers in Electronics
1966	1,080,000
1967	1,084,000
1968	1,110,000
1969 (Sept.)	1,147,000

Moreover there is no great rush by American companies to use cheap labor in underdeveloped countries, McCauley says. He states that of the \$1.4-billion in total goods shipped into the U. S. under Item 807 in 1968, \$1.1-billion came from labor in developed areas, such as Canada and Europe.

The consequences of repealing 807 "would be bad for the United States, bad for foreign trade, bad even for U.S. labor," McCauley contends.

Goldfinger has a different view of the statistics. In a statement on U. S. trade policy before the Joint Economic Committee of the AFL-CIO, Goldfinger said on March 18:

"Offset by defense contracts, over-all U. S. employment in the [electronics] industry thus far has tended to show improvement, but in consumer electronic products, TV sets, radios, etc., the trend has been to substitute foreign production for U.S. production at the expense of U. S. jobs."

Goldfinger asserts that thousands of workers in electronics are confronted by "import-related job losses and production cutbacks as defense contracts decline."

McCauley says, however, that if 807 is repealed, U. S. companies would purchase even more of their parts from foreign sources because there would no longer be any tariff incentive to use American components. "The purchase of components, from overseas companies," he adds, "would displace American labor who now make such components."

ELECTRONIC DESIGN has obtained a list showing 31 foreign electronic companies doing business on Taiwan as of June, 1968. Nearly all of the firms are American, and the total employment for 22 of these concerns comes to 12,014; there are no figures for the nine other companies.

According to the April 10, 1969

NEWS

Item 807, (continued)

issue of *IUE News*, a publication of the International Union of Electrical, Radio and Machine Workers:

"A study of wage rates showed that 70% of the Taiwanese electrical workers make less than 10 cents per hour. Including fringe benefits, the average wage paid by and American employer was found to be 11 to 15 cents. The minimum work week is 48 hours."

Another list dated 1968 shows there are about 35 U. S. electronic plants in Mexico, employing 2,717 workers at about \$2.50 a day.

Abe Morgenstern, research director for the IUE, has told this magazine that he is less concerned about present shipments of goods under 807 than about future trends.

Electronics exports from Taiwan, he says, will shoot from \$60-million in 1968 to \$500-million in 1972. About 650,000 black and white TV sets were exported from Taiwan to the U. S. in 1969—an increase of 80% over the year before, according to Morgenstern.

"General Instrument," he says "is making 75,000 tuners a week in Taiwan, but they just closed their plants in the U.S. and laid off 3000 to 4000 workers." And, he says, "the same is true with Zenith, Admiral and others."

In the January 17, 1969 issue of *IUE News*, the union states: "The

effect of imports on IUE's members was pointed up dramatically when Westinghouse laid off 600 employees at its Metuchen, N.J., plant just three weeks before Christmas. The company said it was curtailing production of television sets and stereo phonographs in favor of importing them from abroad—probably Japan."

Despite the fact that employment in the electronics industry has been increasing, Morgenstern argues, the increases have been in defense-related areas. "What the electronics industry is doing now," he says, "is shipping non-defense production overseas."

Employment in components, TV and radio has gone down by 45,000 jobs in the last three years, according to Morgenstern.

Nonetheless, when *ELECTRONIC DESIGN* checked with National Semiconductor in San Ysidro, Calif., that company stated that its employment in the U. S. had increased significantly over the last three years. But it would not cite specific figures.

The importers' views

To get the importers' views on the consequences of repeal of 807, *ELECTRONIC DESIGN* queried General Electric, National Semiconductor, RCA, Zenith, Radio Corp., Fairchild Camera and Instrument, Control Data, Admiral, and Texas Instruments.



The total value of goods imported into the United States in 1968 under Item 807 amounted to about \$1.4 billion, according to the Tariff Commission. Of this total, the value of consumer electronics, components, ferrite-core memories and other electrical equipment was \$269-million.

Big companies affected

Major electronics companies doing business under Tariff Item 807, according to the Electronic Industries Association, include the following:

Bendix Corp.
Control Data Corp.
Motorola, Inc.
Fairchild Camera & Instrument Corp.
Texas Instruments, Inc.
Arvin Industries, Inc.
Corning Glass Works, Signetics Corp.
CTS Corp.
General Electric
General Instrument Corp.
RCA
The Magnavox Co.
North American Rockwell Corp.
Philco-Ford Corp.
Sylvania Corp., Semiconductor Div.
TRW, Inc.

A spokesman for Admiral said his company was no longer concerned because it had transferred all production and assembly of items formerly imported under 807 to overseas operations. Texas Instruments released a statement that said:

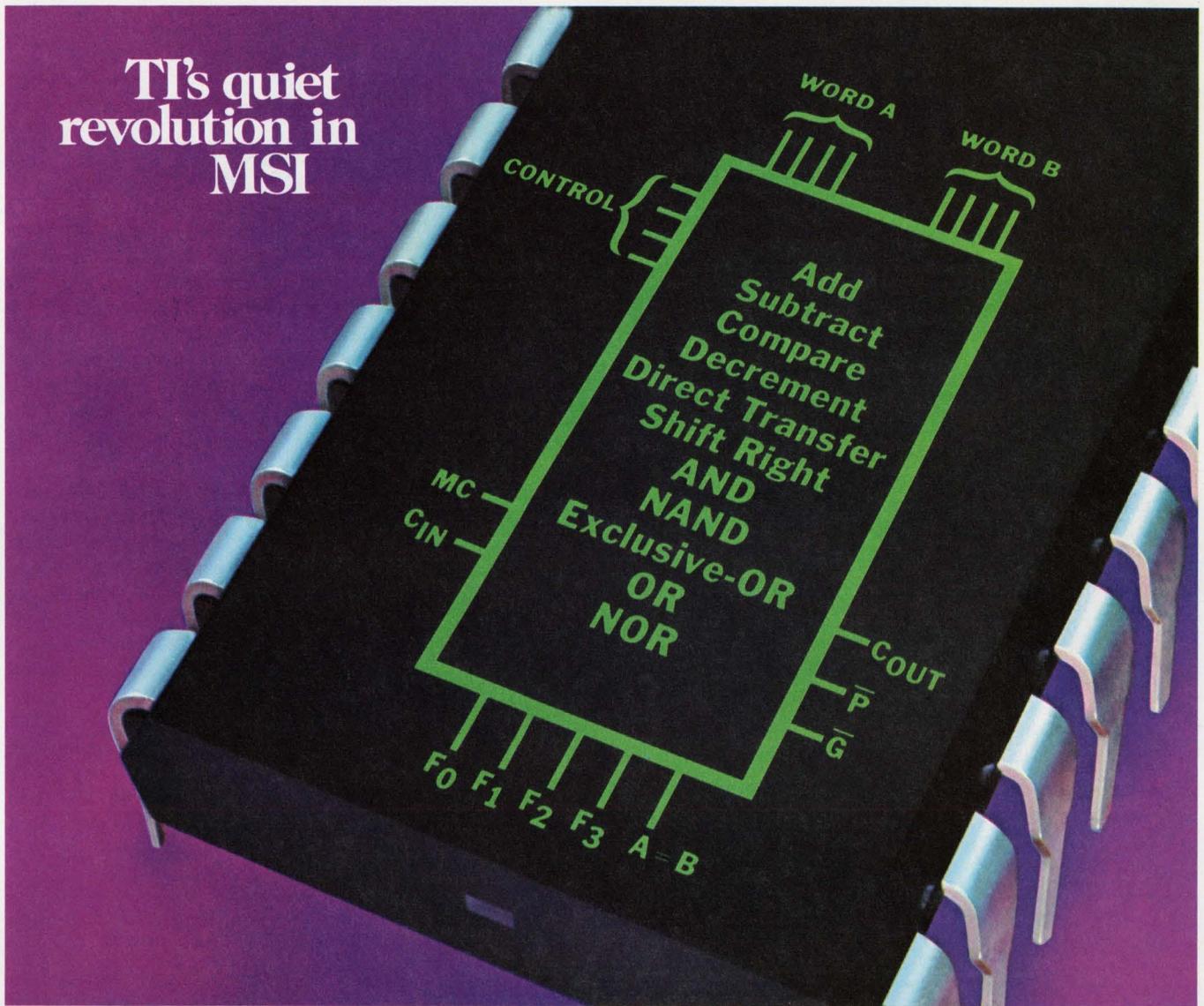
"Repeal of Item 807 would bring about the anomaly of placing duty on American-made goods, and since the same duty rate would be applied to cheaper foreign-made goods, the end result would be to encourage greater use of foreign-made piece parts and components in goods manufactured overseas and destined for U. S. markets."

There were no "on the record" comments from the other companies.

While national trade policy may seem remote from the hearings on 807, the final decision on this issue will affect the economic structure of hundreds of electronic firms, and nearly all of the big ones.

The marketing manager for a large semiconductor manufacturer, who asked not to be named, told *ELECTRONIC DESIGN* that the "imposition of additional duty is *not* the principle at stake here; we think it is healthy to take advantage of the world as a whole in making decisions as to how to manufacture and sell, since we are in world competition." ■■

TI's quiet
revolution in
MSI



CPU in a 24-pin package:

TI's new SN54/74181 arithmetic logic unit.

Equivalent to 75 TTL gates, TI's new MSI arithmetic logic unit is the closest thing yet to a 4-bit CPU in a package.

The SN54/74181 performs 16 arithmetic binary manipulations on two 4-bit words—including add, subtract, compare, decrement, direct transfer and shift right. It will also perform all possible 16 logic functions of two Boolean variables—including AND, NAND, exclusive-OR, OR and NOR. It's the most complex arithmetic integrated circuit available today.

As for speed, four SN54/74181s can be teamed with one new SN54/74182 carry look-ahead generator to add/subtract two 16-bit words in 36 ns typ.

All of which means that with TI's Series 54/74 MSI, the arithmetic section of your processor has more built-in versatility and flexibility for higher level performance. Economically.

In 100-999 quantities, the dual-inline plastic SN74181 is \$16.50; the SN74182, \$3.63.

Of course, digital processors can be

built with small-scale integrated devices. But as many as 25 may be necessary to duplicate all the performance of just one SN54/74181.

To get your CPU under way this new way, you should have the 184-page supplement to our TTL catalog. Circle 249 on the Reader Service Card or write Texas Instruments Incorporated, P.O. Box 5012, M.S. 308, Dallas, Texas 75222. Or your authorized TI Distributor has copies.



TEXAS INSTRUMENTS
INCORPORATED

It's time to consider CW chemical lasers

High-efficiency, compact, inexpensive units are still under development, but no longer mere curiosities

David N. Kaye
West Coast Editor

Cw (continuous-wave) chemical lasers have progressed to a point where they are no longer merely laboratory curiosities but can be thought of in terms of future applications. These applications will fall in any area that requires a compact, efficient, inexpensive, high-power laser.

Some of the applications may include power transmission and long-distance communications in space; military field uses where a convenient source of electrical power is not available; industrial applications where small size is important—and potentially as a trigger for nuclear fusion.

On May 9, 1969, the first cw chemical laser was developed at Aerospace Corp. in El Segundo,

Calif., by a team that included Dr. Theodore A. Jacobs, head of the Aerophysics Dept., Dr. Harold Mirels, head of the Aerodynamics and Heat Transfer Dept. and Dr. Donald L. Spencer, manager of the Heat Transfer Section.

According to Dr. Jacobs, powers in excess of 630 W have now been obtained. When the cw laser first operated, the team got less than 1 W from it. Radiation is in the 2.6 to 2.9-micron region.

One of the major features of this type of laser is its high efficiency. Dr. Jacobs points out, "The efficiency of conversion of chemical energy to laser energy is 12% at the present time." Most other types of lasers have efficiencies on the order of 2% or less.

"Arc-heated nitrogen is used," says Dr. Jacobs, "to partly or com-

pletely dissociate sulfur fluoride (SF_6) in order to create fluorine (F) atoms (see diagram). The gas is expanded and forced through a nozzle to form a supersonic jet of F atoms. Hydrogen is diffused into the jet. The reaction creates vibrationally excited hydrogen fluoride (HF^*) which is made to lase in an optical cavity."

Vibrationally excited hydrogen fluoride has both a vibrational and a rotational state. In the optical cavity, HF^* reacts with a photon—arising spontaneously from the noise in the cavity—and changes its state. The vibrational level decreases by one, and the rotational level increases by one. This change in state gives off energy in the form of laser light. Each time the HF^* changes state, a different frequency of light is given off. The most significant wavelengths noted so far have been 2.640, 2.707, 2.795, and 2.871 microns.

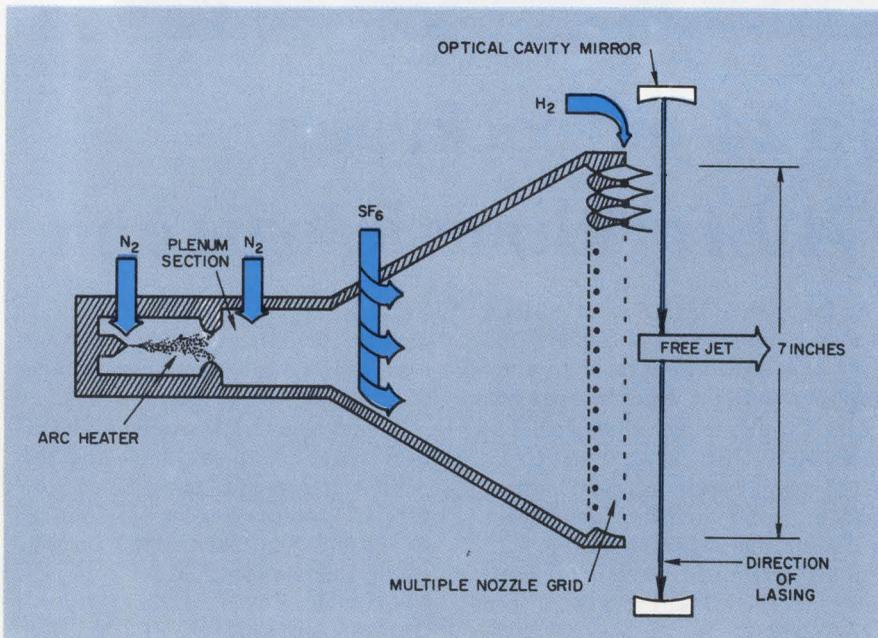
Small cavity, high power

Two 2-inch diameter gold-coated beryllium-copper mirrors located approximately 40 inches apart make up the laser cavity. Various mirror radii in the range of 85 inches or more are used. The supersonic jet of HF^* , however, flows only through 7 inches of the cavity. In order to get an equivalent amount of power out of a CO_2 laser, the cavity would have to be more than 10 feet long.

Limitations on the efficiency of the laser come primarily in two areas. The major loss is due to the fact that heat, as well as light, is given off when HF^* changes state. Second, is the loss due to the cavity itself.

The arc heater is not included in the efficiency calculations. Other more efficient means will be used in the future, such as combustion and regenerative heating.

Development of the laser is supported under a contract from the Air Force Space and Missiles Systems Organization. ■■



Cw chemical lasing can be achieved through the above scheme. Sulfur fluoride is injected into hot nitrogen, causing the fluorine to separate out. Hydrogen is mixed with the fluorine atoms to create vibrationally excited hydrogen fluoride. The hydrogen fluoride passes through an optical cavity at supersonic speed and changes state, causing lasing in the cavity. Light is given off at 2.6 to 2.9 microns.



**That bread 'n' butter
JAN 1N3611
you've been using all along
suddenly
isn't so bread 'n' butter!**

**now available ...
TX 1N3611
100% process screened
by Unitrode**

**the one and only voidless
monolithic fused-in-glass
controlled avalanche
JAN TX 1N3611 Series
2 amp rectifiers.**

competitively priced

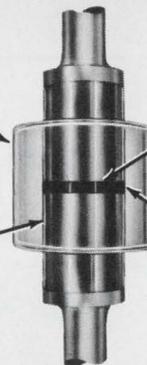
Unitrode also provides TX 100% process screening on JAN 1N4942 Series Fast-Recovery Rectifiers. Also available in stock for off the shelf delivery, JAN 1N4245 Rectifiers, and JAN 1N4956 Zener diodes.

Contact the factory, or your local Unitrode representative.

WHAT'S INSIDE MAKES THE DIFFERENCE . . . THIS IS WHAT'S INSIDE EVERY UNITRODE DIODE

Hard glass fused to all silicon and pin surfaces creates a voidless monolithic structure. Perfect seal against all moisture and contaminants.

Temperature coefficient of glass and pins is matched to silicon. No degradation under severe thermal stress of high transients or repeated temperature shock — even from -195°C to $+300^{\circ}\text{C}$.



Metallurgical bonds of pins to die faces at 1000°C allows extremely high surge capability, low thermal resistance. Virtually indestructible construction.

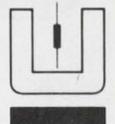
Controlled avalanche and permanently stable surface leakage characteristics. Hyperclean silicon surface fused only in hard glass. No oxides, silicones, or varnish are used.



Send for our Short-form Catalog C-146 and samples of the 1N3611. The catalog is just loaded with charts, graphs, curves, specs, and all kinds of goodies you'll enjoy.

For fast action, call Dave Greene COLLECT (617) 926-0404.

UNITRODE



580 Pleasant St., Watertown, Mass. 02172 • (617) 926-0404

INFORMATION RETRIEVAL NUMBER 17

A hospital data system designed by an MD

Physician-engineer offers electronic prescription for medical men suffering from computer phobia

Elizabeth de Atley
West Coast Editor

How would you design a medical information system that a doctor would be willing to use? Most doctors hate to type and don't want to learn even a simple program language like BASIC. They are perfectly satisfied with present methods of recording medical information on hospital patients.

Most doctors just scrawl their prescriptions in the patient's record book and give it to a nurse to decipher. From these scrawls, she must prepare lists of special diets for three meals a day, lists of medications to be given at different hours, requisitions for the

pharmacy and laboratory, medical reports, etc. A computer might do the job more efficiently. But would a doctor use it?

Should such user idiosyncracies affect the choice of computer memory? Is hard copy necessary, and if so, how much?

Dr. William Chapman of the Palo Alto (Calif.) Medical Clinic who is both an internist and an electronics engineer has been asking himself questions like these for years. He has worked as a consultant for Lockheed Missiles & Space Co., Sunnyvale, Calif., on a regional time-shared medical information system that is not yet operational, and last June he formed his own company, Spectra

Medical Systems, Inc., to assemble the hardware and design the software for an information system of his own. ELECTRONIC DESIGN asked him four questions:

1. What is the need for such a system?
2. Why haven't such systems been built before?
3. What criteria did you follow in selecting the hardware?
4. In what areas do you think technological advances are necessary to optimize future systems?

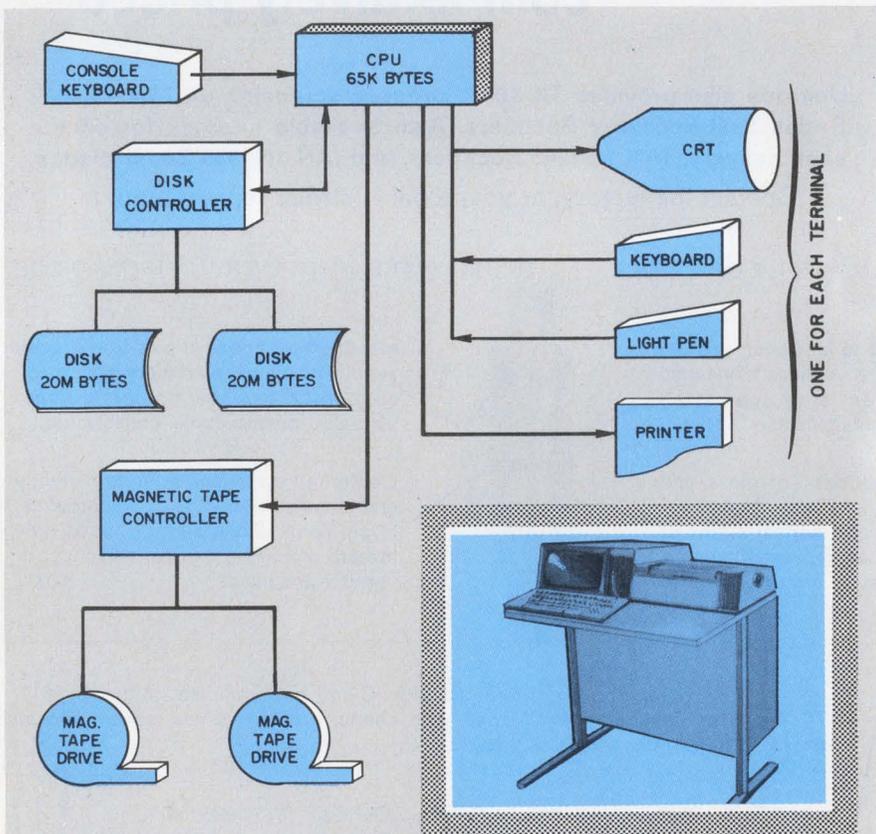
His answers are summarized here.

1. Who needs one?

The need for such a medical computer information system, says Dr. Chapman, is urgent. In fact, he says, 25% of the total operating budget of the average hospital goes to pay for the handling and sorting of medical information by nurses. Most of this work, he points out, could be done by a computer system that would cost only 3% of the total operating budget. Furthermore, with a shortage of nurses, the need becomes critical. Some hospitals have had to close down entire wings, he says, because they couldn't afford to hire nurses to staff them.

2. Why no system before?

People have been talking about medical information systems for at least 10 years, Dr. Chapman says, and a number of companies have worked on them, but it wasn't until last January that a system—manufactured by National Data Communications Inc., Dallas, Tex.—was finally completed and put on the market. Why were none of the earlier systems successful? Partly because of a lack of communication between hospital personnel and systems analysts, Dr. Chapman says, and partly because of the



Basic requirements for the Spectra Medical System are shown in the block diagram. The magnetic tape will duplicate information on the disc file and will also be used to store records of patients who have left the hospital. An artist's conception is shown above.

A person wearing a blue jacket is shown from the chest up, working on a Honeywell H112 minicomputer. They are holding a small, rectangular module and inserting it into a larger, rack-mounted unit. The background is a soft-focus, bokeh-style image of light-colored, rounded shapes, possibly flowers or leaves, in shades of yellow and blue. The overall lighting is warm and focused on the person and the computer.

Spend seven fun-filled days with your very own minicomputer.

Just call the nearest Honeywell office listed below.

Tell a sales representative you'd like to borrow an H112 Minicomputer. Within a few days you'll have the basic under-\$5K 12-bit H112: 4K core memory, control logic, power supply, and drawer.

For the next seven days, the H112 will be yours almost free – just for a \$50 handling charge.

Run through a few demonstration programs. Study the modular design that makes it easy to add another 4K of our memory, μ -PAC logic modules, A/D converters, or digital subsystems. It's that flexible. Pick out the options you need.

Plug them in. No repackaging. No need to engineer your own interfaces.

In a week you'll have learned a lot about the H112 Controller/Computer. Its fast execution times. Effective memory utilization. Advantages of a data word with greater width.

Call now. Or write for our new H112 technical bulletin. Honeywell, Computer Control Division, Framingham, Mass. 01701.

Northeast (212) 275-6200 ■ New England (617) 237-2630 ■ South (713) 785-3200 ■ Midwest (312) 671-1800 ■ West (213) 278-1910.

The Other Computer Company:
Honeywell

(MD designer, *continued*)

wrong choice of computer. Most of the systems used a large computer like the 360/40, because at the time nothing else was available. Unfortunately, Dr. Chapman notes, such large computers are complex and difficult to program. Furthermore their biggest asset, their large core memory, is not needed in a medical information system. A small "midi" or minicomputer, combined with fast-access disc storage, can do the job more efficiently, Dr. Chapman contends. To support this view, he points out that the National Data Communications System, which beat all the others to the marketplace, uses a Honeywell 516 computer. Called REACH, the system sells for about \$8 per hospital bed per day. Although REACH is basically an excellent system, Dr. Chapman says, he believes his company will produce a better one at half the price.

3. What are hardware criteria?

For the doctor who hates to type, ease of data entry is the most important criterion. It almost has to be, Dr. Chapman says, in the form of displays on a CRT screen—displays that query the doctor and allow him to respond by pointing.

The system being designed by Spectra, Dr. Chapman reports, will work as follows:

"The doctor sits down at the terminal, identifies himself by typing in a code designation, and a list of his patients appears on the screen. He selects one with the light pen, and the display then changes to an index of possible orders, followed by the question, 'What order do you want to write?'

"The doctor points to the order he wants—let's say it's a medicine order. The question, 'What letter does it start with?' then appears, followed by an alphabet. If he points to the letter A, the display then says, 'Here are all the drugs that start with A,' and it lists them, together with the recommended dosage. He points to one, or types it in if it is not listed.



William Chapman, MD, company president and an engineer.

"Each time the display changes, the first two lines indicate what went before, so that if the doctor is interrupted, he can quickly see where he left off. When he has completed all the orders, he pushes the 'review' button and the orders are listed on the screen. He can change something by pointing to it, pushing an 'erase' key and typing in the correction. When he is satisfied, he pushes the 'enter' button and puts it into the computer, which then prepares the reports the nurses need to take care of their patients and distributes requisitions throughout the hospital."

Fast-access disc essential

The key to this system, Dr. Chapman says, is large-storage capability and fast access to it. "You've got to be able to change the display at each terminal at least once a second," he says. "Otherwise, the procedure will be too slow. That means that if you've got 30 terminals in the hospital, you've got to have a disc-access time of no more than 30 ms."

On the other hand, Dr. Chapman points out, a powerful central-processing unit is not required just to sequence and format the displays and sort the data. The programs controlling these operations are short compared with those that control a mathematical problem, such as a matrix inversion. Therefore the core can be small.

The computer chosen for the Spectra Medical System is an EMR "midi" computer, with 65K bytes of core, and a Burroughs

fixed-head disc file containing 40 million bytes. The computer and disc together cost about \$250,000, Dr. Chapman says, compared with about \$1-million for a 360/40 and a standard IBM disc system. Storage can be added to the disc in the Spectra system in increments of 10 million bytes without having to reprogram the computer. The access time to the disc—that is, the length of time it takes to locate the area of the disc where the data for a particular display is stored—is 20 ms.

Dr. Chapman points out that a small computer with very high-speed access time to a supplementary disc is much easier to program than a large computer with a big core, but slower, disc access.

"If we had chosen a 360/40 computer," the physician-engineer says, "we would have to do more things in parallel, because the disc-access time of a standard IBM disc system is only one-fourth as fast. We wouldn't have had time to complete each disc access before starting another operation. That makes for more complicated programming, and therefore a much longer down time if the system breaks down."

Dr. Chapman estimates that if the Spectra system breaks down, it will be possible to repair it in two hours or less. He feels that this will not seriously disrupt the operations of a hospital, since the system will produce hard copy of all information. During the down time, doctors and nurses can refer to this hard copy and keep interim records on paper, which they will enter into the computer when the system is functioning again.

Data entry by light pen

The system will use Computer Communication, Inc., terminals with CRT, light pen and keyboard. The light pen will be modified, so that when the doctor points at a spot on the screen that spot lights up, telling him where the system thinks he is pointing. This illuminated area will follow the pen as the doctor moves it about the screen, giving him instant feedback as to where he is pointing. This will be accomplished, according to Dr. Edward E. Heller, also a physician

**SPUTTERING
TARGETS**

**GLAZED
PARTS**

Get higher yields across the board

**THICK
FILM
PASTES**

O-I microelectronic materials make the difference.

Higher yields. That's where the little things mean a lot.

Like with package sealants. If you could get 5 more good seals on every 100 packages you make, think of the money you'd save.

Like with thick film conductor pastes. Good paste can make a circuit. Bad paste can break it. Forever.

Like with substrate glazes, insulating films, glazed package parts, preform materials and sputtering targets.

We make them all. And more. They're all compatible, highly sophisticated products from the O-I family of work-together electronic materials.

To you, they mean higher yields. Across the board. We'd like to prove it to you. Write us a letter about your materials needs. We'll get back to you fast with literature. Samples, too, if you'd like.

You'll see. Our materials *do* make the difference.

OWENS-ILLINOIS
ELECTRONIC MATERIALS
Toledo, Ohio 43601

**PACKAGE
SEALANTS**

**INSULATING
FILMS**

**PREFORM
MATERIALS**



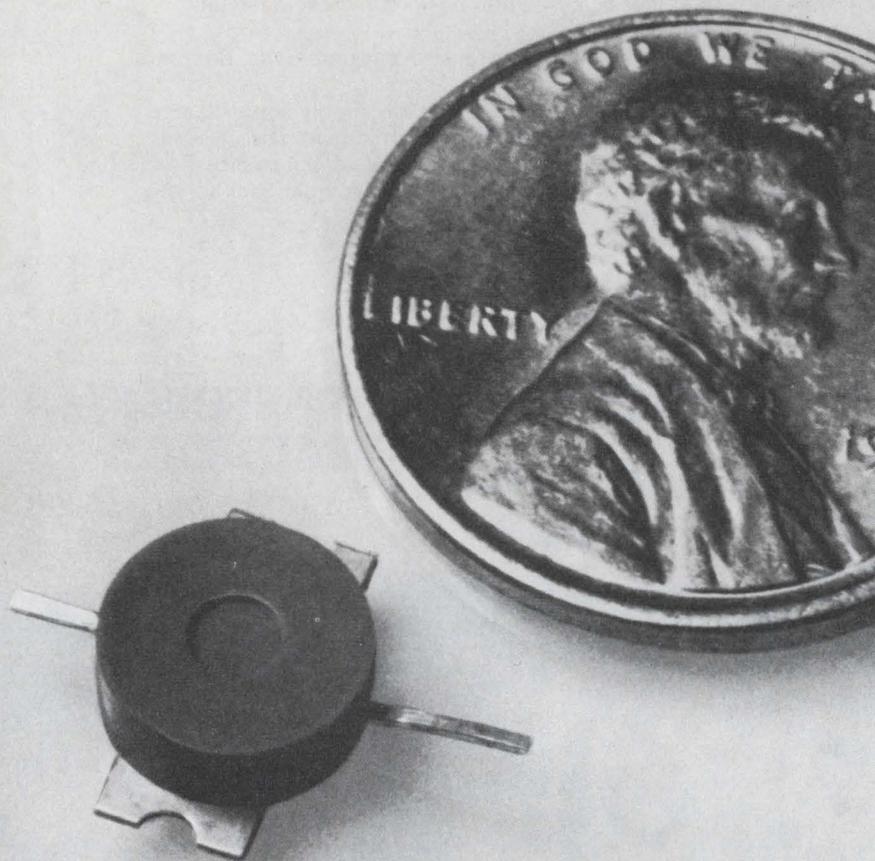
OWENS-ILLINOIS, INC.
Customer Service Mgr.
Electronic Materials
Dept. E-4
Box 1035
Toledo, Ohio 43601

Please send me literature on:

- Package Sealants
- Substrate Glazes
- Sputtering Targets
- Have a technical representative call.
- Glazed Package Parts
- Thick Film Pastes
- Preform Materials

Name _____
 Title _____
 Company _____
 Address _____
 City _____ State _____ Zip _____

Our B 5000 series. It's cheaper than a chip.



If you're into hybrids or miniaturized circuits, standard power transistors are too large.

Yet chips are too delicate and require assembly and handling procedures that cost you time and money.

Enter Solitron's mesa-construction silicon NPN B 5000 series.

The smallest power transistor available for hybrid use this side of a transistor chip, yet unlike a chip—it's rugged and reliable.

In the end, it's less expensive.



256 OAK TREE ROAD, TAPPAN, NEW YORK
PHONE (914) 359-5050/ TWX: 710-576-2654/ TELEX: 13-7346

NEWS

(MD designer, *continued*)

and vice president of Spectra, by electronics in the light pen that will sense the instantaneous presence of the electron beam and compute the location of the spot from the time it takes the beam to travel in a raster scan from position zero to that spot. When the doctor is satisfied that he is pointing where he wants to point, he pushes a button and enters the information into the computer.

In other light-pen systems, Dr. Heller says, the user must push two buttons—one to light the screen and show him where he is aiming, and another to enter the information into the computer. However, Dr. Heller feels this is a needlessly tedious operation for the doctor.

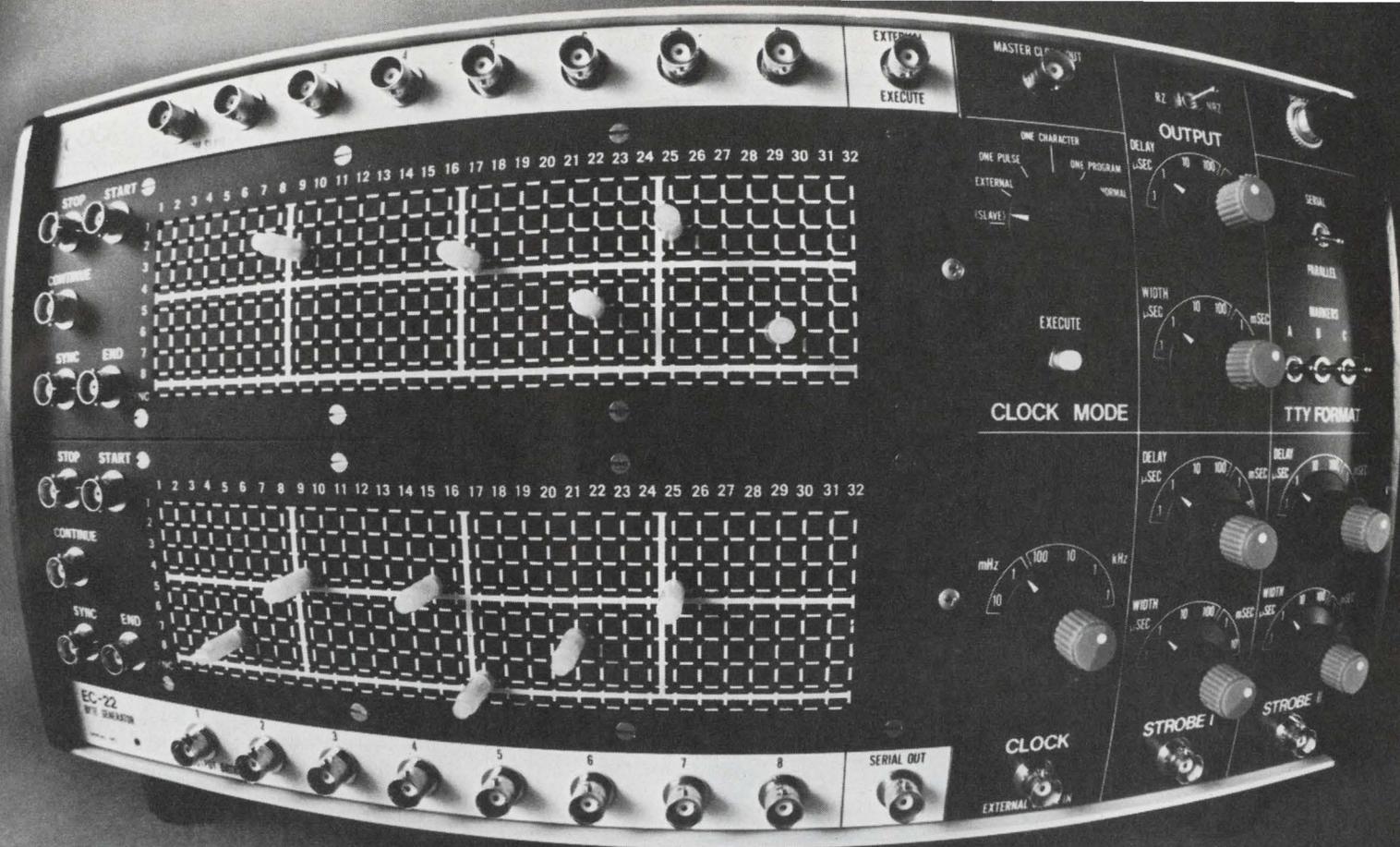
4. What advances are needed?

As for technological advances that Dr. Chapman would like to see in hardware for this application, he points to these areas:

- Better mass storage—that is, lower price, faster access and greater size.

- Cheaper interface electronics between the computer and the TV terminal. "Between the computer and the TV screen at each terminal," says Dr. Chapman, "there is about \$10,000 worth of equipment—controllers, multiplexers, etc. There may be anywhere from 20 to 35 terminals in the system. So if the interface cost could come down, it would make a big difference in the system cost."

Dr. Heller points out that as mass storage gets better and cheaper, the terminals will have to improve to take advantage of it. He visualizes a portable system in an attaché case, complete with some kind of flat TV screen and a light pen for entry. This would eliminate the need for a printer at every terminal, since the doctor could carry the terminal about with him and call up the patient's records from the central computer whenever he needed them. ■■



The \$2500 Necessity.

If you use an oscilloscope at your lab or production facility, then you need our EC-22 Byte Generator™. This compact, versatile electronic marvel is designed for simulation and testing of all digital equipment.

It features 32 or 64 eight-bit bytes; serial or parallel output; variable program length; automatic ASCII code formatting; expandable pattern in length and width by stacking units; and up to 8MHz bit or byte rate.

The EC-22 is perfect for — Testing of peripherals, data terminals, CRT displays, IC's, LSI's, and PC's — Simulation of computer output, Telemetry, and Teletype — Generation of analog functions.

Considering what the EC-22 does for only \$2,500, it's a steal. Get in touch with us today, and we'll tell you how the EC-22 can help make your job a whole lot easier. It's nice to be needed. Call Bill Noren, collect.

Adar Associates, Inc., 85 Bolton St., Cambridge, Mass. 02140. (617) 492-7110.

Computer terminal uses photochromic CRT

The latest entry into the growing computer graphics display field is a time-sharing terminal that contains a new cathode-ray tube using photochromic glass as the storage and display medium. Called the 904, the device is made by Corning Data Systems, Raleigh, N.C.

Photochromic glasses, developed by the company, darken when exposed to ultraviolet light and erase (regain transparency) when exposed to red light.

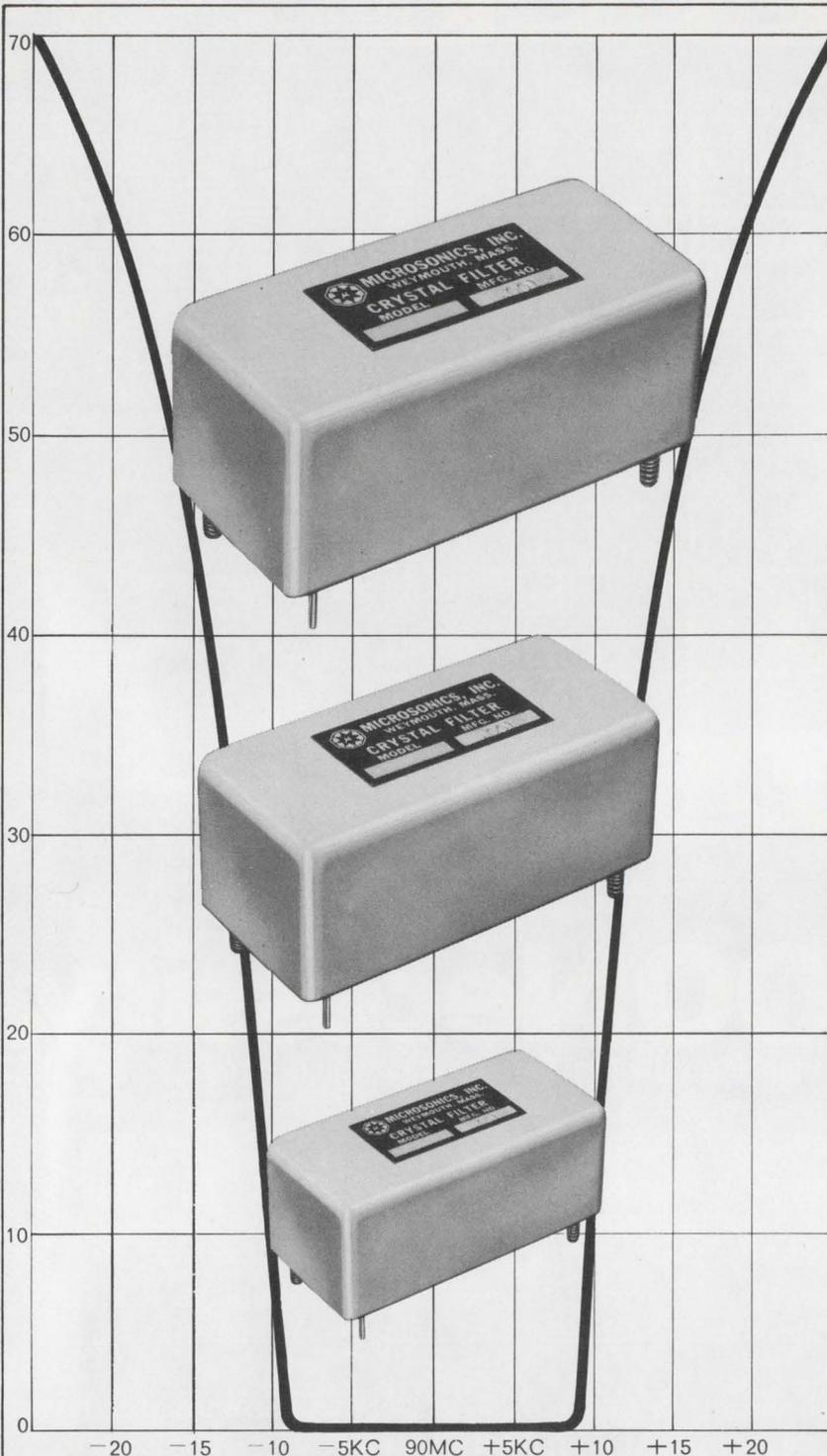
The electron beam in the CRT is converted into ultraviolet light. This activates pinpoint areas of the tube's photochromic faceplate, fixing an image that is retained until it is erased by the operator. The image retention of the photochromic glass enables image storage without need for the associated refresh electronics and circuitry of conventional CRTs.

The image on the photochromic faceplate is then projected through a lens system onto the display screen.

The 904 interactive graphic computer terminal, which was recently unveiled in New York, com-



Interactive display terminal from Corning contains a photochromic CRT. A superimposed slide is shown on the screen.



MICROSONICS
for proven design, reliability &
performance in
CRYSTAL FILTERS



Write for Bulletins today

MICROSONICS

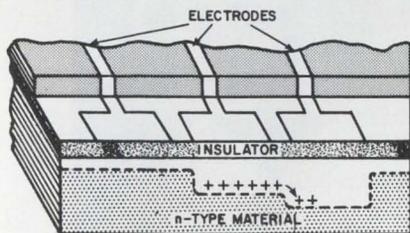
60 Winter Street, Weymouth, Mass. 02188
Tel: 617 337-4200

A division of the Sangamo Electric Company

bines graphic and alphanumeric display, and contains a built-in electrostatic hard-copy device and a system for superimposing slide data over computer-generated information.

The display screen has a capacity of 4608 alphanumeric characters arranged in 64 lines of 72 characters each. ■■

New devices developed at Bell Labs



Scientists at Bell Telephone Laboratories have developed a new class of semiconductor devices that, they say, could perform many of the functions of more complex integrated circuits at lower cost.

Called Charge Coupled Devices (CCDs), the circuit is a three-layer structure (see diagram) consisting of a metal conductor, a layer of silicon dioxide and a base of homogeneous silicon semiconductor.

As described, the CCD creates and stores minority carriers, in a spatially defined depletion region—called a potential well—at the surface of the semiconductor. In this case, minority carriers are holes at the semiconductor-insulator interface of an n-type semiconductor.

This charge, or minority carrier, is then moved about the surface of the semiconductor by moving the potential well. It is detected and measured at some location.

Bell Laboratories' scientists produce and move the potential wells with voltages applied to an array of electrodes formed on the insulator-semiconductor layers.

The CCDs are expected to find application as shift registers and imaging devices. ■■

Now choose either

PLASTIC

or

GLASS

FIBER OPTICS

from

WELCH ALLYN

For minimum cost (as in disposable products) or for maximum bundle flexibility, check the advantages of fiber optics assemblies or systems made with Welch Allyn's newly developed *plastic* fibers.

For high precision work, where infra-red light transmission is important, or where fiber optics are exposed to high heat, our *glass* fibers are normally still preferable.

COORDINATED FIBER OPTICS/LAMP SYSTEMS

Glass or plastic, your fiber optics system will have maximum optical performance with custom-built, precision Welch Allyn miniature lamps.

Ask us about your glass or plastic fiber optics assemblies or lamp/fiber optics systems.



Welch Allyn, Inc., Skaneateles Falls, N. Y. 13153 Tel (315) 685-5788

INFORMATION RETRIEVAL NUMBER 23

The more complicated it seems...



The simpler it gets... **CONCENTRATE!**

FROM 4 TO 85 MAGAZINES In May, 1953, only four magazines appeared with basic listings in SRDS's newly created section 40—"Electronic Engineering." They were *Electronic Design*, *Electronic Equipment*, *Electronics*, and *Tele Tech*. Now media buyers are confronted with 85 publications under this heading. Confusing? To say the least. Of course, the 13,706 advertising pages placed in the electronic press last year were mostly divided among the top publications. But even so, making the correct media choice has become a difficult problem.

THE SHAKEOUT TO COME Today there simply aren't enough advertising pages to go around. In the last 3 years, only three magazines increased their total pages (one of the gainers is *Electronic Design*). The other five lost ground, some drastically. One or two may fall by the wayside this year. There is nothing unusual about such a shakeout. It has occurred in other industries. *There is great duplication of effort among the publications* which tends to complicate rather than simplify the advertiser's problem.

CONCENTRATE—BUT WHERE? To reach most engineering prospects most efficiently, advertising should be *concentrated* in the strongest publications. The fewer publications you use, the more impact you will get in those publications. But how do you decide *which* publications to concentrate in?

WHAT IS REALLY NEEDED is a "Simmons" type study in the electronics field—not to determine a simple winner, but to illuminate real differences and strengths. *Electronic Design* has long urged that such a study be undertaken. In the meantime, there is something you can do to make your buying a more enlightened process. *You can make your own readership studies work harder!* They can tell you what combination of magazines to use for optimum efficiency in reaching your market.

BEGIN WITH YOUR READERSHIP STUDIES Circulation doesn't buy—*readers* buy. For this reason, many electronics manufacturers have conducted their own studies of magazine readership over their own customer and prospect lists. Although it is good to find out which publications are best read—it is even better to go one step farther and explore *duplication* of readership. A list of publications ranked by "Read Most"—while valuable for selecting a first book—can be misleading in choosing the second or third book for your schedule.

WHAT DUPLICATION STUDIES REVEAL When you conduct your own readership study, it will tell you which publication gives you the most reach in your market. This is your *basic* book. (In over 90% of all such independent studies this publication is *Electronic Design*.) *It may be that Electronic Design, alone, provides the best means of reaching most prospects at optimum cost.* However, if budget permits, the next step is to extend market coverage as efficiently as possible. Let us assume *Electronic Design* gives you 68% of the market. The next best read book gives 48%. However, if duplication is analyzed, the publication to add is not the runner-up in readership, *it is the publication that adds the most unduplicated readers.* It might be the second or it might be the seventh in terms of "read most"—*only your duplication studies will tell you for sure.*

Electronic Design 5
FOR ENGINEERS AND ENGINEERING MANAGERS
VOL. 18 NO. 5
MARCH 1, 1970

New twist in plated-wire memories now makes it possible to alter stored information with electronic signals. Read cycle times are 125 ns, and access times can be as fast as 70 ns. Capacities range from 20,000 to 164,000 bits, at costs between 5 and 10 cents per bit. Writing speed is approximately 1 us. See p. XXX.

ELECTRONIC DESIGN WILL HELP In addition to sharing the cost of your readership study, *Electronic Design* now makes it easy for you to analyze duplication! On request, we will send you a set of cards with complete instructions for your computer service. The program takes no more than a minute of computer time; you can tabulate your studies faster, more accurately, and with much more information resulting. *You can untangle the media puzzle!* In the OEM, marketing *begins* with *Design*.

Electronic Design

For Engineers and Engineering Managers

A HAYDEN PUBLICATION

850 THIRD AVENUE, NEW YORK 10022 • 212-751-5530



The \$1200 **Bad-Apple** Finder....

..... GR's New 1662 Resistance Limit Bridge!

You can't plug an apple into the new GR 1662 (it's only a one-terminal device), but if you have barrels of resistors to sort, the 1662 will find the out-of-tolerance components for you — quickly, easily, and inexpensively! It's the ideal instrument for selecting and qualifying resistors by percent deviation either manually or in an automatic system.

To handle all the resistance test requirements you're likely to face, the 1662 has percent-deviation ranges of ± 0.3 , ± 1.0 , ± 3.0 , ± 10 , and $\pm 30\%$. Test results are indicated by meter reading, dc-voltage levels, and HIGH-GO-LOW lights. The high limit and low limit can be adjusted independently (by front-panel controls or external dc voltage) to any value within the full-scale meter range.

Use the 1662 for manual sorting and get precise meter readings in one second or use the HIGH-GO-LOW lights for faster sorting limited only by the speed of the operator. Use

automatic sorting equipment like the GR 1782 Analog Limit Comparator (from \$550) to get maximum test rates of four components per second. The 1782 allows simultaneous multiple-tolerance-limit sorting. (Apples can be tested only with a core-memory device.)

For straight resistance measurements, 1662 has a basic bridge accuracy of 0.02%, a comparison accuracy of 100 ppm, and a total range of 1 ohm to 111.1111 megohms. The resolution of the 1662 is 0.01 ohm on the 111-kilohm range to 10 ohms on the 111-megohm range.

Oh, yes. Even at \$1200, the 1662 Resistance Limit Bridge is available with a quantity discount. For more information, write General Radio Company, West Concord, Massachusetts 01781 or telephone (617) 369-4400. In Europe write Postfach 124, CH 8034 Zurich, Switzerland.

Prices apply in U.S.A.

GENERAL RADIO



INFORMATION RETRIEVAL NUMBER 24

Washington Report

Postal strike viewed as boost for automation

The recent postal strike may help speed the automation of the postal system, according to Harold Faught, Assistant Postmaster General for Research and Engineering. The public is now aware of the Post Office's problems and the need for reform, he says.

To automate the system that now sometimes requires several days to move a letter across town will cost approximately \$500-million a year for the next several years, says a spokesman for the Post Office Research and Engineering Bureau. The new equipment would include large quantities of optical character readers, computers and memory units.

'Sickness' in air traffic control disputed

Present air traffic control equipment is "dangerously inadequate," a spokesman for the Professional Air Traffic Controllers Organization said during the union's "sick-out." But Sen. Howard Cannon (D-Nev.), vice chairman of the Senate Aviation Subcommittee, is unimpressed by the accusation, according to one of the Senator's aides.

The PATCO sick-out is "strictly a power play for more control over personnel policy, such as transfers and overtime," the Senator's spokesman said. "The complaint about 'inadequate air traffic control equipment' is a camouflage."

A total of \$2.5-billion for new air traffic control equipment is provided over the next 10 years in the Senate's version of the Aviation Facilities and Expansion Act of 1970. "And PATCO knows this," Senator Cannon's spokesman said.

The controllers' union, in reply to this, says it hasn't been told how the \$2.5-billion will be spent.

A partial answer to this, however, is provided in a recently issued study by an Air Traffic Control Advisory Committee appointed by Secretary of Transportation John Volpe. In general, the study calls for greater automation for the semi-automated "third generation" of air traffic control equipment that the Federal Aviation Administration is now planning to install. The System, the study concluded, should display such information as weather and wind shifts, blocked runways, aircraft emergencies and equipment failure; it should automatically take into account any of these situations in directing traffic.

Study finds defense profits are low

Defense contractor profits are considerably lower than profits made by comparable industrial manufacturers, according to a study financed by the Pentagon. In fact, profit pressure is encouraging larger companies to avoid defense work and go into the production of goods for civilian markets, says the Logistics Management Institute, Sumner, Md., which made the study.

A spokesman for Senator William Proxmire (D-Wis.), a perennial

critic of defense spending, said the Senator would have to study the institute survey before commenting.

Based on 1968 figures the institute found that the average before-tax profits on defense sales were 3.9%, against 7.6% on contractors' commercial sales and 9.3% earned by all-commercial durable-goods manufacturers. Profit on sales actually realized by the defense industry under price-competitive Pentagon contracts averaged 2%. Profits on sales under "cost-plus-fixed-fee" contracts averaged 4.2%; under "cost-plus-incentive-fee" contracts, 5%; under "firm-fixed-price" contracts, 3.3%. As a percentage of total capital investment, major defense companies earned 12.8% before taxes on defense business, against 16.3% on nondefense business and 19.5% netted by durable-goods manufacturers.

Data processors to be exempt from FCC rule

The Federal Communications Commission has proposed that the data-processing industry be allowed to use communications between customers without Government regulation. The reason—that such computer services will flourish best in a competitive environment.

The commission has also proposed that communications common carriers with annual operating revenues of \$1-million or more be allowed to sell data-processing services.

Interested parties are invited to comment on the proposal by May 18.

Air Force races Navy for air-to-air missile

The Air Force has awarded contracts to three companies to begin parallel studies for an air-to-air missile that could eventually bring in billions of dollars—or could be discarded. Called AIM-82, the short-range missile, to be used by fighters for close-in dog fights, will eventually be compared with a similar study by the Navy called Agile. One will be bought by both services and the other one scrapped.

The \$1.5-million, 90-day definition-phase contracts for AIM-82 are held by General Dynamics/Pomona, Hughes Aircraft, and Philco-Ford. The Agile work is in-house at the Naval Ordnance Test Station, China Lake, Calif.

FCC waits for industry's satellite ideas

The Federal Communications Commission is waiting for industry to come up with concepts for a domestic communications satellite system that would best serve the public. After all the proposals have been submitted, the commission will resolve such issues as these: How many systems should be authorized? (The White House has said it favors competitive systems.) Who should own them? Should the satellites be dedicated to one use or required to carry all major types of communications?

Besides proposals, the FCC has asked for comments on whether or not AT&T should be allowed to enter the domestic satellite field. Some contenders for the network have argued that AT&T is so big it would smother competition.

Cutler-Hammer extends its Rockette Switch line with the first totally illuminated rocker.

Totally visual indication of operation. It's Cutler-Hammer's new illuminated Rockette Switch. Another example of how we go just a little further to meet your design and functional needs.

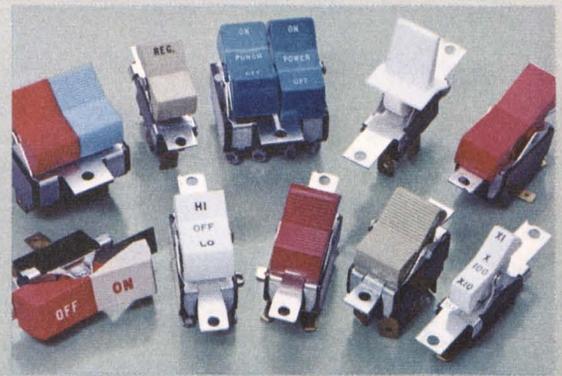
The little *extras* that are part of every Cutler-Hammer Rockette Switch, like the entirely translucent rocker, are what has made us Number 1. The switches people specify when designing commercial appliances and business machines—because quality equipment demands the best.

Our 9 rocker shapes, each in a

wide variety of colors, offer the finest in design flexibility and distinctive appearance. And, the legend is hot stamped.

AC-rated. AC/DC. Printed circuit terminations. Single pole. Two pole. Four pole. Dry-circuit capability, or up to 20 amps. 125 and 250 volt service. Single-, double-, and triple-throw contacts. You name it.

So, on the next piece of quality equipment you design, brighten it with a Rockette Switch from Number 1. Call your Cutler-Hammer Sales Office or Stocking Distributor. Or write for new full-line catalog LD-110-217



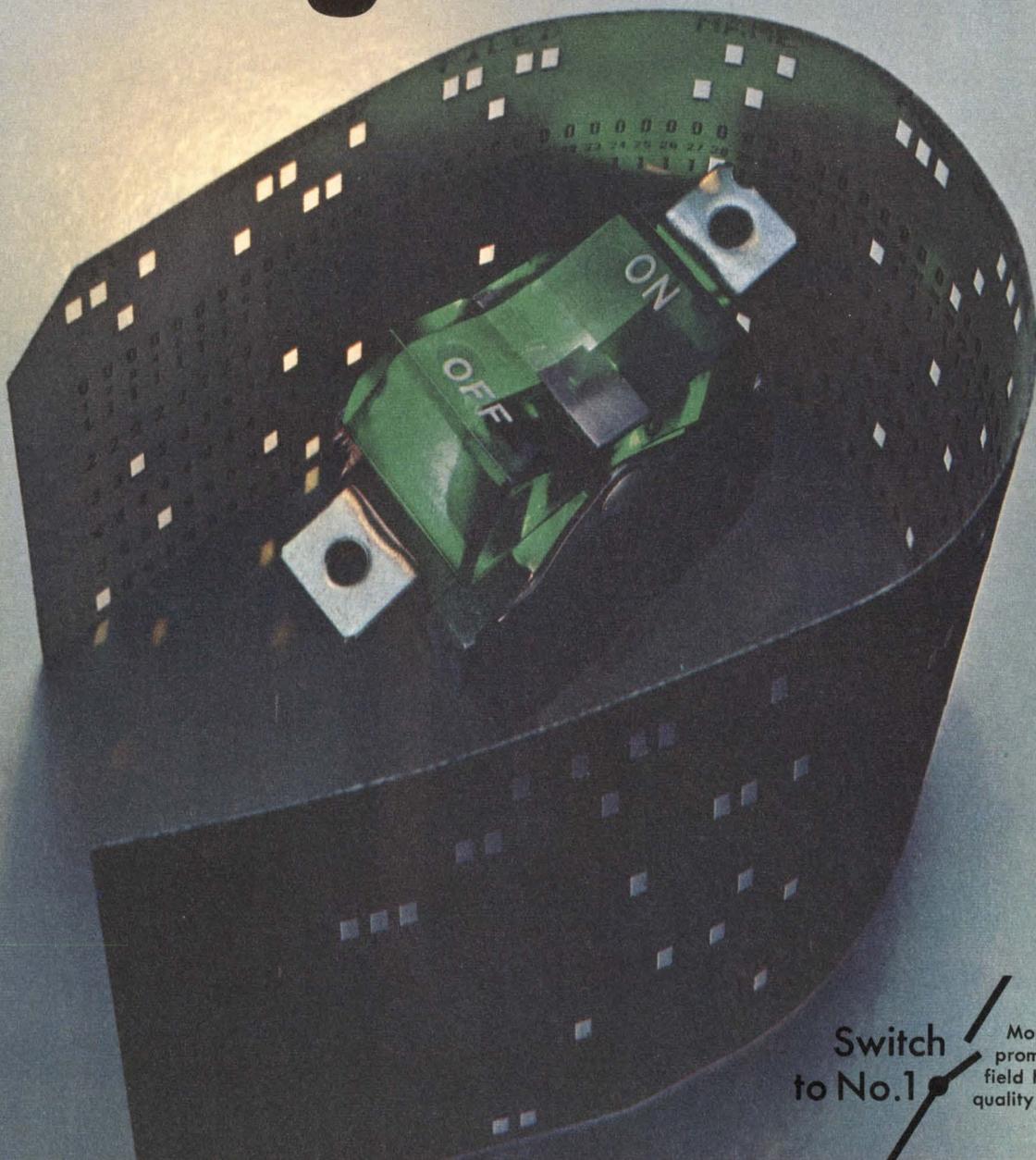
Quality switches for quality equipment. Check with your distributor for our Rockette Line of switches. AC. AC/DC. Low energy. Dry circuit. Up to 20 amps.

CUTLER-HAMMER
SPECIALTY PRODUCTS DIVISION, Milwaukee, Wis. 53201



INFORMATION RETRIEVAL NUMBER 54

Enlightenment.



Switch
to No.1

More than just switches;
prompt availability,
field help, innovation,
quality assurance, too.

more than a power supply

You get more than a power supply when you specify this or any Hewlett Packard power supply. An international network of 220 sales/service offices are at your disposal . . . the most comprehensive service manuals detailing every aspect of the supply from theory and operation to troubleshooting . . . protection circuitry including an internal overvoltage "crowbar" to safeguard delicate loads, standard on this Low Voltage Rack (LVR) Series. OUTPUTS: 10V @ 20, 50, or 100A; 20V @ 10, 20, or 50A; 40V @ 3, 5, 10, 30, or 50A; 60V @ 3 or 15A. RIPPLE AND NOISE: typically 200 μ V rms, 10mV p-p. Remote Programming and lots more. Prices start at \$350.

and you can customize it with these options...

- 10-Turn Output Voltage and Current Controls
- Chassis Slides
- 3-Digit Graduated Decadial for Voltage or Current
- 115V, 208V, or 230Vac Inputs
- 50Hz Input.



HEWLETT  PACKARD

POWER SUPPLIES

Over 100 power supplies are described in the 1970 HP Electronics Catalog. Write for your copy.

hp DC POWER

From 10 μ V to 4000V

From 1 μ A to 2000A

From \$90 to \$3,500

From manual to computer controlled.



LOW COST SUPPLIES

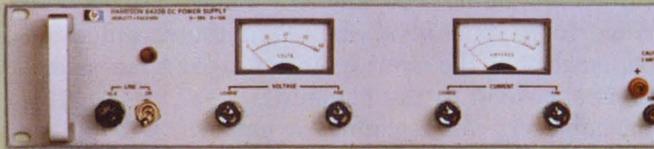
Compact laboratory power supplies can be stacked or rack mounted. Choose from 6 well-regulated models: 10V @ 1A; 25V @ .4A; 50V @ .2A. Three Constant Voltage/Current limiting models — \$90. Three Constant Voltage/Constant Current models — \$115.

Constant Voltage/Constant Current with Automatic Crossover, Remote Programming, Remote Sensing, Auto-Series or Parallel, Optional Internal Over-voltage "Crowbar"



MEDIUM POWER / TRANSISTOR REGULATED

Precisely regulated. Programming speeds as fast as 500 μ s. 20 models: 7.5V @ 3 or 5A; 10V @ 10A; 20V @ 1.5, 3, 5, or 10A; 30V @ 1A; 40V @ .75, 1.5, 3, or 5A; 60V @ 1 or 3A; 100V @ .75A; 160V @ .2A; 320V @ .1A. \$144 to \$395.

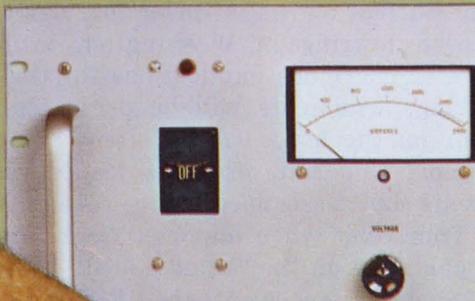


MEDIUM POWER / SCR REGULATED

8 models: 20V @ 15 or 45A, 40V @ 10 or 25A; 60V @ 5 or 15A, 120V @ 2.5A; 600V @ 1.5A. \$360 to \$550.

HIGH POWER/SCR REGULATED

12 Models: 4V @ 2000A; 8V @ 1000A; 18V @ 500A; 36V @ 300A; 64V @ 150A; 110V @ 100A; 220V @ 50A; 300V @ 35A; 600V @ 15A. \$1275 to \$3500.



Letters

It's not all right— engineering, that is

The following letter is in response to one that appeared in the March 15, 1970, issue (ED 6) titled, "Today's youth 'ideal'? He calls them 'fools.'" The writer of that letter reacted violently to our editorial in the Dec. 6, 1969, issue (ED 25) about the negative thoughts "idealistic" youth has about the engineering community. He said that if today's youth is idealistic, then its ideals are certainly completely rotten.

Sir:

Violent reaction, huh, Jack. What's your defense? Not idealistic? Probably no more nor less than any other generation, except that this one is doing something about it. You may not feel the need to justify engineering, but it certainly needs it.

The man in the street confuses science and technology, but it doesn't make too much difference—both have enjoyed the status of something holy for too long. Perhaps it's easier for scientists, but engineers had better start asking "why" instead of simply "how."

In case you haven't noticed, Jack, we're suffocating from our own pollution. Today's idealist—sloppy looking, pot-smoking, long-haired, etc.—didn't make this mess. He hasn't been here that long. He is doing us a favor, Jack, by bringing to the attention of everyone something we should have taken care of years ago.

Spanking won't do a thing to solve the problem. It might help you, but it won't cure him. You haven't seen anything yet, Jack, so stick around.

J. F. Hinds

Andover, Mass.

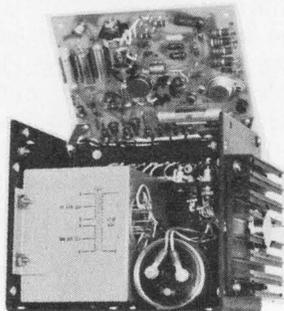
Military Power

ERA supplies it off the shelf!

ERA CERTIFIED MIL SPEC POWER MODULES FULLY MEET OR EXCEED:

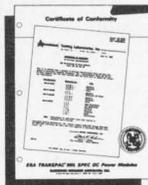
MIL-E-4158, MIL-E-5400, MIL-E-16400,
MIL-E-5272, MIL-T-21200, MIL-E-4158

- no engineering or prototype costs
- checked, approved and certified
- minimum cost for single or quantity orders
- fast delivery
- 77 proven and tested models
- repairable 75°C silicon types
- encapsulated types
- hundreds of variations in each group



Satisfy your most exacting military requirements with off-the-shelf certified ERA Mil Spec DC power modules. Choose from 77 stock models. Proven designs ...no engineering or prototype costs AND, you get certification from one of America's leading independent testing laboratories.

Write for free informative booklet describing tests and results along with the ERA catalog.



ELECTRONIC RESEARCH ASSOCIATES, INC.

67 Sand Park Road, Cedar Grove, N.J. 07009 • (201) 239-3000

SUBSIDIARIES:

ERA Acoustics Corp. • ERA Dynamics Corp.
Astrocom Inc. • The Magitran Company

INFORMATION RETRIEVAL NUMBER 26

SIDELIGHTS

What a computer hasn't got—a head

Most stories about computers—mini to maxi—concentrate on what they can do and how they can do it better than a man can. But in gathering material for his special report on minicomputers (p. C6), Computers Editor Milton Lowenstein (see photo) found an area where men can outperform computers at their reputedly most efficient job—repetitive tasks.

The idea came out during a conversation with Cloyd Marvin, vice president of marketing, for Four-Phase Systems, Cupertino, Calif. Marvin pointed out that layouts for his company's LSI artwork for semiconductor memories are always made by men. Computers—so far—are too expensive for the work. A single cell of random-access memory requires several complex superimposed masks. Each cell is then repeated hundreds or thousands of times, depending on the circuit being built. The memory needed for a program to perform this task, using computer-aided design, is so large that the average in-house or time-shared computer is not equal to the demand.



A man, however, can recognize a pattern, and he can suppress details while performing the over-all layout. Later, he can add the fine details. So memory in a machine isn't everything—as long as man has a head.

A man, however, can recognize a pattern, and he can suppress details while performing the over-all layout. Later, he can add the fine details. So memory in a machine isn't everything—as long as man has a head.

What would repeal of 807 mean to you?

What started off as a brief preview of a Tariff Commission hearing in Washington, in May, became a story with enormous implications for the industry. At the hearing, arguments will be presented by industry and labor on the hotly debated Item 807 of the U. S. Tariff Code. Under it, products made from American components but assembled in a foreign country are exempt from duty when imported back into the States; duty is paid only on the "value added" by foreign labor. If the item is repealed, the Electronic Industries Association says, imported electronic products will cost more in the U. S., American-owned plants abroad will use cheaper foreign instead of American-made components, and competition with Japan will stiffen.

News Editor John Kessler interviewed such sources as Alfred R. McCauley, special counsel to the EIA, and Abe Morgenstern, research director of the International Union of Electrical Radio and Machine Workers. The story begins on p. 24.

INFORMATION RETRIEVAL NUMBER 27 ►

2nd Son of Ubiquitous®

The new lil' Ubiq®, the smallest real-time spectrum analyzer for on-line frequency measurements of noise, vibration, and underwater signals.

Now there are two basic real-time spectrum analyzers, each designed for a specific job.

The big Ubiquitous UA-6A for the lab is the finest, most flexible and precise instrument, to determine significant parameters during the R&D phase of study.

And now the new lil' Ubiq UA-10 — the smallest, easiest to operate, for use in the field, right at the source of the signals or in production where portability and economy are important, but where the highest speed and resolution are not required.

For special requirements, we make the 1000-line UA-9 with twice-as-fine resolution as the UA-6A; and the 100 kHz UA-8H, which operates five times as fast as the UA-6A.

We also make cross-PSD, correlation, and analyzer-computer systems.

Call us for a real-time solution to your signal processing problems.



FEATURES	BIG UA-6A	NEW LIL' UA-10
Number of frequency points	500	200
Dynamic range	54 dB	48 dB
Number of analysis ranges	10	7
Narrowest built-in bandwidth	.02 Hz	.1 Hz
Widest coverage	40,000 Hz	20,000 Hz
Provision for machine signatures through external sampling	built-in	built-in
Transient capture	automatic built-in	manual (automatic option)
Frequency accuracy	digital marker calibrated to .2%	.5% read from display
Oscilloscope display, chart recording, and X-Y plotting	yes	yes
Single frequency select	with digital switches	with 10-turn dial
Companion averager	dual 500-pt.	single 200-pt.
Height	12½"	7"
Rack mounting	yes	yes

federal scientific



FEDERAL SCIENTIFIC CORPORATION
 ORIGINATORS OF THE UBIQUITOUS® SPECTRUM ANALYZER
 SUBSIDIARY OF ELGIN NATIONAL INDUSTRIES, INC.
 615 W. 131ST ST., N. Y., N. Y. 10027. TEL: (212) 286-4400.



ELECTRONIC MATERIALS

DOW CORNING®

140 RTV coating

clear, flowable silicone rubber coating; non-corrosive to copper and other metals

TWO OUNCES

DOW CORNING

ELECTRONIC MATERIALS

DOW CORNING®

3140 RTV coating

clear, flowable silicone rubber coating; non-corrosive to copper and other metals

TWO OUNCES

DOW CORNING®

3141 RTV coating

white, flowable silicone rubber coating; non-corrosive to copper and other metals

RUBBER COATING; NON-CORROSIVE TO COPPER AND OTHER METALS

NET WT. 2 oz/57 g

DOW CORNING

DOW CORNING®

3141 RTV coating

white, flowable silicone rubber coating; non-corrosive to copper and other metals

NET WT. 2 oz/57 g

DOW CORNING®

3142 RTV adhesive/sealant

translucent, room-temperature-curing silicone rubber adhesive/sealant; non-corrosive to copper and other metals

NET WT. 2 oz/57 g

DOW CORNING

DOW CORNING®

3144 RTV adhesive/sealant

translucent, room-temperature-curing silicone rubber adhesive/sealant; non-corrosive to copper and other metals

NET WT. 2 oz/57 g

ELECTRONIC MATERIALS

DOW CORNING®

3145 RTV adhesive/sealant

gray, non-slump silicone rubber sealant; non-corrosive to copper and other metals

TWO OUNCES

ELECTRONIC MATERIALS

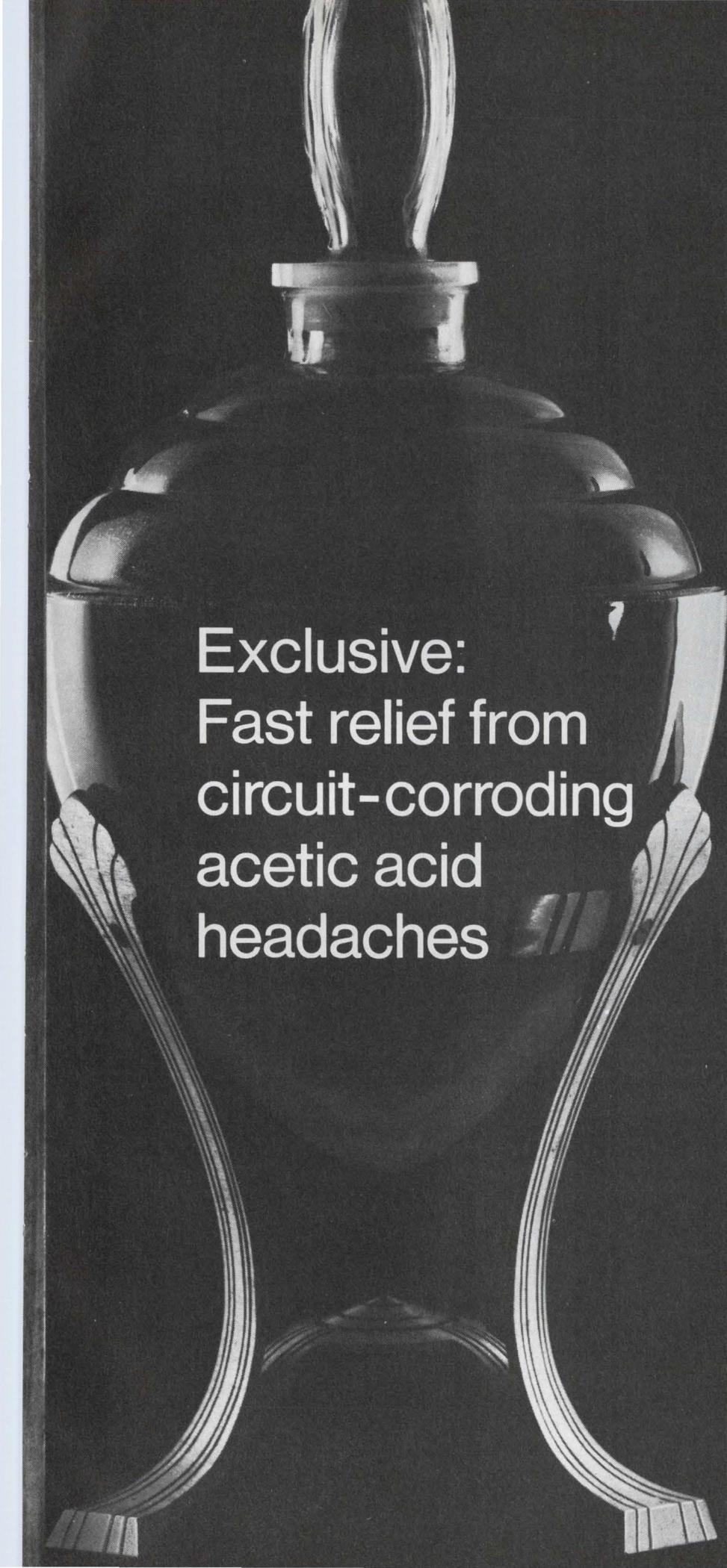
DOW CORNING®

3145 RTV adhesive/sealant

gray, non-slump silicone rubber sealant; non-corrosive to copper and other metals

TWO OUNCES





Exclusive:
Fast relief from
circuit-corroding
acetic acid
headaches

Dow Corning® silicone sealants and protective coatings are the only ones that do *not* release acetic acid or other corrosive by-products during cure. They were specifically developed to protect delicate circuit boards and other electronic components from corrosion, dust, dirt, abrasive particles, solvents and chemicals. They are strong, have excellent bond strength, electrical strength; are easy to apply, and cure quickly. There's no "vinegar" smell, either. Dow Corning 3140 (clear) and 3141 (opaque) RTV coatings are ready-to-use silicone rubbers that cure at room temperature. They are ideal for conformal coatings on printed circuit assemblies or for encapsulating small circuits or connectors. Dow Corning 3144 (clear) and 3145 (opaque) RTV adhesive/sealants are high-strength, non-corrosive, nonflowing silicone rubbers used to bond components and seal housings and connectors.

Stop component corrosion with these Dow Corning coatings and sealants. For more information, write Dow Corning Corporation, Dept. B-9342, Midland, Michigan 48640.

*Electrical / Electronic
materials from*

DOW CORNING

DOW CORNING

- Four full digits plus "1" for 20% overranging
- Rechargeable battery operation optional
- Measures ac and dc volts in four ranges to 1200 volts
- Measures ohms in five ranges to twelve megohms
- Active 2 pole switchable filter
- Automatic polarity indicator
- All functions push-button selectable



The digital multimeter you can believe

Announcing the Fluke 8100A, a completely portable 0.02% digital multimeter for \$695.

The only way to build a multimeter with no last digit uncertainty is to add an "extra digit." That's exactly what we've done with the new Fluke 8100A. Here is an instrument with nine times the accuracy of three digit units selling at only half the price of comparable four digit multimeters.

How?

We've used an A to D conversion technique new to the DVM field. The result is an instrument with low power drain, simplicity of circuitry, troublefree oper-

ation and the uncommon accuracy you expect from Fluke.

Standard features include ac measurement accuracy of 0.2% and resistance, 0.1%. For real portability, batteries will operate the multimeter continuously up to eight hours without recharging. Battery operation, the only option, is priced at \$100. Accessories available include high frequency and voltage probes, switched ac-dc current shunts and a ruggedized case.



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

At last. A high-reliability capacitor you actually can rely on.

Our brand new TLW. It's the first-ever capacitor with a special glass-to-metal seal for positive hermetic sealing to prevent electrolyte leakage. There's just no better way to seal a capacitor.

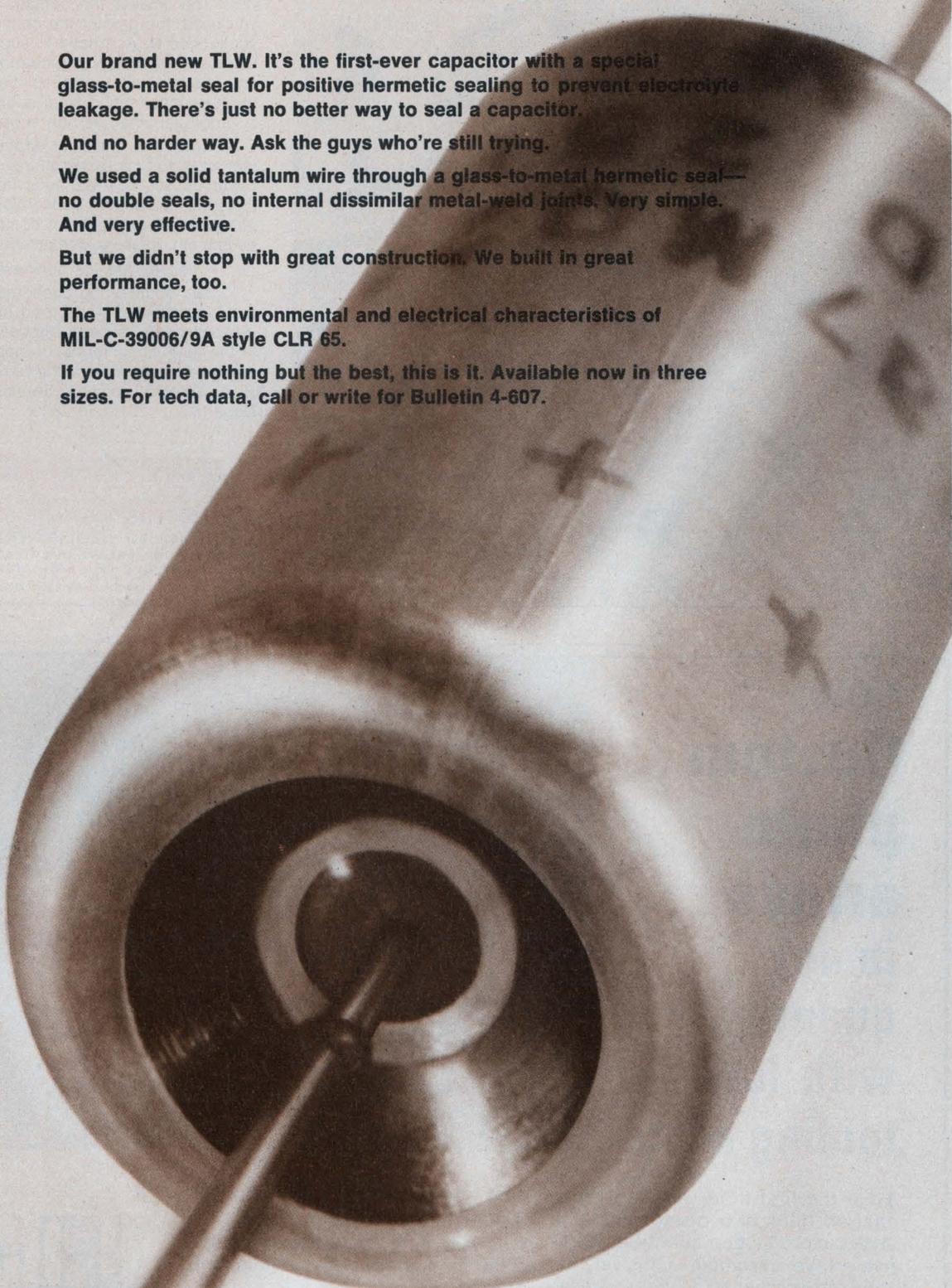
And no harder way. Ask the guys who're still trying.

We used a solid tantalum wire through a glass-to-metal hermetic seal—no double seals, no internal dissimilar metal-weld joints. Very simple. And very effective.

But we didn't stop with great construction. We built in great performance, too.

The TLW meets environmental and electrical characteristics of MIL-C-39006/9A style CLR 65.

If you require nothing but the best, this is it. Available now in three sizes. For tech data, call or write for Bulletin 4-607.



MALLORY

MALLORY CAPACITOR COMPANY

a division of P. R. MALLORY & CO. INC.

3029 E. Washington St., Indianapolis, Indiana 46206; Telephone: 317-636-5353

Electrical and electronic components • sequence timers • metallurgical products • batteries

INFORMATION RETRIEVAL NUMBER 30

Mini contacts, maxi line.



The smaller the contact material you need, the greater the chance is that you'll need H. A. Wilson to supply it. Our wide capability, engineering expertise and vast manufacturing facilities combine to let us recommend what is best for you . . . not just what we can supply.

When you have an application that calls for micro-miniature contact materials, such as MIL spec relays, telemetering equipment, conventional relays, potentiometers, telephone communications equipment, flashers, contact Engelhard.

Chances are it's not new to us.

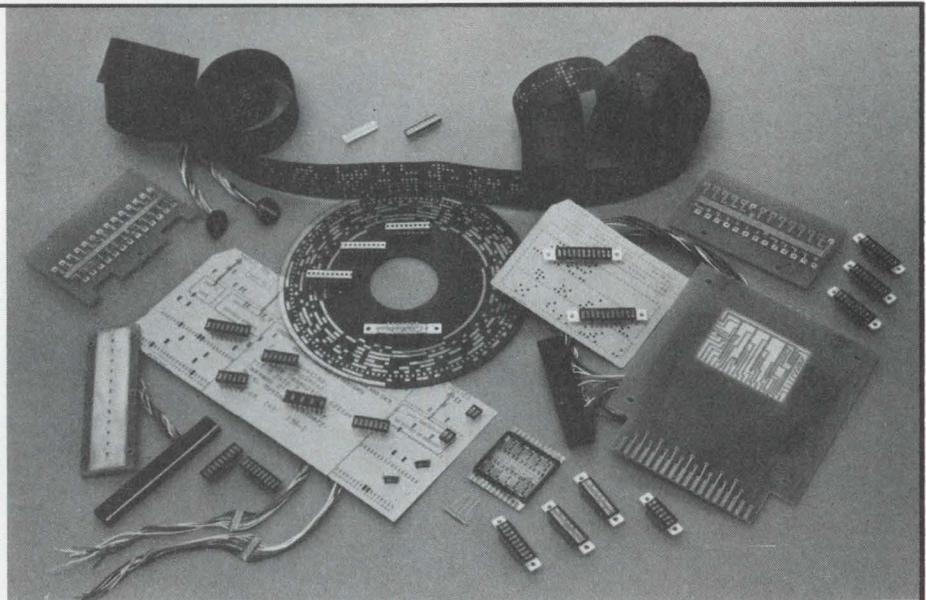
Our engineering background, manufacturing facilities and broad experience in applications surpass those of any one in the field. For information and/or technical assistance, call or write the H. A. Wilson Technical Service Department (201) 686-6600.

ENGELHARD

ENGELHARD INDUSTRIES DIVISION
ENGELHARD MINERALS & CHEMICALS CORPORATION
2655 U. S. ROUTE 22, UNION, NEW JERSEY 07083
An Equal Opportunity Employer

INFORMATION RETRIEVAL NUMBER 31

NOW...
**Custom
photo
arrays
in any
quantity,
with low
tooling costs**



1 For the first time, you can order custom thick film phototransistor arrays in production quantities. **Custom** arrays, designed exclusively for your requirements, to your specs. 500 . . . 1,000 . . . 10,000 or more! Only at HEI.

2 Thick film photo arrays cost less — as much as 50% less because thick

film technology eliminates the cost of individual packages.

3 Low tooling costs average about \$250 for custom arrays. Again, only at HEI.

Photo array design packet with application notes describes HEI thick film and phototransistor array capability. Yours for the asking; circle the number or write:

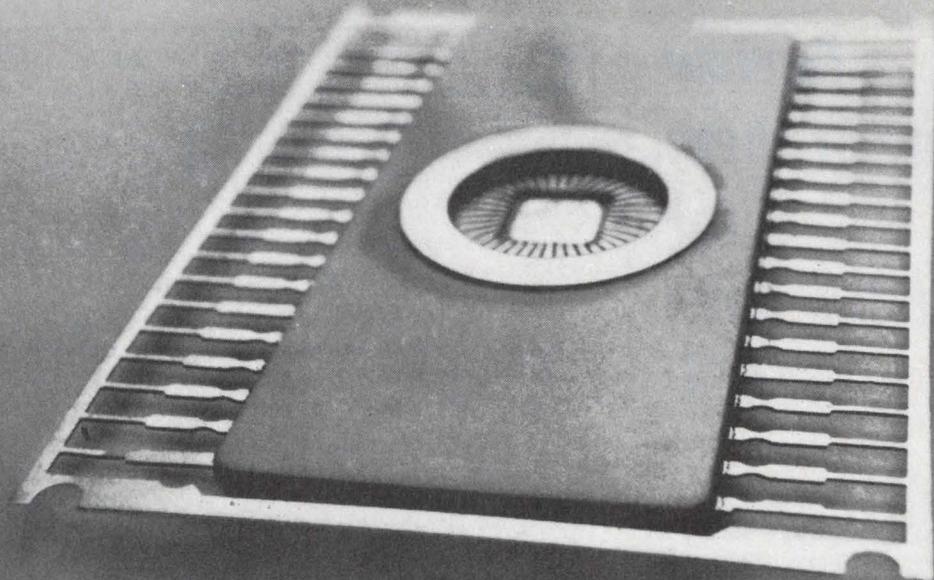
 **HEI inc.**

Jonathan Industrial Center
Chaska, Minnesota 55318
Phone (612) 448-3510

INFORMATION RETRIEVAL NUMBER 32

Sylvania introduces a new 40-lead, glass-ceramic, sandwich-type, unitized, hermetically sealable large scale integrated circuit package.

(whew.)



Here is the first glass-ceramic package in the IC major leagues. And that, friends, marks the beginning of the end of the LSI package shortage. Write to: Sylvania Precision Materials, Parts Division, Warren, Pa. 16365. Or telephone: 814-723-2000. Ask for Bill Williamson.

SYLVANIA
GENERAL TELEPHONE & ELECTRONICS

MICROELECTRONIC DESIGN

Edited by Howard Bierman

A complete and concise survey of the entire field of microelectronics providing practical and professional ideas from the pages of *Electronic Design*. Almost 90 important studies cover all aspects of this rapidly expanding technology—basic integrated circuit components, thick and thin film, reliability, black-boxing, etc. Valuable data charts on more than 500 devices, a list of manufacturers, and a full bibliography insure the book's usefulness. 320 pages, 8½ x 11 illustrated, clothbound.

#5762 \$11.50

ELECTRONIC DESIGN TECHNIQUES

Edward E. Grazda

This vital reference presents fresh ideas and proven techniques selected from articles that appeared in *Electronic Design*. Grouped in sections, they cover the use and design of amplifiers, resistor networks, filters, control devices, power supplies, microwave systems, oscillators, and pulse and switching circuits. Tables, nomographs, performance charts, and guidelines for techniques in many areas make this an extremely valuable tool for the engineer. 312 pages, 8½ x 11, illustrated, clothbound.

#5648 \$13.95

DESIGN OF TRANSISTORIZED CIRCUITS FOR DIGITAL COMPUTERS

Abraham I. Pressman

Offering a firm knowledge of both principles and practice, this authoritative book employs "worst case" design calculations as an essential aspect of this type of design. It covers the major schemes currently employed in designing computer logic, including Pyramiding Factors, Turn On, Turn Off, and Storage Time calculations. Circuit analysis and all aspects of output waveforms are calculated treating the transistor as a current switch. 328 pages, 6 x 9, illustrated, clothbound.

#0215 \$13.95

ENGINEERS' RELAY HANDBOOK

Revised Second Edition

National Association of Relay Manufacturers

More than ever "a relay handbook to rely on,"* the Revised Second Edition of this practical working reference provides a complete, authoritative roundup of essential information on the operating principles, properties, performance characteristics, application requirements, specifications, and testing of relays.

New sections detail reed and mercury wetted relays, and solid state devices. Particularly valuable features are the complete discussion of magnet wires, and the unique description of hybrid combinations of relays and solid state devices. This time- and money-saving handbook includes numerous diagrams, charts, and tables, and a complete, up-to-date bibliography. *From a review of the First Edition, *Control and Measurement*. 355 pages, 7¾ x 10¾, illustrated, clothbound.

#5867 \$13.95

MATRIX ALGEBRA FOR ELECTRONIC ENGINEERS

Paul Hlawiczka

A basic course for the practicing engineer or student, for whom matrix algebra is often an indispensable tool for solving problems in physics and electronics. Gives a general orientation and shows the solution of simple problems. Part I covers the essentials of matrix methods and their applications. Part II treats more complex methods, applying them to differential equations of linear networks. 224 pages, 5¾ x 8¾, illustrated, clothbound.

#5629 \$8.75

MICROWAVE SYSTEMS PLANNING

Kenneth L. Dumas and Leo G. Sands

Designed for managers and engineers, this book defines and explains in a semi-technical manner the important criteria involved in the planning, engineering, and installation of microwave communications equipment. Covers point-to-point FM systems beginning with frequency, wave theory and propagation, and following through to hardware theory and the practical aspects of establishing a microwave path with a high probability of good performance. 152 pages, 6 x 9, illustrated, clothbound.

#5696 \$8.00

NONDESTRUCTIVE HIGH POTENTIAL TESTING

Harold N. Miller

This single-volume sourcebook covers the essentials of nondestructive electrical testing from general principles to specific how-to instructions. It stresses important techniques for determining the ability of solid, gas and liquid insulation to withstand predetermined amounts of over-voltage without failure. Guides to proper selection of test sets and mechanical features are also included. 160 pages, 5½ x 8½, illustrated, clothbound.

#5028 \$8.95

SIMPLIFIED MODERN FILTER DESIGN

Phillip R. Geffe

Bringing together the various modern, or network-synthesis methods in filter design, this book enables the engineer to achieve practical design more easily. Extensive tables of numerical data preclude much of the difficulties in design. Covers lowpass, high-pass, simplified and refined designs, band-stop, attenuation, equalizers, linear-phase and delay equalizers, measurement techniques, etc. 182 pages, 5½ x 8¾, illustrated, clothbound.

#0317 \$9.95

Time- and Money-Saving Guidebooks!

**Review
any of them
for
10 full days
—FREE!**



HAYDEN BOOK COMPANY, INC.
116 W. 14 St., New York, N.Y. 10011

ED-470

Please send me the books circled below on 10-day free examination. At the end of that time, I will remit payment, plus postage, or return the books without obligation.

5867	5648	5629	5762
5676	5028	0215	5537
5512	0317	5696	

Payment enclosed (Hayden pays postage). Same return privilege.

Name _____

Firm _____

Address _____

City _____

State _____ Zip _____

On all overseas orders, payment in U.S. dollars must be enclosed. Publisher pays postage with same return privilege.

400 IDEAS FOR DESIGN

Selected from *Electronic Design*

Here are over 400 tested engineering ideas selected from the popular "Ideas for Design" column of *Electronic Design*. These ideas proved their value as parts of larger designs and aids in measuring the parameters or testing the effectiveness of designs. Arranged in convenient categories for handy reference, they provide practical tips on improving equipment performance, developing versatile designs, saving on materials and time, etc. 232 pages, 8¾ x 11¼, illustrated, clothbound.

#5537 \$10.95

SYNTHESIS OF RC NETWORKS

Hun H. Sun

Dealing with the fundamentals of both active and passive networks, this convenient reference for faculty and research personnel includes new and original contributions by the author. For example, it covers the algorithm for ladder development and the criteria for determining the negative real roots of a polynomial. These class-tested materials are backed up by problems and suggested readings. 150 pages, 6 x 9, illustrated, clothbound.

#5676 \$7.50

ELECTRICAL INTERFERENCE

Rocco Ficchi

Provides the designer, field engineer, program manager and technician with a broad view of interference in modern electronics systems. The book shows the entire field as a unified discipline and makes it possible to solve problems encountered in small radio receivers on up to large missile systems. Includes material on how interference control is introduced in design and the best practices to contain interference. 256 pages, 6 x 9, illustrated, clothbound.

#5512 \$9.95

Smooth Application Sailing With GE's Fleet of 150-Grid Relays

Here's Why.

Easy to Evaluate and Select — Physical and operating characteristics of all five 150-grid relays are very similar. If you are familiar with one, you know them all.

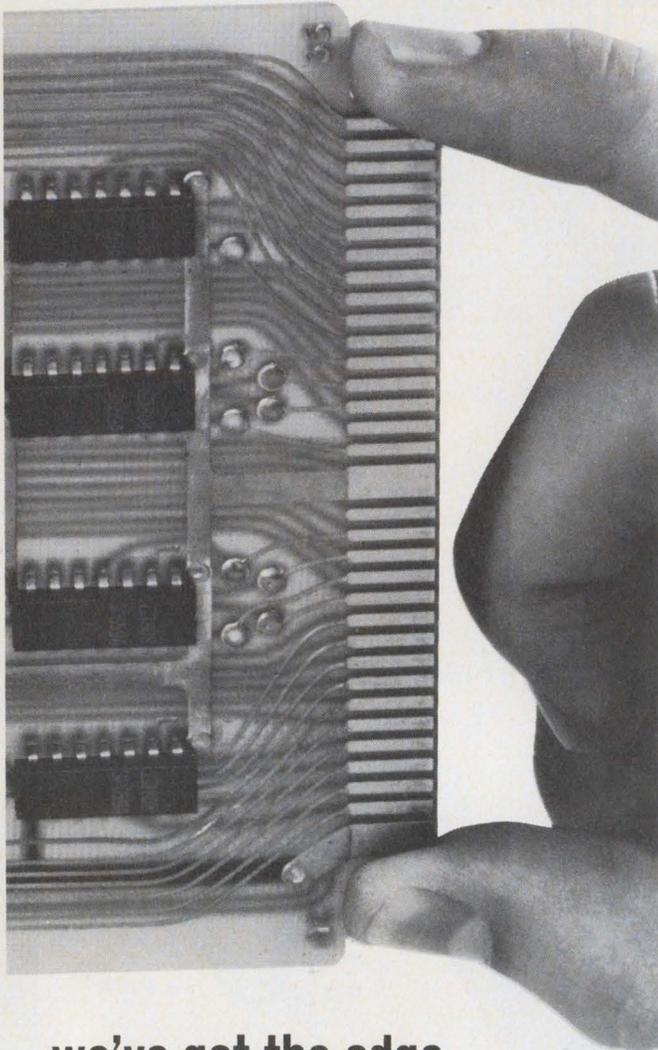
Wide Application Capability — For your electronic circuit needs . . . 2-pole, 4-pole, latching, sensitive, AND-logic. Also, a wide choice of coil ratings, mounting forms, and headers to match your exact requirements.

Top Quality and Reliability — The GE 150-grid relays have been proven in a great many severe equipment applications the past 4 years. These include the Apollo space vehicle and other major aerospace programs.

Quantity Discounts — Apply to the total number of GE 150-grid relays purchased of all types.

Sail through your work load with this time-saving, money-saving, problem-solving GE 150-grid sealed relay fleet. Call your nearest GE Electronic Components Sales office or distributor, or write Section 792-46, General Electric Co., Schenectady, New York 12305.





we've got the edge on our logic competition

And it starts with the 70 connection edge of all our logic assemblies. Our design brings more digital functions to the outside world, puts more functions on a card. And the trend toward more complex functions and large scale integration won't obsolete our design - in fact, we're helping make it possible.

Get an edge on your competition, choose from the industry's widest range of logic assemblies - DTL for moderate speeds, TTL for high frequencies, and MSI for low cost through better packaging.

In the Cambion line, you'll find all the logic cards you'd expect to need plus those one-of-a-kind required to complete your system without having to develop the card yourself. You'll also find all the necessary accessories, connectors, card drawers and files and power supplies. In fact, you can start your system design at any level and gain a competitive edge with Cambion logic assemblies and accessories. We've got a manual full of them we'll be glad to send you. Just send us your name. Do it today. Cambridge Thermionic Corporation, 445 Concord Avenue, Cambridge, Mass. 02138.

Standardize on

CAMBION®

The Guaranteed Logic Assemblies

INFORMATION RETRIEVAL NUMBER 36

escap® 26PL

miniature
DC servo
motors

high ratio/power
volume
exceeds 80%
efficiency
bell shaped rotor
self-supporting
skew winding
made in switzerland

Designed for instrumenta-
tion, chart drives, servo
systems. Send for all the
facts.

Portescap U.S.
730 Fifth Ave., New York, N.Y.
10019 tel: (212) 245-7716 •

actual size



INFORMATION RETRIEVAL NUMBER 37

With M-E's ABC modular power supply system you create your own low-cost power supply package. **A.** Choose from supplies with outputs from 3 to 200 volts. **B.** Select one of four panel styles in quarter- or half-rack sizes: (1) blank; (2) on-off control with pilot light; (3) metered: volts and amps; or (4) complete with volt and amp meters, on-off control, pilot light, output terminals, and voltage adjust. **C.** Pick the four-module or eight-module rack.

Input: 105-130 VAC, 50-60 Hz
Output: 3V/10A to 200V/1.0A
Regulation: Line: 0.02%
Load: 0.02%
Ripple: < 500 μ V rms
Load Response: < 50 μ seconds
Operate Temp.: 0-50°C,
71°C. derated
Overload Protection: Solid-state.
Crowbar optional

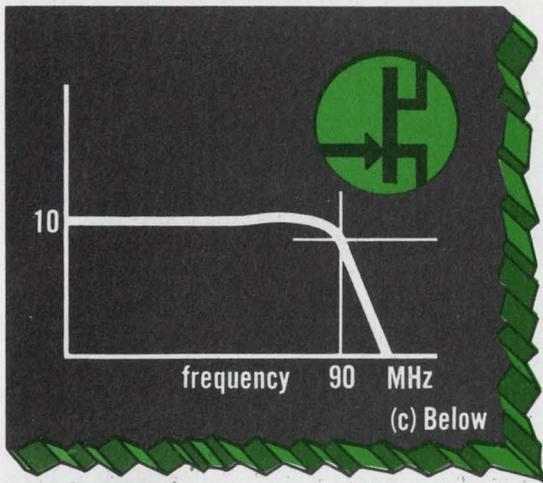
Send for tech specs on all ABC Series models, panels, and racks.

M Mid-Eastern Industries A Division of Enanco, Inc.
660 Jerusalem Rd. / Scotch Plains, N.J. 07076 / (201) 233-5900

M-E's new Pick-Your-Power Pack. It's simple as ABC.

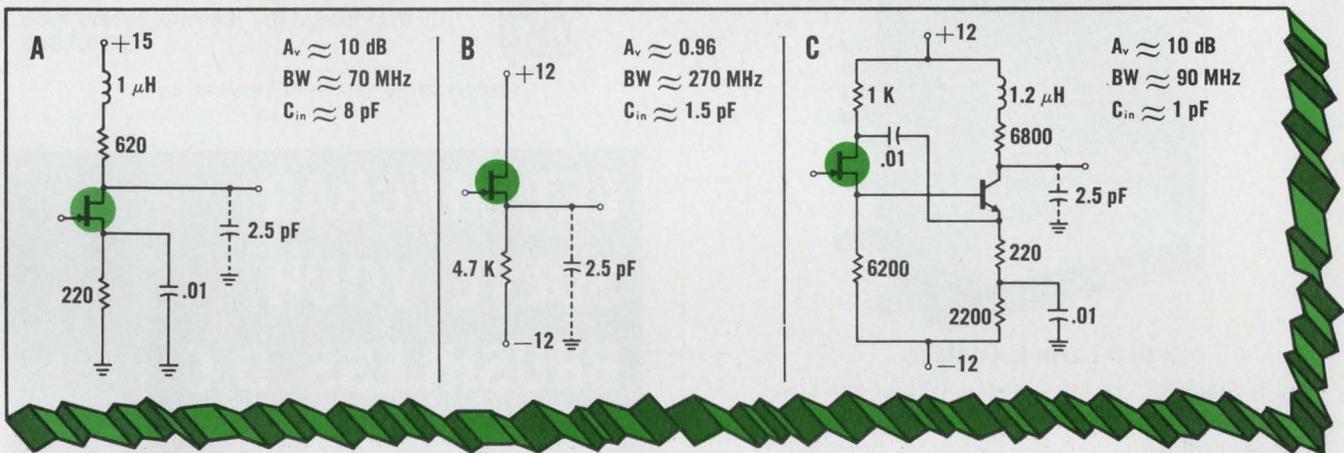


INFORMATION RETRIEVAL NUMBER 38



FETS FOR VIDEO AMPS from SILICONIX.

If you've a wide band application (approaching 100 MHz), need high Z_{in} ($10\text{ M}\Omega$ @ 1 MHz) and want low C_{in} (down to 1 pF), think FETs. Here are three circuit ideas for starters:



Siliconix assumes no responsibility for circuits shown, nor does it represent or warrant that they do not infringe any patents.

The Siliconix 2N5397 gives you the best gfs/C_{in} . We do have FETs with even lower C_{in} . For details on these and other circuit approaches, write or call any of the numbers below.

New York: Sy Levine (516) 796-4680
New England: Al La Croix (617) 762-8114
Ft. Worth/Dallas: Charlie Williams (214) 231-8151
St. Louis: Jim Spicer (314) 291-3616
Minneapolis: Ed Koelfgen (612) 920-4483
Southern California: Dave Ferran (213) 420-1307
Northern California: Chuck Brush (408) 246-8000



Siliconix incorporated

2201 Laurelwood Road • Santa Clara • California 95054
 Telephone (408) 246-8000 Extension 201 • TWX: 910-338-0227
 In Europe: Siliconix Limited, Saunders Way, Sketty, Swansea, Great Britain

Hart-Advance Space Savers



2 to 8 Form C contacts

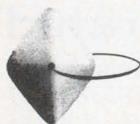
Really Stacked! We know space, weight and costs are big problems for you. That's why we designed VersaPac miniature relays—to do a lot more: minimize at 1-2 cu. in., lightweight at 1-1.4 oz., economical. Socketed types also available.

Plenty of Life. VersaPac relays are regular old graybeards when it comes to long life. Plug them in and forget about them for over 100,000,000 operations.

Solid, Man! You get unusually precise adjustments because of the one-piece core and frame assembly made of special Armco magnetic ingot iron.

Cross-Bar Contacts. Contacts are single or bifurcated and rated at 3 and 5 amps, 6-115 volts. Gold-plated silver-alloy contacts.

For full details, write today for Distributor Catalog DSC-4.

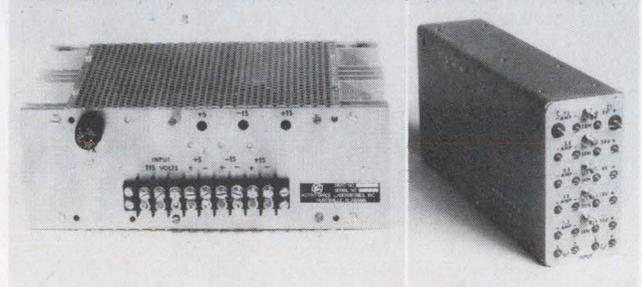


HART-ADVANCE RELAY DIVISION
OAK ELECTRO/NETICS CORP. • CRYSTAL LAKE, ILL. 60014
PHONE: 815-459-5000 TWX: 910-634-3353

INFORMATION RETRIEVAL NUMBER 39

Custom Power Supplies

CUSTOM DESIGNED MULTI-OUTPUT POWER SUPPLIES
ASSURE THE LOWEST COST, SMALLEST PACKAGE
FOR ANY APPLICATION



FEATURES:

- | | |
|---------------------------------------------|-------------------------------------------------------|
| Most economical cost | Incorporation of special features |
| Most efficient package size and form factor | Design approach optimized for application |
| Optimized performance parameters | Thermal management fully considered in initial design |

For an immediate quote on your Power Supply requirements, forward your specifications to

Astro-Space Laboratories, Inc.



110 Wynn Drive, N.W. / Huntsville, Alabama 35806
205/837-5830

INFORMATION RETRIEVAL NUMBER 40

LET MACBAR SOLVE YOUR BRUSHLESS D.C. MOTOR PROBLEMS

We are specialists in the design and production of custom built brushless d.c. motors ranging from 5 in. oz. to 50 ft. lbs. We have many years of experience in producing these custom motors to exact customer specifications. Our brushless d.c. motors offer the highest reliability, performance and long life. If you have a specific problem in this area, contact us. Our highly trained staff is always at your service.

MacBar Mechanisms Inc.

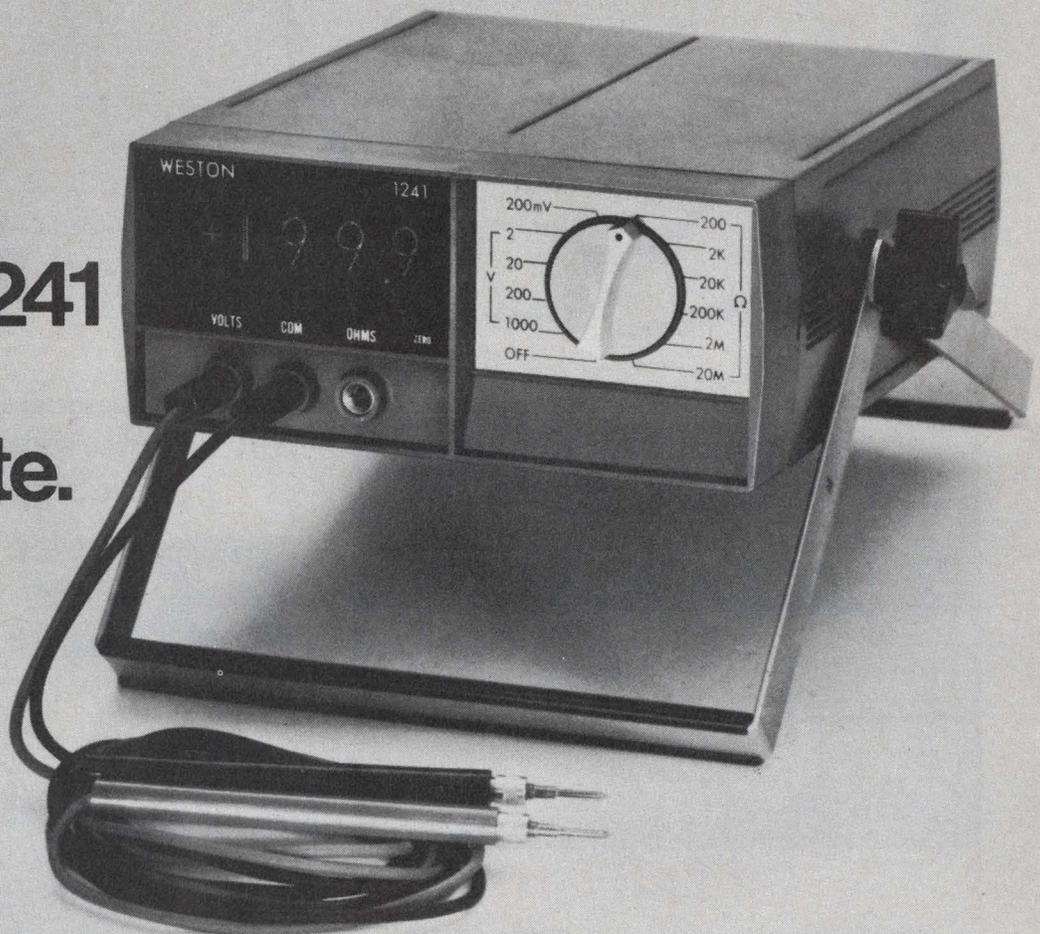
11 West Mall, Plainville, N. Y. 11803 • Phone: 516 694-5360

INFORMATION RETRIEVAL NUMBER 41

ELECTRONIC DESIGN 9, April 26, 1970

Any DC VOM with 0.1% accuracy should cost more.

Model 1241
\$289
complete.



We wanted the price low enough that anyone taking DC voltage or resistance readings wouldn't have to think twice about choosing our new Model 1241. As it turned out, we can give you an even bigger break. Because most of the circuitry, as well as the rugged housing and many convenience features, had been developed previously for the Weston 1240 DMM which we introduced last November.

Here's a proprietary-designed Weston instrument you can pack in your tote case, use on the bench, or mount in a

standard 3½" panel. The only "extra" you may ever need is an optional battery pack for remote field applications. Model 1241 gives you high-impedance measuring capability to 3½ digits on five voltage and six ohm ranges.

In addition to its outstanding accuracy of 0.1% of reading $\pm 0.05\%$ F.S. on Volts ($0.5\% \pm 1$ digit on Ohms), this advanced meter features complete circuit overload protection. Fuses are replaceable without opening the rugged, glass-filled thermoplastic case. And, of course, there's Weston's patented dual

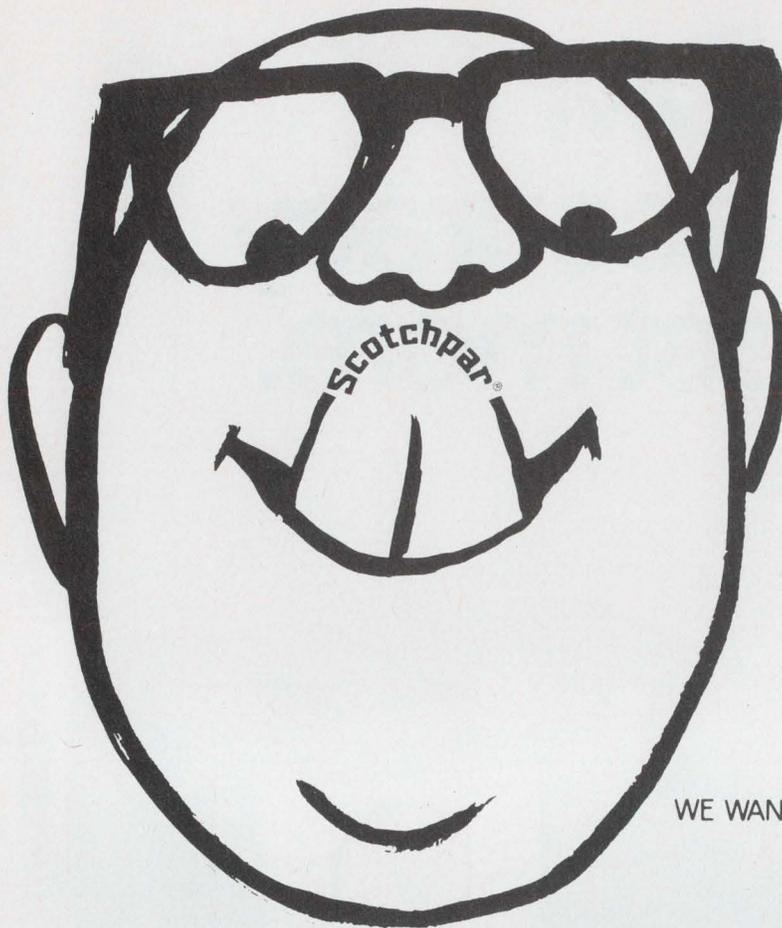
slope* integration, automatic decimal positioning, and non-blinking display.

If you want to see how much quality a dollar will buy today, contact your Weston Distributor. He also has in stock our 1240 DMM, with 26 AC-DC ranges plus all the above features. Or write today for complete specifications.

WESTON INSTRUMENTS DIVISION,
Weston Instruments, Inc., Newark, N.J.
07114, a Schlumberger company

WESTON®

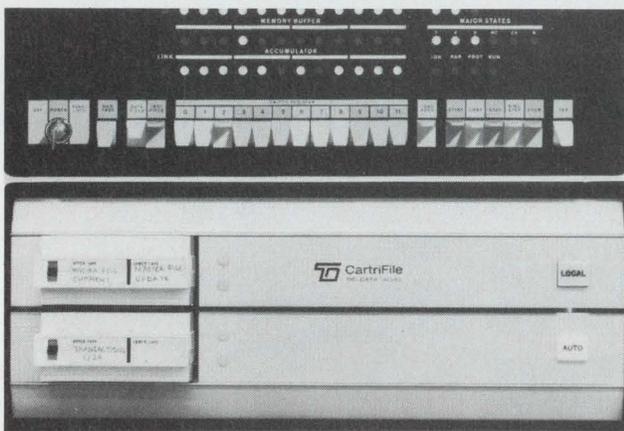
*U.S. Pat. #3,051,939



WE WANT OUR NAME ON THE TIP OF YOUR TONGUE!

Scotchpar 3M
BRAND POLYESTER FILM COMPANY

INFORMATION RETRIEVAL NUMBER 43



CartriFile

With the Small Computer — an EDP system for business data processing, process control, integrated circuit testing, inventory control — in stand-alone or terminal configurations.

- 4 mag tape transports & controller
- cartridge-loaded
- high transfer rates
- error detection & correction
- simultaneous reading & writing



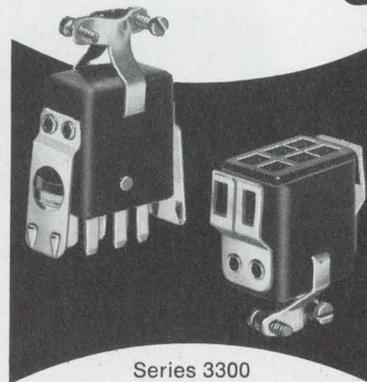
Interfaces are available for 25 mini computers. Prices start at \$2,900.
TRI-DATA 800 Maude Ave., Mountain View, Ca. 94040
 (415) 969-3700

INFORMATION RETRIEVAL NUMBER 44

Set an improved *PDQ standard
by comparing with

BEAU

Connectors



Series 3300

*PDQ:

Price — right
 Delivery — dependable
 Quality — proved

BEAUPUG® Series 3300 electrical connectors, for instance, have been developed to provide a reasonably priced, reliable, versatile connector for chassis, cable and modular use where space is not a prime consideration.

Request PRICE/
 CATALOG No. 75-DA

Beau Products Division

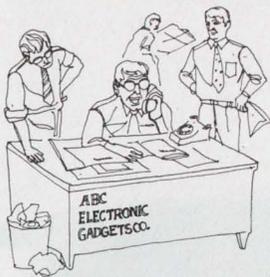


**Vernitron
 Electrical Components**

117 Union Avenue, Laconia, N.H. 03246
 Tel: (603) 524-5101 TWX: 710-364-1843

INFORMATION RETRIEVAL NUMBER 45

ELECTRONIC DESIGN 9, April 26, 1970



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

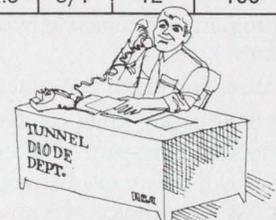
RCA tunnel diodes offer prime advantages of immediate availability plus remarkable stability proved by over a million device-hours of testing.

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

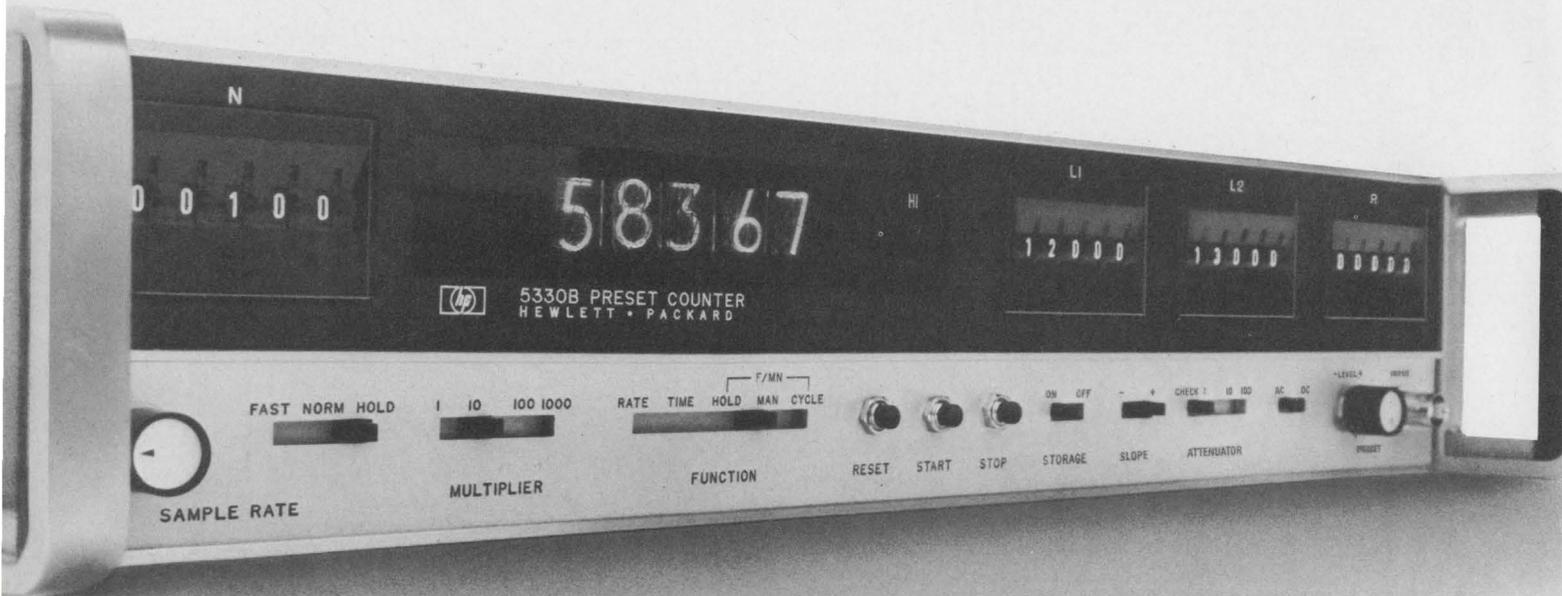
Added features: the gold-plated leads require no pretinning for soldering efficiency. And the package lends itself well for high-volume PC-board mounting operations. Use RCA tunnel diodes especially in your high-speed switching and high-frequency signal-processing applications.

See your local RCA Representative for more information. Or call your RCA Distributor—he's fully stocked. Special selections are yours if you need them. For technical data on specific types, write: RCA Electronic Components, Commercial Engineering, Sec. DSG-26, Harrison, New Jersey 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

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



RCA



Quite simply, the most versatile preset counter ever.

It's the new 5330B Preset Counter from Hewlett-Packard. It can do about twice as much work as the second best preset counters. Yet it's priced about the same.

This 10 MHz counter can:

Normalize counted data to units such as gpm, psi and rpm.

Issue control signals when preset count or count rates are reached.

Introduce a selected offset in the reading.

Be programmed remotely by automatic systems.

Totalize, find ratios and time intervals.

The 5330B gate times can be selected by a 5-decade front-panel "N" switch to any number of time units between 1 and 100,000. With a choice of 1 μ s, 10 μ s,

0.1 ms and 1 ms time units ("M"). So you can get normalizing factors from 1 to 10⁸.

This flexibility, together with the two limit control switches (L1 and L2), lets you virtually automate many processes such as batching. The limit switches generate output signals when the preset count is reached. These signals become the commands for your computer-run system.

The optional zero offset can be set at any number between 0 and 99,999. This lets your count start from a specific number and return to that number automatically.

All four of these functions can be remotely preset. It's also the first preset counter to offer an anti-noise option. This rejects high frequency noise that might mask low-frequency data.

You can also use this preset counter as a frequency divider. As a delay generator. Or as a precise, digitally selectable pulse generator.

If the 5330B is too versatile for you, the 5330A should be just right. It does slightly less (without limits, but zero offset option available), and costs slightly less.

The 5330A is \$1200. The 5330B is \$1550. To find out just how much they can do for you, call your local HP field engineer. Or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT  PACKARD

ELECTRONIC COUNTERS

Publisher

Hugh R. Roome

Editors

New York Office
850 Third Ave.
New York, N.Y., 10022
(212) 751-5530

Editor: Frank Egan

Managing Editor: Ralph Dobriner
Managing Editor: Raymond D. Speer
Microelectronics, Steven A. Erenburg
Computers, Milton J. Lowenstein
Circuits, Don Mennie
Microwaves, Michael J. Riezenman
Management, Richard L. Turmail
News, John N. Kessler
Military-Aerospace, John F. Mason
New Products, Roger Allan
New Products, Lucinda Mattera
Directory Manager, Greg Guercio
Copy, Marion Allen

Field Offices

Massachusetts

Jim McDermott
P.O. Box 272
Easthampton, Mass. 01027
(413) 527-3632

San Francisco

Elizabeth de Atley
2051 Wellesley St. (Suite D)
Palo Alto, Calif. 94306
(415) 321-7348

Los Angeles

David Kaye
2930 Imperial Highway
Inglewood, Calif. 90303
(213) 757-0183

Editorial Production

Dollie S. Viebig
Richard D. Grissom

Art

Art Director, Clifford M. Gardiner
Assistant, William Kelly
Rita Jendrzejewski
Lynn Thompson
JoJo Miskimmon

Production

Manager, Thomas V. Sedita
Helen De Polo
Kathleen McConkey
Leslie Stein

Circulation

Manager, Nancy L. Merritt

Information Retrieval

Genate Piccinetti

EDITORIAL



The industry can help solve postal chaos

Labor trouble is not the only problem facing the U. S. Post Office Dept. A headache of major proportions is the evergrowing volume of mail that must be handled each day by the nation's 32,000 postal offices. This year, nearly 82 billion pieces of mail will be processed. The New York City post office alone deals with 35 million pieces of mail daily, more for instance, than all of Belgium handles.

Despite a budget of \$7.13 billion and 725,000 workers, the Government's largest civilian agency is gradually cracking under the strain. The fact is that the American postal service is slower and less reliable than those of many other nations—even some underdeveloped ones.

In 1968 the President's Commission on Postal Organization, headed by former AT&T chairman Frederick R. Kappel, declared that each year the Post Office "slips farther behind the rest of the economy in service and in efficiency." The commission found that mail handling has changed little in the past century. Last May, President Nixon said: "Total reform of the nation's postal system is absolutely essential."

With the recent strike still haunting the Government, it appears that this long-awaited reform will finally take place. Modernizing this Model-T monolith will require billions of dollars to be spent over many years and will utilize the technological skills of the nation's scientists and engineers—a sort of postal "Project Apollo."

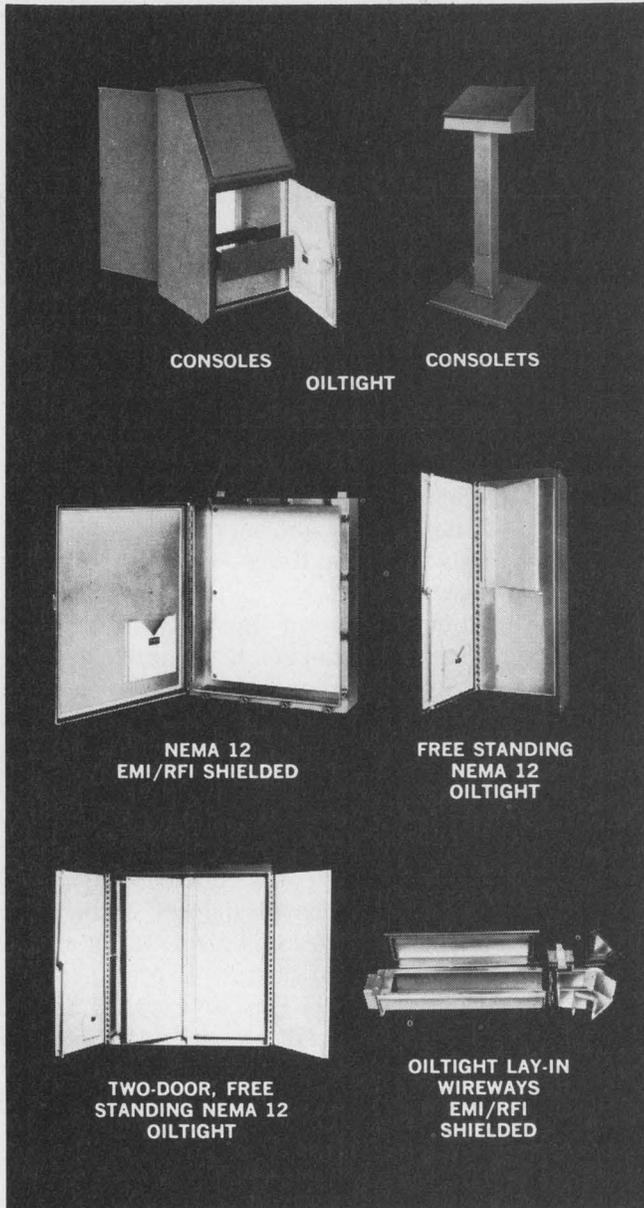
The Post Office has in recent years begun to employ several sophisticated systems to speed up the handling and processing of mail. Optical scanners are being used to sort and cancel letters. Machines are being developed to read zip code numbers and extensive use is made of computers, primarily for administrative and payroll purposes.

Nevertheless, only a tiny portion of the enormous resources and skills of the electronics industry has been brought to bear on the problems of the Post Office.

We believe that, first and foremost, the postal system's deteriorating and archaic approaches to both moving the mail and administering the organization need to be overhauled. And we also believe that electronics technology will play an increasingly important role in postal reform.

RALPH DOBRINER

Hoffman's Pollution Solutions



Hoffman enclosures are designed to keep your electronic instruments and controls pollution free. So if you're having a problem with oil, dust, moisture or electromagnetic interference, Hoffman has a variety of solutions for you. In many shapes and sizes.

Within this wide variety of products, however, one thing never varies. Quality. Since their introduction, Hoffman enclosures have met with widespread acceptance because of their consistent high quality. And we're not about to change that.

If you would like our latest literature, please write.

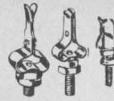
Hoffman

HOFFMAN ENGINEERING COMPANY
Division of Federal Cartridge Corporation
ANOKA, MINNESOTA DEPT. ED61

**ELECTRICAL
ENCLOSURES**

INFORMATION RETRIEVAL NUMBER 48

FOR EXCELLENCE IN TERMINATION HARDWARE SPECIFY GRAYHILL



Test Clips

Test Clips

Adjustable tension, threaded studs or plug in bases, various sizes.



Push Posts

Push Posts

Plunger action lets you connect and disconnect quickly and easily, assures positive contact.



Stand-Off Insulators

Binding Posts

Screw type or spring loaded, banana plug or stud mounting, single or multiple units, with various colors for circuit identification.



Binding Posts

Stand-Off Insulators

High dielectric strength, low loss insulation, low moisture absorption, various mounting styles.



Sockets

Sockets

Lamp or transistor, various colors, various mountings including printed circuit.



Plastic Molded Parts

Custom Molded Parts

Tight tolerances provide you with "assembly ready" units. Thermosetting plastics to meet most specifications.

For your Grayhill Engineering Catalog offering complete technical data—contact

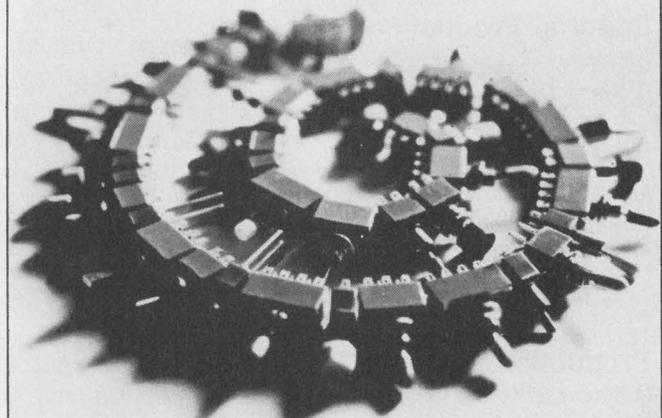


565 Hillgrove Avenue
LaGrange, Illinois 60525
Area Code 312, Phone 354-1040

... the Difference Between Excellent and Adequate

INFORMATION RETRIEVAL NUMBER 49

**WE'LL GIVE YOU
100 SUBMINIATURE
TOGGLE SWITCHES AND
ONLY CHARGE YOU
FOR ABOUT 92.**



The price of all C&K toggle switches has just been reduced approximately 8%. Same C&K quality. Same Made-in-America label. Now at the lowest price ever. Inflation. Thy days are numbered.

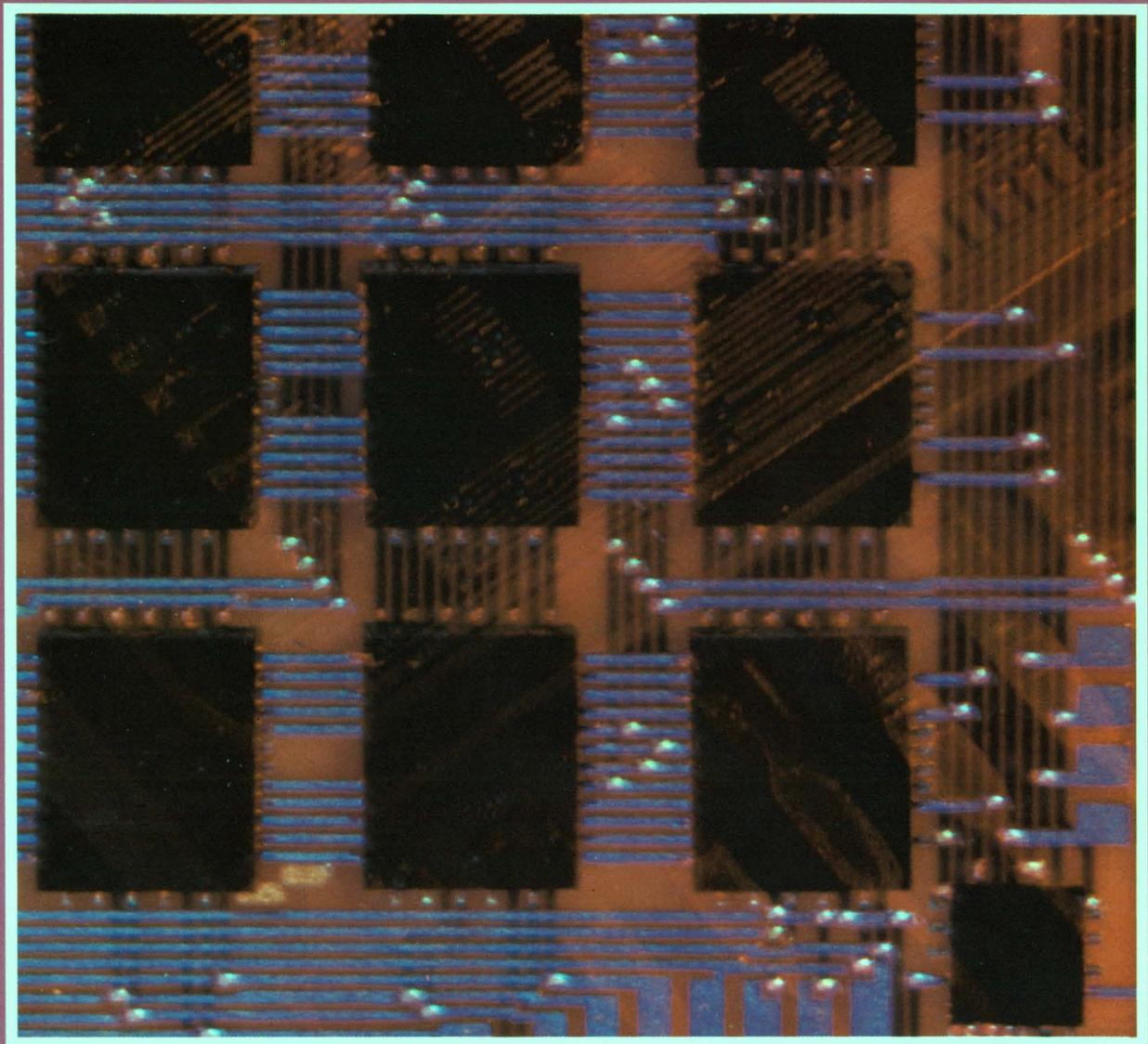
C&K COMPONENTS, INC.

103 Morse Street, Watertown, Massachusetts 02172
Tel: (617) 926-0800

INFORMATION RETRIEVAL NUMBER 50

ELECTRONIC DESIGN 9, April 26, 1970

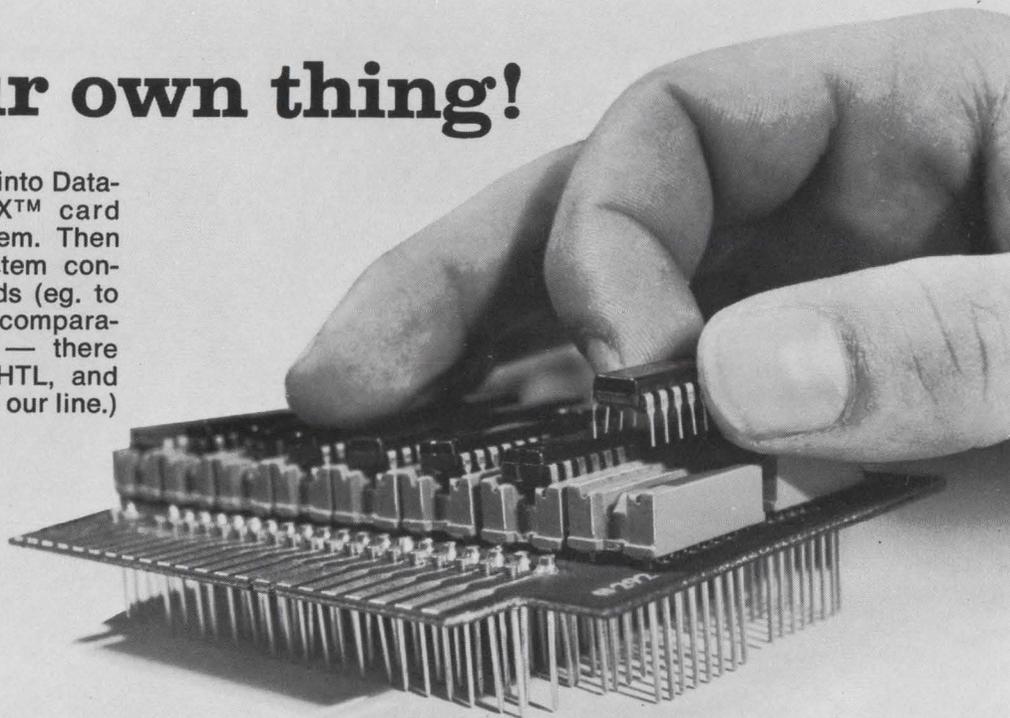
Spring Joint Computer Conference 1970



An Electronic Design Special Report

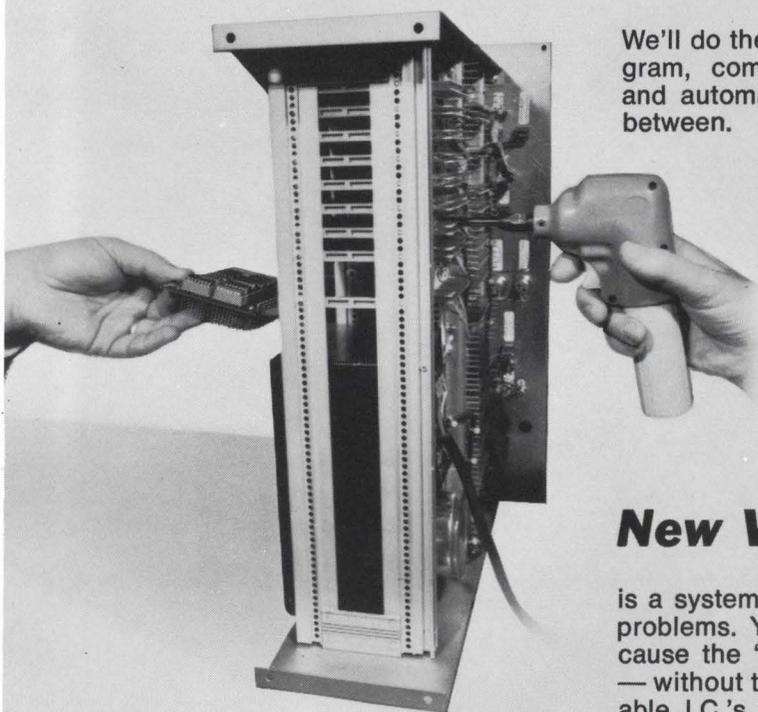
do your own thing!

Plug standard I. C.'s into Datascan's new Wrap-X™ card and interconnect them. Then to complete the system connect to function cards (eg. to decimal converters, comparators, shift registers — there are over 100 DTL, HTL, and TTL function cards in our line.)



or let us wrap it up!

We'll do the job from your schematic or block diagram, complete it with computer-aided design and automatic wire wrapping — or anywhere in between.



New Wrap-X Concept

is a systems approach to solving your packaging problems. You save time, money and trouble because the "X" factor is now part of your system — without the cost of customizing. Standard, available, I.C.'s, plus Datascan Wrap-X cards and function logic cards are all interconnected to give you one-company responsibility for completely wired and tested hardware, at lower installed costs.

Start saving with Wrap-X cards, write for complete information.

Datascan

DATASCAN, INC.
1111 Paulison Avenue, Clifton, N. J. 07013
Telephone 201-478-2800

we're **JACKING UP** the
current rating on eleven of
the **JQE** power supplies



THE 0-25 VOLT, 0-36 AMPERE MODEL IS NOW GOOD FOR 0-25 VOLTS AT 0-40 AMPERES. THE 0-36 VOLT, 0-25 AMPERE MODEL IS NOW RATED FOR 0-30 AMPERES. OUR 0-55 VOLT MODEL USED TO BE 0-18 AMPERES. NOW IT'S 0-20 AMPERES!

— No Other Characteristics Have Changed —

All ratings are still good, *without derating over a -20°C to +71°C temperature span, continuous duty.* The regulator still provides a line effect (105-125V a-c) less than 0.0005% and load effect (0-100%) less than 0.005%, ripple: less than 100 μ V rms.

JQE models feature optional overvoltage protectors, operational control and, with their high-speed programming option, are the most powerful wide-band amplifiers offered. (60W to 1125W!!)

Kepco's brand new 1970 catalog lists all eleven increased-rating JQE models *PLUS* three NEW MODELS, 0-150 VOLTS at 0-1.5A, 0-3.5A and 0-7A. A total of 32 JQE models in all plus, of course, some 200 other power supplies, modules, high voltage, high speed, bipolar, digitally-controlled and current regulators.

... write for your copy today
Dept. V-05

KEPCO®

KEPCO, INC. • 131-38 SANFORD AVENUE • FLUSHING, N.Y. 11352
(212) 461-7000 • TWX # 710-582-2631
Telex: 12-6055 • Cable: KEPCOPOWER NEWYORK

INFORMATION RETRIEVAL NUMBER 121

ZM1000
READOUT
TUBE
NOW



295
IN THOUSAND LOTS



The Amperex ZM1000 is the first digital numerical indicator tube, designed from the ground up for high-volume applications. It provides big economies, not only in initial cost but also in application. Its low price of \$2.95 in thousand lots is only part of the story... in volume, the ZM1000 sells for less than \$2.00.

We scrapped every notion about how to make numerical indicator tubes and developed a completely new design that offers unsurpassed performance and reliability at mass-production prices.

Every ZM1000 has a built-in decimal-point indicator. Use it if you wish—or ignore it... in either case, there's no additional cost for the decimal-point. The ZM1000's large numerals are clearly legible at 35 feet, yet an 8-digit readout can be installed in only 6 inches of panel.

Superior design makes the ZM1000 more economical to use, too; its high-temperature base is designed to plug directly into a printed circuit board or an inexpensive, readily available socket.

- IMPORTANT FEATURES
- Dynamic life expectancy..... 200,000 hrs.
 - Height of numeral..... 0.6"
 - Tube diameter..... 0.75"
 - Height of tube..... 1.67"

For complete data and comprehensive application bulletin on indicator-driver circuits for the ZM1000, write: Amperex Electronic Corporation, Semiconductor and Microcircuits Division, Slatersville, Rhode Island 02876.

Amperex®
TOMORROW'S THINKING IN TODAY'S PRODUCTS

A NORTH AMERICAN PHILIPS COMPANY

1970 Spring Joint Computer Conference

special report

by **Milton J. Lowenstein**, Technical Editor

The minicomputer: The machine with an endless future has excited a great deal of interest because of its myriad applications and its versatility C6

product source directory

Minicomputer manufacturers are almost as numerous as the uses for their products. Here is a listing of them and their current models C25

products

Digital 16-bit computer uses both IC and core memories for a low cost and 100-ns cycle time. C36

Desk-size terminal computers communicate with any other terminal or act as free standing systems C42

Off-line, on-line printers furnish book quality printed copies at low cost. C46

Desk-top data display incorporates a keyboard input and a CRT monitor in a \$500 package. C41

Novel storage terminal provides low-cost computer graphics in a 30 MHz read-and-write bandwidth. . . . C51

Cover courtesy of Computer Microtechnology, Inc., Sunnyvale, Calif. shows a 40%-bit read/write hybrid semiconductor memory.

The minicomputer:

machine with

"The minicomputer industry is the fastest-growing segment of the fastest-growing business in the world."

This statement by the director of marketing of a minicomputer manufacturer—Allen Z. Kluchman of Data General Corp., Southboro, Mass.—sums up the impact of an idea that has been kicked around in the computer industry for six or seven years but only began to bear fruit two years ago.

The minicomputer's name comes from its small size, but its most significant feature is its relatively low cost. Doubling its physical size probably would not affect the rising sales curve drastically; doubling its price would have a strong adverse effect. All of the applications, therefore, reflect the fact that it can penetrate markets never before entered by computers.

The computer industry is now turning out its third generation of large machines. Today's minicomputer has the computing power of the first-generation Univac I, but it is rapidly growing beyond that benchmark. New developments in large-scale integration (LSI) of semiconductors, either already here or just over the horizon, will accelerate that growth.

The applications of the minicomputer run the gamut of the computer business:^{1,2} It is used alone to solve scientific and engineering problems. It gives the small businessman the ability to automate his payroll, billing and inventory-control operations. It is used to control the operations of process industries and manufacturing plants. It replaces hard-wired logic in switching systems. It performs as a data concentrator for data-communications systems. It operates test lines in manufacturing and reads, records and reduces data for engineers in development laboratories. It maintains the medical and financial records of patients in hospitals.

The list is endless. In the words of one manufacturer: "The market grows with each inquiry from a prospective customer."

Some of the minicomputers are general-purpose and can be adapted to any number of different applications. These machines give up some computing power and speed for their flexibility, but the big demand for them, and consequently the longer production runs and higher

sales, make it possible to cut prices.

Other minicomputers are aimed at specific markets and are more specialized. These machines have higher performance and probably higher initial costs.

Some of these generalizations do not take into account the cost of peripheral equipment, which makes the minicomputer a computing system. They are impressions gained from talking to many manufacturers, however.

Electronic engineers have three areas of contact with the minicomputer. They are the design of the machine, its component parts and its peripheral equipment; the use of the machine as an adjunct to other engineering endeavors, such as problem-solving or as a laboratory tool; and the engineering of applications for customers who have a specific task to perform. All include hardware and software design.

For an engineer to perform these functions, he must be aware of the characteristics and limitations of the machines.

Let us, therefore, take a look at some of the many possibilities. The engineer is probably most familiar with computers used to aid in the design of circuits and equipment.³ Can the minicomputer operate in this area?

A challenge to time-sharing

Here it is a question of minicomputers vs commercial time-sharing services, and the stand that one takes depends strongly on the speaker's affiliation. The user's point of view is "show me." The time-sharing service or the manufacturer of computers for use in commercial time-sharing has little but disdain for the minicomputer. The minicomputer manufacturer echoes Eliza Doolittle: "Just you wait. . . ."

The issue, of course, is how to get more computing power for the dollar. The time-sharing service is weighted down by the cost of communication lines, over which it has no control, and terminal charges while the user is on-line but not computing. These two costs can amount to half or more of the total charge for the use of a time-shared computer.

The big machines that the commercial services offer, however, can do a great deal of com-

an endless future

Glossary of common computer terms

Byte. A group of bits, usually 4 to 8 that form a sub-unit of information. A word may contain one or more bytes.

Central processing unit (CPU). The arithmetic and control portions of a computer.

Compiler. A computer program that prepares a machine language program from subroutines written in other programming languages.

Cycle time. The time required to complete one loop. It is the basic time unit of computer operation.

Direct memory access. Direct communication between memory and peripherals. In computers where this is not inherent, a device that bypasses the CPU.

Firmware. Programs or instructions stored in read-only memories; analogous to software in a hardware form.

Hard copy. Computer output in a form that can be saved—for example, printout on paper is hard copy; display on a cathode-ray tube is not.

Hardware: The physical components of a computer.

Interface. A connection between a computer and some other device that either transmits to or receives information from the computer. Interfaces must provide information in a form compatible with computer's needs.

Interrupt. A break in the flow of a program that permits the program to be resumed at a later time. The source of the break may be internal or external.

Language, assembly. A computer language that has a one-to-one correspondence with an assembly program, which directs the computer to operate on a symbolic language program to produce a machine language program.

Language, higher order. A programming language that is independent of the computer. It usually resembles natural languages and requires a compiler for translation into machine language. FORTRAN and ALGOL are examples.

Language, machine. A programming language

used directly by a machine. It includes machine addresses and operation codes. It is the end result of compiling a source language program.

Macroprogram. A computer program written as a sequence of instructions in a source language.

Main frame. The central processing unit of a computer plus the input/output unit and the random-access and read-only memories. The mainframe is the computer without peripherals.

Microprogram. A computer program written in the most basic instructions or subcommands that the computer is capable of executing; commonly it is stored in a read-only memory.

Multiprogramming. A method by which many programs can be operated on within the same time span. The programs are overlapped or interleaved. This technique is the basis for time-shared operation.

Operating system. The totality of software that describes the methods by which data is processed to obtain a desired result.

Peripheral. A device through which the computer communicates to the outside world. The term may also include auxiliary memories, such as tape, disc and drum.

Random-access memory (RAM). A memory that can be written into or read by locating any address in which data is stored.

Read-only memory (ROM). A memory in which the information is stored at the time of manufacture. The information is available at any time, but it can be modified only with difficulty.

Software. The programs and instructions for a computer.

Word length. The number of bits in a sequence that is treated as a unit and that can be stored in one computer location. Longer words imply higher precision and more intricate instructions.

puting that the minicomputers cannot. The reason: the very large memories that the big machines have. Complex programs cannot be stored in small memories. Richard McNair, computer scientist of XDS, El Segundo, Calif., a supplier of computers to many time-sharing services, refers to this when discussing computer-aided design (CAD) for circuit programs. He says: "The size of the programs that are being used in CAD are such that the minis cannot handle the number of program statements required. CIRC dc has 7000 statements, and CIRC ac and SCEPTRE have over 15,000. Some things can perhaps be put on a minicomputer instead of in commercial time-sharing, but I don't know what. I think that time-sharing can do most CAD better."

XDS's manager of product marketing, Lawrence Israel, has a different reason for believing that minis pose no serious competitive problem for time-sharing services. He says: "The running costs of a self-contained in-house computing system—including maintenance, setting up and choosing auxiliary and peripheral equipment—have an adverse effect on cash flow that use of a time-sharing service does not."

Israel also points out that time-sharing services supply more than just time on a computer. They are large suppliers of software to their customers. The user of an in-house computer system must either buy or supply his own software. Israel foresees minicomputers restricted to data communications, control and laboratory system applications.

Time-shared minicomputers offered

Three of the largest manufacturers of minicomputers see few restrictions on the use of their machines. They are Digital Equipment Corp. of Maynard, Mass.; Hewlett-Packard, Palo Alto, Calif., and Varian Data Machines, Newport Beach, Calif. Both Digital Equipment and Hewlett-Packard now offer minicomputers for in-house computing applications, and Varian is planning to offer one shortly. These systems adopt one feature of their competitors: they are interactive time-shared computers. Usually as many as eight remote terminals can be linked to one minicomputer central processing unit.

Minicomputer manufacturers refute the anti-mini arguments one by one. The minicomputer manufacturer can choose, set up and maintain a system for a user. The system can be leased, so that the customer need not make a capital investment. The manufacturer can make software available—perhaps not free, but neither is a time-sharing service's software strictly free either. Time-sharing service charges include the cost of software. The only objection that the

minicomputer manufacturer cannot answer is that the computing capability and memory size offered by the time-sharing services is larger.

But in one respect the minicomputer can outperform the time-sharing service, according to Zvonko Fazarinc, an engineer with Hewlett-Packard. He does not design computers, but he does have one available for his use in designing test equipment.

Fazarinc dismisses the small memory as of little importance. His machine has a 16,000-word memory, but he believes that 8000 words are sufficient for most jobs. He concedes that SCEPTRE needs over 15,000 source statements, but he says that SCEPTRE has general-purpose capabilities to make it useful for a wide variety of problems. Fazarinc's circuits have restricted requirements and can be designed with much smaller programs. He says: "We make the program as big as the circuit requires."

A typical problem—the design of a Schmitt-trigger—was run by Fazarinc in CIRCUS, SCEPTRE, SYSCAP and on his mini. The running times were 80, 85, 30 and 35 seconds, respectively—this in spite of the fact that the big programs ran on machines that could multiply 500 times as fast as the minicomputer.

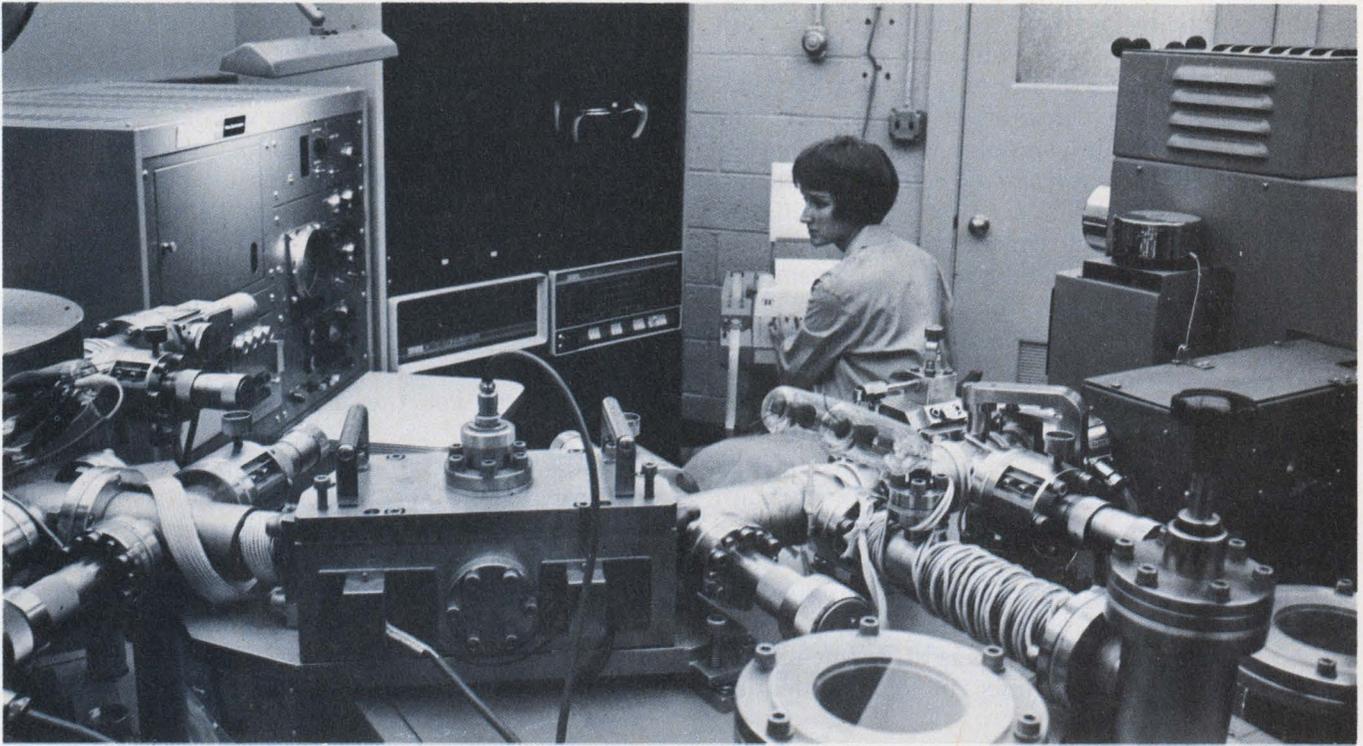
Up-to-date software needed

Another disadvantage of the time-sharing services' CAD programs, according to Fazarinc, is that they are obsolete. They are being maintained on-line only because nothing better is available. Fazarinc calls them obsolete because they are all linear programs with limited nonlinear capabilities. He thinks that the engineer with a nonlinear problem is better equipped to solve it if he has his own minicomputer at hand and can try out his own programs. Fazarinc says:

"Linear circuit analysis by computer is a waste of time. It has been done over and over again. If a circuit-analysis program can't do nonlinear problems, it is useless."

Fazarinc is particularly in favor of a minicomputer terminal dedicated to serving one engineer at a time. This permits the use of a program as a substitute for an actual circuit on a laboratory bench. The dedicated computer allows the engineer to study his circuit in depth; to examine its performance at any point. A plotter, or a device as simple as a strip-chart recorder, can be attached to the computer to make hard copies. The low cost of the minicomputer makes such dedicated operation possible.

It is likely that these two strongly opposing opinions—that minicomputers cannot design effectively, on the one hand, and that they will displace commercial time-sharing services, on



Mass spectrometer measurements are run in a laboratory environment under the control of a minicomputer.

The use of semi-skilled personnel foreshadows similar applications in the field.

the other—overstate the case for and against the in-house, stand-alone minicomputer. The future will probably see some compromise in marketing positions.

A projection by the Diebold Group, Inc., a New York management consulting concern, indicates that another rapidly growing segment of the computer industry over the next five years will be in information services. This category includes time-sharing services as a significant component. Diebold says that there is room for both the time-sharing and minicomputers to grow here.

On the lower level of capabilities, the desk-top calculator enters as a possible competitor of the minicomputer. Some programmable desk-top calculators have a degree of sophistication that approaches that of the minicomputer. But the price does, too—and that is the kicker. The most elaborate desk-top calculators, which are completely self-contained machines (they require no auxiliary equipment to perform their functions, however limited), can be installed on an engineer's desk for about \$5000. The addition of such frills as a printout and a plotter can double this figure. A time-shared minicomputing system with eight terminals can be installed for \$25,000 to \$50,000. Each terminal costs as little as \$3000 and is, therefore, competitive with the desk-top calculator.

The likelihood is that the winner in this particular showdown will be the mini. Sophisticated desk-top calculators will be forced to become

either more simple (and cheaper) or more elaborate—until they, too, are minicomputers.

The problem-solving minicomputer will carve out a niche for itself between the successors of the adding machine on one side and sophisticated commercial time-sharing services on the other. It is likely that none of the three manufacturing categories will suffer too badly in this competition, because each will grow in its own area as the market expands.

Minicomputers to concentrate data

Communication of data over leased telephone lines is very expensive. It is, in fact, one of the major cost items in the use of commercial time-sharing systems. One reason for the high cost is that most user terminals are standard teletype or electric typewriters that operate at low data rates. The ordinary voice-grade telephone line is capable of transmitting data considerably faster than the average terminal can handle it.

Other factors enter into the cost of using telephone lines in time-sharing. Users operate in an on-line mode when, in reality, they are only pondering their next step. A user who is attempting to decipher the computer's diagnostic statement while on-line is wasting valuable telephone time. High-speed terminals can transmit data more rapidly, but they cannot speed up the operator of the terminal.

Because of these considerations, the minicomputer will become a partner of time-sharing in

another way: as a data concentrator for both the user and the service. The concept is simple. Use a minicomputer at the output of a terminal to store data being transmitted by the user. The memory in the minicomputer thus becomes a fairly large buffer storage. When all of the information has been delivered by the terminal to the minicomputer, the central time-shared computer can be accessed and the data transmitted at high speed in a brief time. The process is reversed for data transmission from the central computer.

When a time-shared computer user has many terminals at one site, the technique is even more useful. The user in this case can be connected continuously to the central computer through only one data line. All of the terminals feed into the buffer storage in the minicomputer, which in turn transmits the data over the single line. In addition to the computations being time-shared, the data transmission is also time-shared with a consequent savings in communication costs.

First used in laboratories

The earliest applications of minicomputers were in the development laboratory, where the ability of the machine to digest large stores of data was of special interest.^{4,5} Engineers and scientists were among the first to conceive of the possibilities of small computers, and they provided the impetus that led to the development of the minicomputer.

At first, the computer was used to record data and to perform elementary operations on it. As the technique became more elaborate, the minicomputer was required to perform at higher and higher levels, until the current capabilities were reached. Now, engineering measurements that require many days or weeks of conventional data-taking by technicians and computation by engineers can be completed in hours.

The key to the technique is to make use of measuring instruments as peripherals to the minicomputer. The instruments must either have computer-compatible digital outputs, or, if they are analog instruments, they must have a suitable analog/digital converter as an interface to the computer.

Interactive experiments made possible

One unique consequence of the minicomputer in the laboratory is the practicality of interaction between the engineer and the experiment. The computer is operated on-line. The results of an experiment are available in real time, so the experimenter can return to the set-up, modify it and obtain new results—all in less time

than it previously had taken to copy down the readings of the instruments.

The practicality of using a minicomputer in the laboratory to perform as an on-line controller for the taking of data and as a computer for the reduction of data depends on many factors. They include the kind of data being taken and the speed at which it is read; the amount of computation needed to reduce the data to usable form; the need for modification of experimental set-ups as the experiment proceeds; and the quality and quantity of hardware and software necessary to get the experiment going in the first place.

The applications of the technique cover the electromagnetic spectrum and then some. Conventional electrical measurements—including voltage, time and frequency responses, spectrum analysis and the like—are commonplace. More abstruse applications include pulse-height measurements in high-energy physics, nuclear magnetic resonance, laser and maser phenomena and mass spectrometers. On the less sophisticated end of the list, the engineering and scientific applications merge with those of the test line and the factory. As older techniques become more familiar, they are adopted by the production department and new, sophisticated devices replace them in the science laboratories.

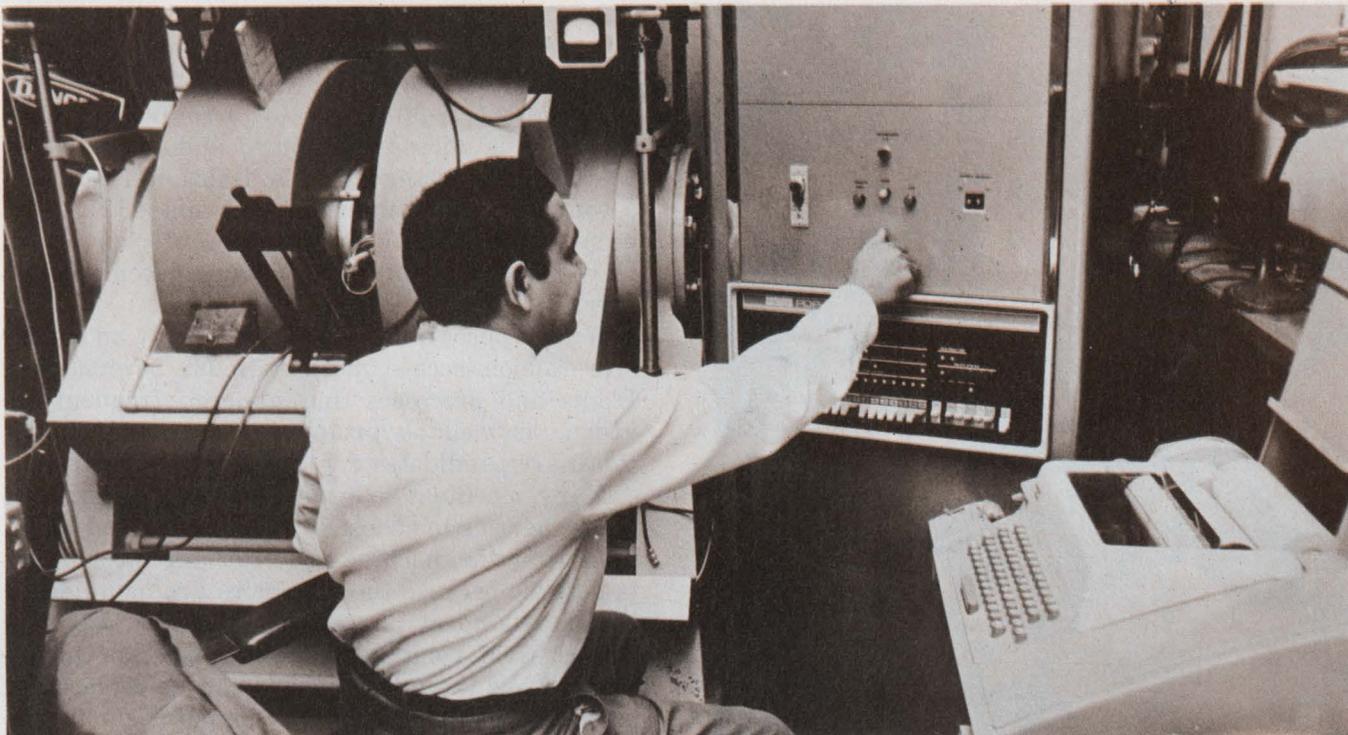
Hard-wired logic replaced

Hard-wired logic has been used for many years in many forms. Before logic terminology became common and before electrical engineers were aware of Boolean algebra, designs embodying these techniques were created with relays. One such application was an automatic elevator control. Later hard-wired circuits followed in the wake of electronic technology: vacuum tubes, thyratrons, semiconductor diodes, transistors.

There are three basic operations in hard-wired logic: interlocking, sequencing and selection. All of these can be performed with minicomputers. The sensing elements, whether they be switches, photoelectric devices, proximity devices or any other detector, become the peripheral devices for the computer. The interconnection of the logic that determines the mode of operation becomes either a computer program (software) or a microprogrammed read-only memory (firmware).

Minicomputer cuts design costs

The major reason for using a minicomputer to replace hard-wired logic is a reduction in cost. Each job requiring hard-wired logic is unique. The traditional approach has been to design the logic circuits—a process that requires the atten-



Nuclear magnetic resonance studies are being done with the aid of a PDP-8/L minicomputer by Dr. Garg of the National Research Council, Ottawa, Can. The reso-

nance chamber in which magnetic and rf fields act on the sample is the large cylindrical device which is shown on Dr. Garg's left.

tion of engineers and draftsmen. Then it is necessary to procure the material, design and fabricate circuit cards, wiring and racks, and to manufacture and test the resulting product. The costs in this process can be considerable, even with relatively simple systems, because of the high labor skills involved.

Until the prices of minicomputers dropped to their present levels, the use of a computer as an alternative to hard-wired logic was not even considered. Now, however, it is possible to eliminate all of the labor costs of the design and manufacturing phases by using a computer. This does not imply that the use of the computer is free. There is the little matter of programming, either micro or macro, which erode a considerable portion of the savings. In some cases, it may cost more to program a computer than to design and build hard-wired logic. But the computer brings additional benefits.

One serious problem in the use of hard-wired logic is that the processes to be controlled are rarely specified fully at the time the logic is being designed. The engineers must make some assumptions that become part of the design. If the assumptions are not consistent, or if the process itself changes after the logic is designed, the logic must be modified after it is built. Such modification requires more engineering time, more documentation and rewiring, and this can easily double the cost of the original design.

But with a computer program, the modifica-

tions are made to the software, and this is a much simpler, and less costly and less time-consuming operation.

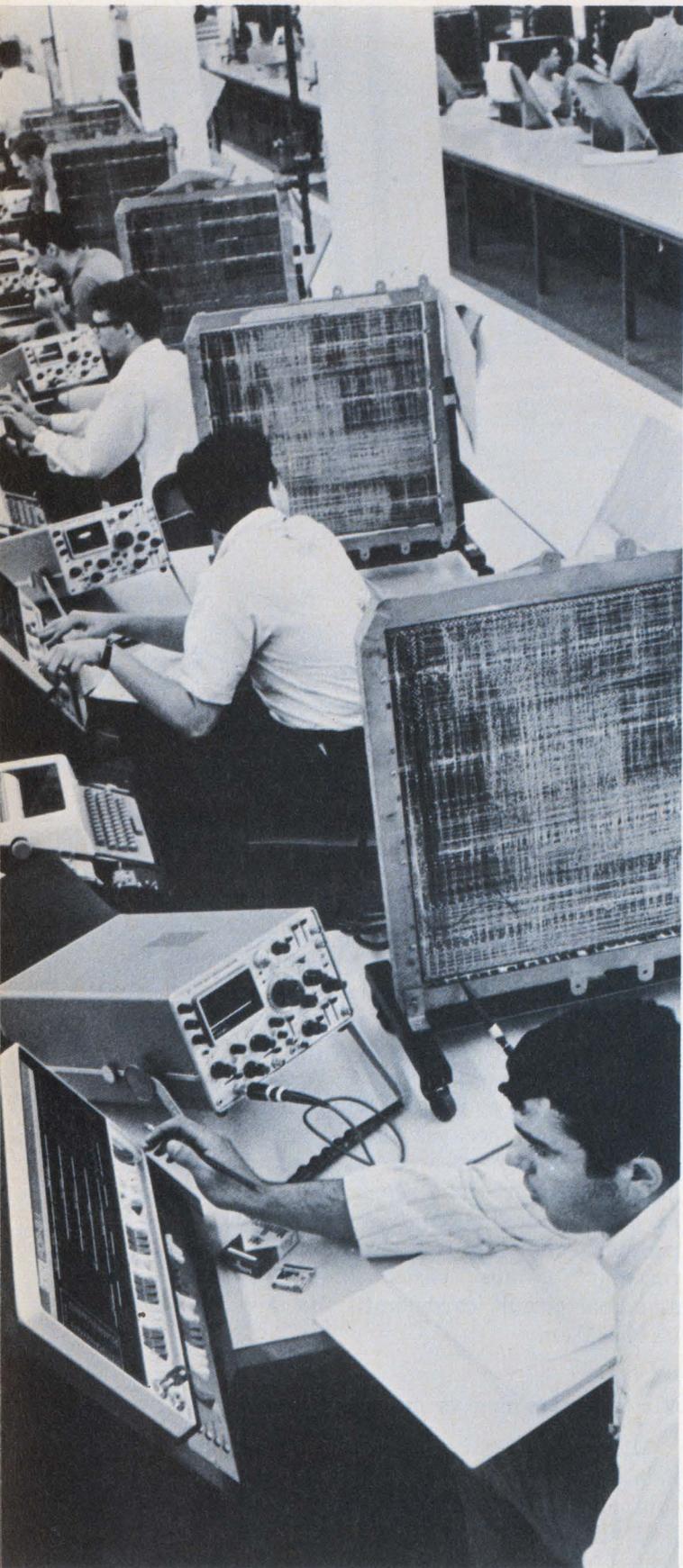
After the control system is put into operation—in a chemical plant, say—the plant may find it necessary to alter its operations. With the minicomputer, the alteration can be made by modifying the software again. With wired-in logic, the hardware must be ripped out and completely redesigned.

Maintainability is also improved with use of the computer, because the machine is a standardized component with a recognized maintenance procedure. The repair and maintenance of hard-wired logic requires the attention of a trained technician. Computer repairs can be performed, in most cases, simply by replacing standard circuit cards until the device is again in operation.

Microprogramming vs macroprogramming

Minicomputers designed to be used as replacements for hard-wired logic are usually called controllers. These machines are typically organized with 8-bit word length and either random-access memories (RAM) or a combination of random access and read-only memories (ROM). The 8-bit word and the ROM are factors in making minicomputer controllers the lowest priced main frames in computer catalogs.

When a read-only memory is specified, the



Minicomputers are used to test minicomputer subassemblies at the Digital Equipment Corp., Maynard, Mass. Besides performing all the tests, a hard copy of the results becomes part of the documentation of each part. The Digital plant now probably has the highest concentration of test minicomputers everywhere.

user is accepting some limitation on the flexibility of the machine in exchange for a saving in initial cost. However, complete flexibility is not usually a requirement for a controller. Since the ROM is microprogrammed and is not easily accessible for change, it is a desirable feature in a controller when unauthorized tampering must be prevented. The microprogram, of course, can be revised at any time should this become necessary.

If macroprogramming is necessary, an extensive random-access memory must be included. Plants and processes that undergo frequent revision, as well as prototypes for new installations, are candidates for computers with RAMs.

Many machines are now on the market that allow the user to choose between RAM and ROM, even after the machine has been purchased. This is possible because the memories are mounted on the same kind of plug-in circuit cards that give this class of computer a high degree of modularity. Thus the memory card can be replaced at a fraction of the cost of the computer should the original choice of memory prove to be wrong.

Minicomputers invade the factory

Minicomputers are about to become standard equipment in the modern factory.^{6,7} By replacing hard-wired logic, they can function as machine and process controllers. They can also exercise supervisory control over a series of machines and processes. Probably the most significant new application is in running test lines⁸ at both the incoming inspection and final test points.

The use of computers in factories is expanding into smaller and smaller plants. These applications involve the control of inventory, cost and labor units. Minicomputers can perform the entire function in small factories and can feed information into central computers in larger factories.

Numerical control has been another expanding area of computer use in manufacturing. Until recently, only large computers were available, so machine tools had to be controlled in groups to take advantage of the computer's capacity. Now the smaller machines allow integral computers to be installed on machine tools, with an important improvement in flexibility of use.

Computers test other computers

One of the most interesting minicomputer applications got its start not long ago when Digital Equipment Corp. began to use its own products to test its output. The Digital plant now probably has the highest concentration of test minicomputers anywhere.

Every stage of manufacturing is tied to a

computer test line. Logic modules are tested through all of their functions in a small fraction of the time that the same job would take if done manually. As an added plus, a hard copy of the test results is immediately available for each module. If the unit passes, the printout is a record of the test; if it doesn't pass, the printout describes the repairs that are needed.

At higher levels of assembly, the computer-controlled test line performs similar, but more involved functions. Final test of virtually all minicomputers of any manufacture is now carried out by a companion unit. Programs are written to exercise all computer functions and to supervise environmental testing, since repeated heat soaks are a standard procedure in the quality-assurance procedure.

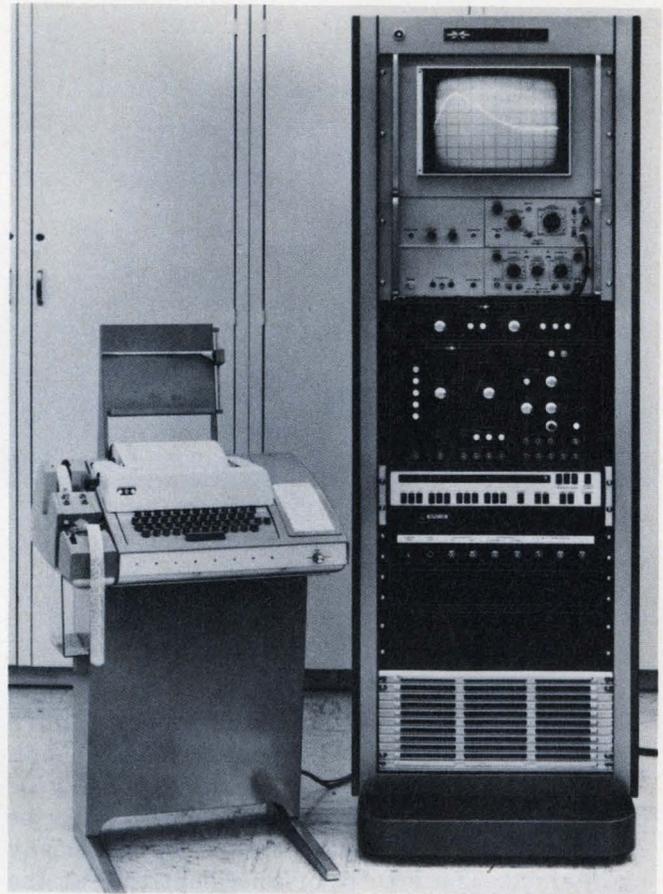
Manufacturers of other products also rely on automated test lines. Steel mills that produce tinplated sheets for cans use sensors connected to minicomputers to detect flaws in the plating. A large roll of finished sheet cannot be scrapped because of a few pin holes in the surface; neither can the flawed material be used for tin cans. The solution is to mark each flaw with paint as it is detected, so it can be removed at the canning plant. Simultaneously a printout of the location of each flaw is made by the computer. The printout becomes a permanent record of the roll of sheet and is attached to it when it is shipped. The record is also useful as a check on the plating process itself.

Test and manufacturing can be combined, as in an installation described by Computer Automation, Inc., Newport Beach, Calif. The controlled process is the trimming of a resistor to a high tolerance. The resistance is measured and fed into the minicomputer, which in turn controls a laser beam that burns away resistor material in precisely controlled increments. The process continues until the resistor meets the required tolerance.

Instant trouble-shooting possible

Diagnosis and repair of defective equipment is another related application. General Automation, Inc., Orange, Calif., has some computers attached to microphones and spectrum analyzers to monitor the performance of machinery. The computer performs a frequency scan and determines the spectrum of the sound. A defective part like a dry bearing has a different spectrum from a good one. This technique is capable of wide use (see "Curing Engine Failures Before They Occur," ED 7, April 1, 1970, p. 30).

The auto industry is toying with the idea of using minicomputers in its service organizations to speed the repair of cars and to help overcome the shortage of trained mechanics. The ingenu-



Spectrum analyses are carried out in real time and the results can be obtained on the graphic display or on hard copy from the Teletype. The minicomputer is the SPC-12 manufactured by General Automation, Anaheim, Calif., and installed by Spectral Dynamics Corp.

ity of engineers in adapting sensing instruments to interface with minicomputers will rapidly expand this area of application.

'Family trees' can be built

Closely related to both factory operation and data concentration is the use of hierarchies of computers to oversee intricate operations.⁹ The minicomputer, because of its small size, low cost and ruggedness, is installed at the lowest level of the hierarchy. It can control the unit operations of a plant. It can also be installed as a data concentrator for time-shared terminals. The minicomputers then communicate with a larger time-shared computer that performs computations and data reduction. This machine may also issue production orders to the computers in charge of unit operations. A larger central data processing computer is the highest level in a plant. All financial, production and cost data finally arrive at this machine for disposition. Thus the entire record-keeping and operational supervision of a large plant can be kept under the constant surveillance of one or more computers and data processors.



Instant evaluation of an experimental potato picker is done by a minicomputer at the Institute of Agriculture, Edinburgh, Scotland.

The ability of hierarchal computer control to display this omniscience has important ramifications for all levels of corporate management. Lower management's functions will probably be diluted, while higher management will be strengthened. Over-all control will be more easily maintained. The effects of miscalculation at the higher levels of decision may, however, prove more damaging.

A boon to hospital care

As engineers move away from the military aerospace area, they will begin to find employment in unfamiliar fields. One of these that possesses a world of electronic riches is the hospital. The minicomputer will increasingly demand more and more electronic expertise in the hospital.

Hospital use of computers is expected to be one of the major growth areas. The reasons are much the same as those in other applications: greater demands for service and fewer trained personnel to provide it. Typical uses for minicomputers in hospitals are in patient care and clinical applications. Further in the future are data retrieval and diagnosis.

Patient care requires the use of sensors interfaced with the computer. A typical installation¹⁰ makes use of blood-pressure instruments, thermometers, respiration and pulse-rate transducers, as well as more elaborate devices like electrocardiographs and electroencephalographs. These instruments feed signals to a minicomputer that has a display unit at a nurse's station. Alarm levels can be set for each patient, to alert the nurses to an impending crisis. Periodic print-outs of each patient's readings provide a hard copy for the physician and replace the familiar

and traditional hospital chart.

Medications and dosages can be programmed into the computer to remind the nurse at proper intervals. (A serious problem in some hospitals is incorrect or improper dosage administered by overworked nurses.) With more equipment, the computer can take over control of some types of therapy. Temperature can be maintained; artificial kidney dialysis and certain types of intravenous infusion can be controlled. The list can go on and on.

Minicomputers make all of this possible by being available at low cost. They can be divided among hospital floors in large urban medical centers, and they can be used with equal ease in small rural or suburban hospitals. The engineer may become as important an employee in the future hospital as the medical doctor is now.

End user vs OEM

The design of a computer control is a problem in system engineering. This simple fact has touched off one of the most intense debates in the minicomputer industry. The thesis is: Resolved, control systems are to be sold through OEM (original equipment manufacturer) channels. Manufacturers have taken positions ranging from the affirmative to the equivocal to the negative, with varying degrees of intensity. A look into the background of the thesis can be instructive.

A computer by itself can perform no useful function. At the minimum, it must have input and output devices properly interfaced and system software that directs it to operate. The average user of a control system is not a sophisticated computer engineer. He is, more likely, a man who wants a job done at minimum cost and maximum effectiveness and who does not care who or what does the job.

The minicomputer manufacturer, at this stage in the development of the industry, is relatively small but innovative. His financial resources, with some significant exceptions, are limited. He has no facilities for manufacturing peripheral equipment, and he has only a small staff capable of writing extensive programs.

A gap therefore exists between the user and the manufacturer that complicates the interchange of information. This gap is bridged by the OEM. The original equipment manufacturer supplies complete operational control systems to the user; he buys the computer from one source and the peripherals from others. He also provides the specialized software and instruction of personnel that is needed by the user.

The OEM performs one more very important task. He broadens the market, by bringing computer control to the attention of prospective

users who would otherwise be ignorant of its advantages to their operations.

Manufacturers stake their claims

The marketing strategy adopted by a minicomputer manufacturer depends very heavily on his financial strength. The giants—Digital Equipment Corp., Hewlett-Packard and Honeywell—profess interest in the user market. The independents, on the other hand, eschew the user and woo the OEM. But the division is not that cut and dried.

Among the giants, Digital Equipment and Honeywell do a sizable business with the OEMs; and some independents are not averse to short-circuiting the OEM if a particularly juicy opportunity should come their way. Only Hewlett-Packard seems to have taken an unequivocal stand in favor of selling to the user, and this because of the unique capabilities that the company has in all areas of computation, instrumentation, interfacing and software.

Main frames are only one aspect

Prospective computer-control customers should not be beguiled by the low prices quoted for minicomputer main frames. A control system consists of the main frame, peripherals, hardware and software interfacing, maintenance and upkeep, and system software. One knowledgeable estimate is that each of the first four items accounts for one-sixth of the system's total cost, and the system software for the remainder. Therefore the typical minicomputer control system costs in the neighborhood of \$60,000.

Maintenance and upkeep can present serious problems. No one doubts that peripherals, many with moving parts, can break down, but the reliability of the main frame is a matter of debate. Curiously, the larger manufacturers stress main frame maintenance more heavily than do the smaller ones. This is not because computers made by big companies are less reliable, but because big companies are more likely to have extensive repair facilities.

Maintenance and repair is not a serious problem for a sophisticated user. The design of all minicomputers is modular, with all components mounted on circuit cards. A minimum of instrumentation can localize a failure, and replacement of a card is simple. It is the unsophisticated user who may suffer seriously from a failure. If he bought his system from an OEM, he must rely on the OEM for service if complete satisfaction is to be expected.

One exuberant exponent of the minicomputer—Data General's director of marketing—remarked recently (conservatively, some in the industry

say) that there were 2000 potential applications for the machine. This report has covered about six of them. The others are out there in the field, where inquisitive engineers are busily interfacing small computers to anything that moves.

In the future, there is the possibility of a minicomputer in every kitchen and in every automobile. What is more likely is that the minicomputer will lose its identity as a breadbox-sized device and will be hidden inside of the equipment it controls. The likelihood of this development is based on maturation of the concept of large-scale integration of semiconductors.

Right now, LSI memories are beginning to appear as production items. Memories with 4000 bits on a 1-inch-square chip are now practical. Logic circuits with similar densities are somewhat further off, but they are imminent. LSI will have several effects on the minicomputer (and perhaps also the large computer). It will make all computers much smaller; it will make them cheaper. It may turn the semiconductor manufacturers into computer manufacturers, thereby making them direct competitors of their current customers.

At least one minicomputer manufacturer—General Automation, Inc., of Orange, Calif.—has recognized this threat and has taken steps to hedge its bets. It is selling its computer production as a package with system software; if it is pushed out of the hardware business one day, it will buy the hardware from others and continue to sell software. Others are ignoring the possible threat and staking their futures on the reputations they are developing.

Whatever the future holds for the minicomputer industry, it is certain to be lively, whether from a business¹¹ or a technical aspect. ■■

References:

1. Long, William H., "Invasion of the Minicomputers," *Automation*, August, 1969.
2. Lapidus, Gerald, "A Look at Minicomputer Applications," *Control Engineering*, November, 1969, pp. 82-91.
3. Lowenstein, Milton J., "For Design the Program is the Thing," *Electronic Design*, No. 23, Nov. 8, 1969, pp. C8-C19.
4. Penczer, Rudolf E., "Automation in Data Acquisition," *American Laboratory*, April, 1969.
5. DeCastro, Edson D., "What Can You Do With a Minicomputer," *Industrial Research*, November, 1969.
6. Noonan, Ronald P., "What Kind of Computer for Your Plant," *Chemical Engineering*, June 2, 1969, pp. 114-116.
7. Bailey, S. J., "On-Line Computer Users Polled," *Control Engineering*, January, 1969, pp. 86-94.
8. Bobroff, Dimitry A., "Avoid Pitfalls in Computerized Testing," *Electronic Design*, No. 17, Aug. 16, 1969, pp. 196-201.
9. Young, Neal F., "Distributed Computer Systems," *Automation*, October, 1969.
10. Kessler, John N., "Where EE and MD Link Up to Prolong Life," *Electronic Design*, No. 4, Feb. 15, 1970, pp. 24-28.
11. "Small Control Computers," *Investment Research Report*, July 31, 1969, Equity Research Associates, New York, N.Y.

MEM

4096 bit

64 bit

It's in stock! It's ready to plug in! Right now! Order your evaluation units now. Computer Microtechnology Inc. has perfected the CM2400 4096 bit memory module. All decoding, driving, sensing and output functions are included in this 1.5" x .2 in. package. Order yours today!

Your memory system requirements will be fulfilled by using the CM2400 4096 bit memory module. Now, you can build a memory system of whatever bit size you want as easy as you put together your logic. Your noise and interconnection problems are minimized by containing all high level MOS voltages within the module. This memory was designed for you. Order yours today!

Computer Microtechnology Inc. continues to pioneer the field with both MOS and bipolar processing, multilayer metal ceramic packaging, beam-lead interconnections and specially developed test systems. The CM2400 4096 bit memory module is the latest product for your memory systems. Check the specs, then call one of the offices listed to order yours.

CM2400 4096 BIT MEMORY MODULE

Organization . . . 1024 words by 4 bits
Read/Write Cycle . . . 600 nsec
Power Dissipation . . . 1.5 watts
Compatibility . . . DTL and TTL
Packaging . . . 26 leads dual-in-line
Price . . . \$1200, 1-9 Delivery . . . Stock
Order yours today!

It's in use! It's in stock locally! Right now! Order units for your equipment now. Computer Microtechnology Inc. is supplying the top computer and terminal manufacturers with CM2100 64 bit bipolar read/write memories. All decoding, driving and sensing circuitry is on the chip of this self-contained memory. Order yours today!

Your high speed scratchpad and buffer memory requirements will be satisfied with the CM2100 memory. You will have superior performance because these units have the best combination of specifications including a minimum write pulse width of 12 nsec typical. Order yours today!

Computer Microtechnology Inc. continues to bring you advanced products for your memory systems. The CM2100 memory is an example of this with its expansion capability through chip select input and wired-OR outputs. Check the specs, then call one of the offices listed to order yours.

CM2100 64 BIT BIPOLAR READ/WRITE MEMORY

Organization . . . 16 words by 4 bits
Read Access Time . . . 40 nsec typ, 60 nsec max
Minimum Write Pulse Width . . . 12 nsec typ, 25 nsec max
Compatibility . . . DTL and TTL
Packaging . . . 16 lead dual-in-line
Price . . . \$40.00, 1-24 Delivery . . . Stock
Order yours today!



Computer Microtechnology, Inc.

610 Pastoria • Sunnyvale, California 94086 • (415) 736-0300

100ry

decoder

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

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

Computer Microtechnology Inc. continues to supply products that increase the capability of memory systems. The CM1400 decoder illustrates this with its high speed and other excellent specifications. Check the specs, then call one of the offices listed to order yours.

CM1400 3 BIT BINARY TO ONE OF 8 LINE DECODER

Propagation Delay ... 50 nsec typ, 100 pf load
Power Dissipation, AC and DC ... 140 mw typ, +5 and +10 V
Output High Voltage ... 9.5 V typ, -0.1 mA
Packaging ... 16 lead dual-in-line
Delivery ... Stock
Price ... \$15.25, 1-24
Order yours today!

Call any of these offices to obtain more information or to order Computer Microtechnology products.



Computer Microtechnology Inc

CM AREA OFFICES

Plant	East	West
610 Pastoria Sunnyvale, Calif. 94086 (408) 736-0300	10 Dale Street Waltham, Mass. 02154 (617) 891-0002	1627 Pontius Avenue Los Angeles, Calif. 90025 (213) 478-1285

CM REPRESENTATIVE OFFICES

Calif., Ariz., Nev., Texas	Mid-Atlantic	Illinois
Cain & Co. (213) 476-2251 (415) 948-6533 (602) 265-4477 (214) 599-2897	Graydon Sherman (516) 487-9696 (201) 538-9246 (315) 637-9861 (215) 644-7316	L-TEC (312) 286-1500 Minn. & Wisc. Lloyd Murphy Assoc. (612) 333-4511
Rocky Mountain Interlink Systems (305) 237-7055 New England KCA Electronic Sales (617) 861-9024	Michigan Elko Sales (313) 884-7893 (616) 949-1451	Iowa Seltic (319) 362-8155

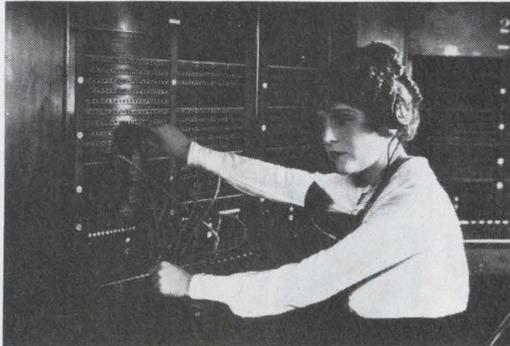
CM DISTRIBUTOR OFFICES

Kierulff Electronics (415) 968-6292 (714) 278-2112 (206) 763-1550 (602) 273-7331 (505) 247-1055 (303) 343-7090	K-Tronics (213) 685-5888 F-J-R Electronics (516) 433-5530 (312) 678-8560 (612) 920-8640	(513) 278-9411 (215) 647-2612 Schley Electronics (617) 926-0235 (201) 935-2120 (516) 621-0025 (301) 948-0250
----------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------

what!



really!



yes, mag
tape
terminals



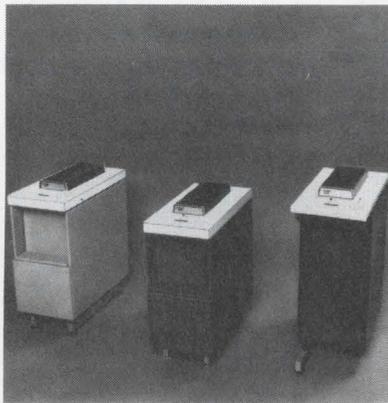
TELETYPE?

It's true.

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

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

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



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

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

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

It contains 100 feet of 1/2" precision magnetic tape.

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

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

DATA COMMUNICATIONS

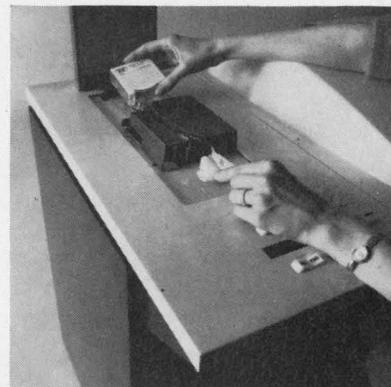
equipment for on-line, real-time processing

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

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

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

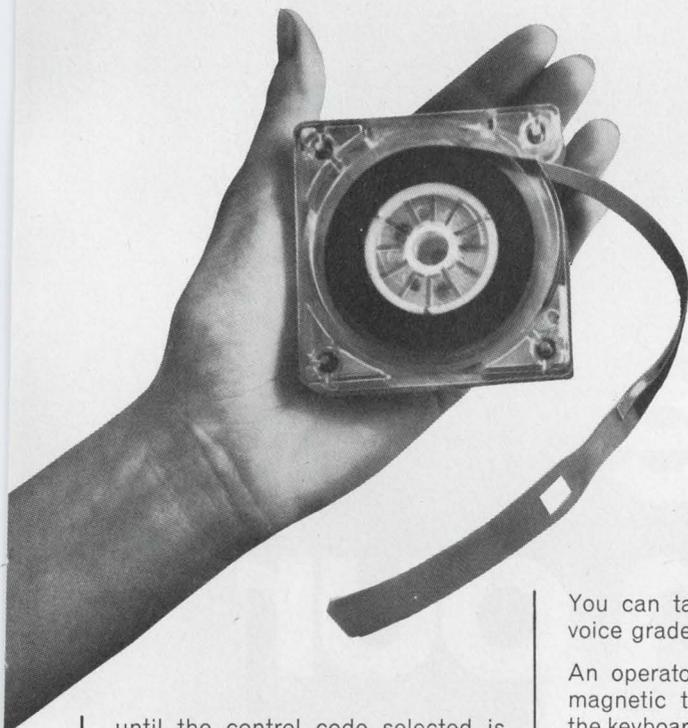
You can zip data along the line at up to 2400 words per minute. For example: Take a standard speed Teletype keyboard send-receive set, and a typical typist. Add a new magnetic tape unit to this combination and the on-line time savings can pay for the magnetic tape terminal in short order.



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

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

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



until the control code selected is detected. Then the terminal stops the tape automatically.

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

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

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

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



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

machines that make data move

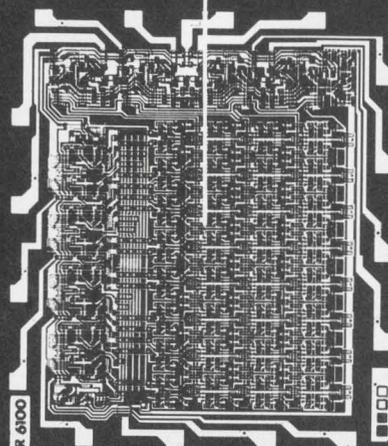
ELECTRONIC DESIGN 9, April, 26, 1970

INFORMATION RETRIEVAL NUMBER 124

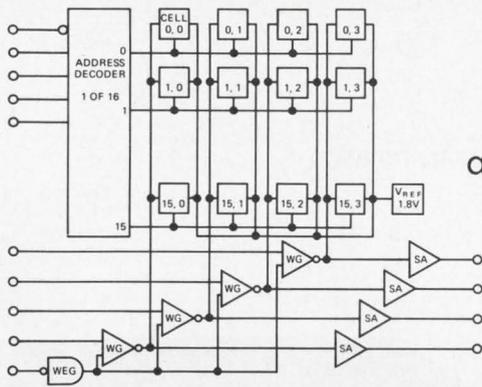


We'd like to put in our 64 bits worth.

350 mW power
dissipation
-55° to +125° C
temperature range
45 ns typical
access time



Immediate delivery at new low prices.



Not all memories are created equal.

Let us point out some exclusive features of the 64 bit bipolar

Random Access Memories

Raytheon has been delivering since last November.

Power down Winsock

Take power. They dissipate only 350 mW per chip, including address decoding, write gates and sense amplifiers. And yet, while we specify 60 ns maximum, read time is typically under 40 ns.

Full mil temp range

Our model RR6100 operates from 0° to 75° C. But the RR5100 is guaranteed over the full mil temp range of -55° to +125° C. And if you really need reliability, Raytheon will pre-test them to the physical and electrical rigors of MIL-STD-883.

Dollar for dollar

But here's the best news. Prices are competitive.

Units are available in flat-packs or 16 lead DIPs

	1-24	25-99	100-999
RR6100	\$40.00	32.50	26.50
RR5100	50.00	40.50	32.50

and delivery is off our distributors shelves.

And the beat goes on

So what's next? Beam-lead 256 bit and 512 bit multi-chip arrays in 24 pin DIPs. For memories to cherish, see Raytheon Semiconductor. We get the ideas and deliver the goods.

350 Ellis Street, Mountain View, California. (415) 968-9211.

Immediate delivery from your local Raytheon distributor.

Alabama
Huntsville
Cramer/Huntsville, Inc.
(205) 536-4493

Arizona
Phoenix
Avnet
(602) 272-6821

California
Culver City
Avnet
(213) 836-7200

Inglewood
Liberty Electronics
(213) 776-6252

Los Angeles
Kierulff Electronics
(213) 685-5511

Mountain View
Avnet
(415) 961-7700

Mountain View
Elmar Electronics
(415) 961-3611

Palo Alto
Kierulff Electronics
(415) 968-6292

San Carlos
Intermark Electronics
(415) 961-5222

San Diego
Avnet
(714) 279-1550

Colorado
Denver
Avnet
(303) 623-6255

Connecticut
North Haven
Cramer Electronics
(203) 239-5641

Florida
Fort Lauderdale
Cramer/Florida, Inc.
(305) 566-7511

Fort Lauderdale
Hallmark of Ft. Lauderdale
(305) 563-3271

Orlando
Hallmark Electronics Corp.
(305) 855-4020

Palm Beach Gardens
Industrial Electronics Assoc.
(305) 848-8686

Georgia
Atlanta
Cramer/Atlanta, Inc.
(404) 451-5421

Illinois
Rosemont
Hallmark Electronics
(312) 299-6602
Schiller Park
Pace/Avnet
(312) 678-6310

Kansas
Prairie Village
Avnet
(913) 362-3250

Maryland
Baltimore
Cramer/Baltimore, Inc.
(301) 354-0100

Baltimore
Radio Electric Service Company of Baltimore
(301) 823-0070

Rockville
Cramer/Washington, Inc.
(301) 424-2700

Rockville
Pioneer Washington Electronics
(301) 427-3300

Silver Springs
Radio Electric Service Company
(301) 588-5140

Massachusetts
Burlington
Avnet
(617) 272-3060

Newton
Cramer Electronics
(617) 969-7700

Michigan
Detroit
Avnet
(313) 538-1000

Minnesota
Bloomington
Cramer Electronics
(612) 881-8678

Minneapolis
Avnet
(612) 920-5866

Missouri
St. Louis
Hallmark Electronics
(314) 521-3800

New Jersey
Jersey City
KRS Electronics, Inc.
(201) 435-3600

Pennsauken
Cramer Pennsylvania
(215) 923-5950

New Mexico
Albuquerque
Avnet
(505) 265-7926

Albuquerque
Century Electronics
(505) 296-5514

New York
Baldwin, L.I.
Hamilton Electro Sales
(516) 223-8000

East Syracuse
Cramer/Eastern, Inc.
(315) 437-6671

Elmhurst
Cramer/Esco, Inc.
(212) 478-4000

Great Neck, L.I.
Time Electronics Sales
(516) 487-0100

South Rochester
Cramer/Rochester
(716) 275-0300

Westbury, L.I.
Avnet
(516) 333-5800

North Carolina
Raleigh
Cramer/Raleigh, Inc.
(919) 876-2371

Ohio
Cincinnati
Cramer/Tri-States, Inc.
(513) 771-6441

Cleveland
W. M. Pattison Supply Co.
(216) 441-3000

Pennsylvania
Hatboro
Avnet
(215) 052-6900

Pittsburgh
Cameradio Company
(412) 391-4000

Texas
Dallas
Avnet/Contact Electronics
(214) 638-2850

Utah
Salt Lake City
Cramer/Hyer
(801) 487-3681

Washington
Seattle
Avnet
(206) 623-8824

Seattle
Kierulff Electronics
(206) 763-1550

Wisconsin
Milwaukee
Hallmark Electronics
(414) 476-1270

Canada
Montreal
Avnet Electronics of Canada, Ltd.
(514) 381-9127

Ottawa
Wackid Radio & Television Labs, Ltd.
(613) 728-1821

Toronto
Avnet Electronics of Canada, Ltd.
(416) 789-1838

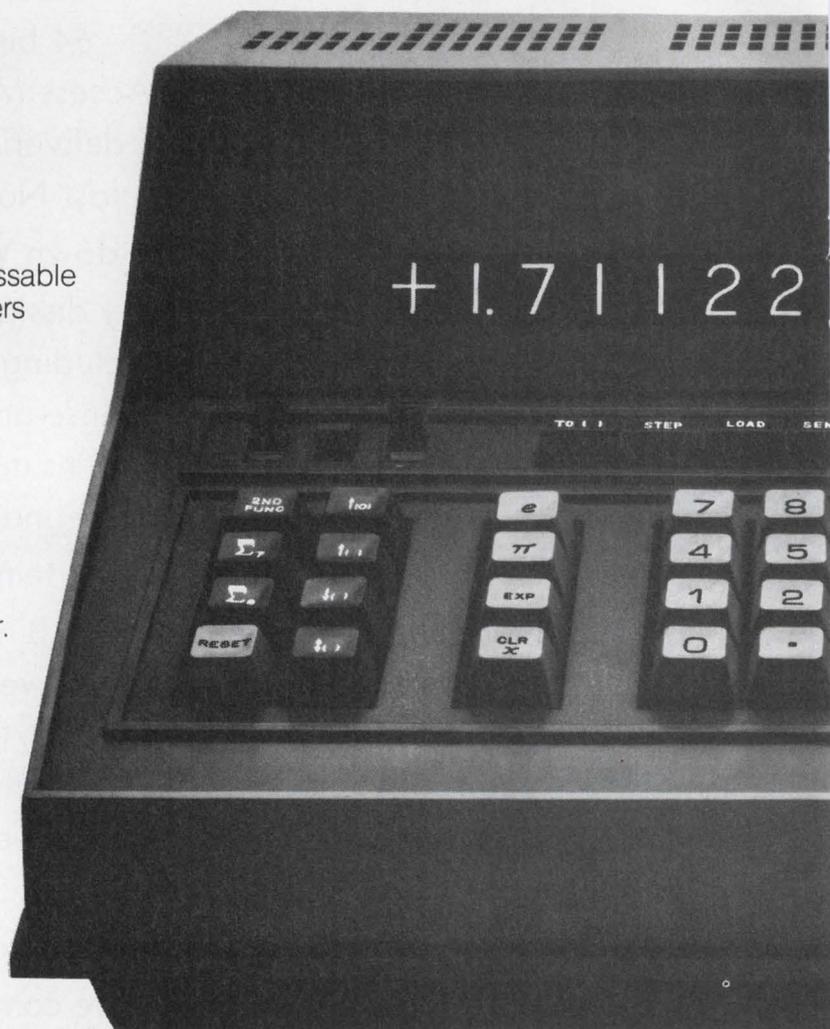


Decimals: Autopoint and scientific notation.

Automatic entry of e and π .

Ten directly addressable
storage registers

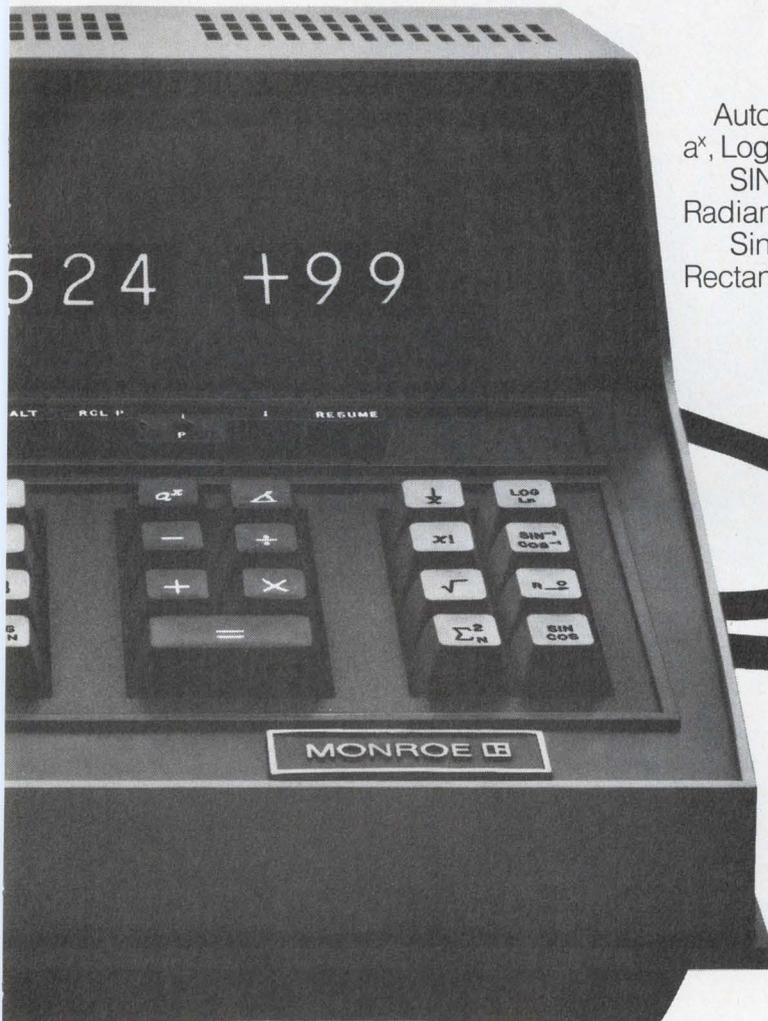
Programming: Up to
128 steps. Conditional
branching and
automatic entry of
programs with card reader.



Model 1655. Size: 13" x 13½" x 6½".

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

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



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

Just plug in
and put it to work.

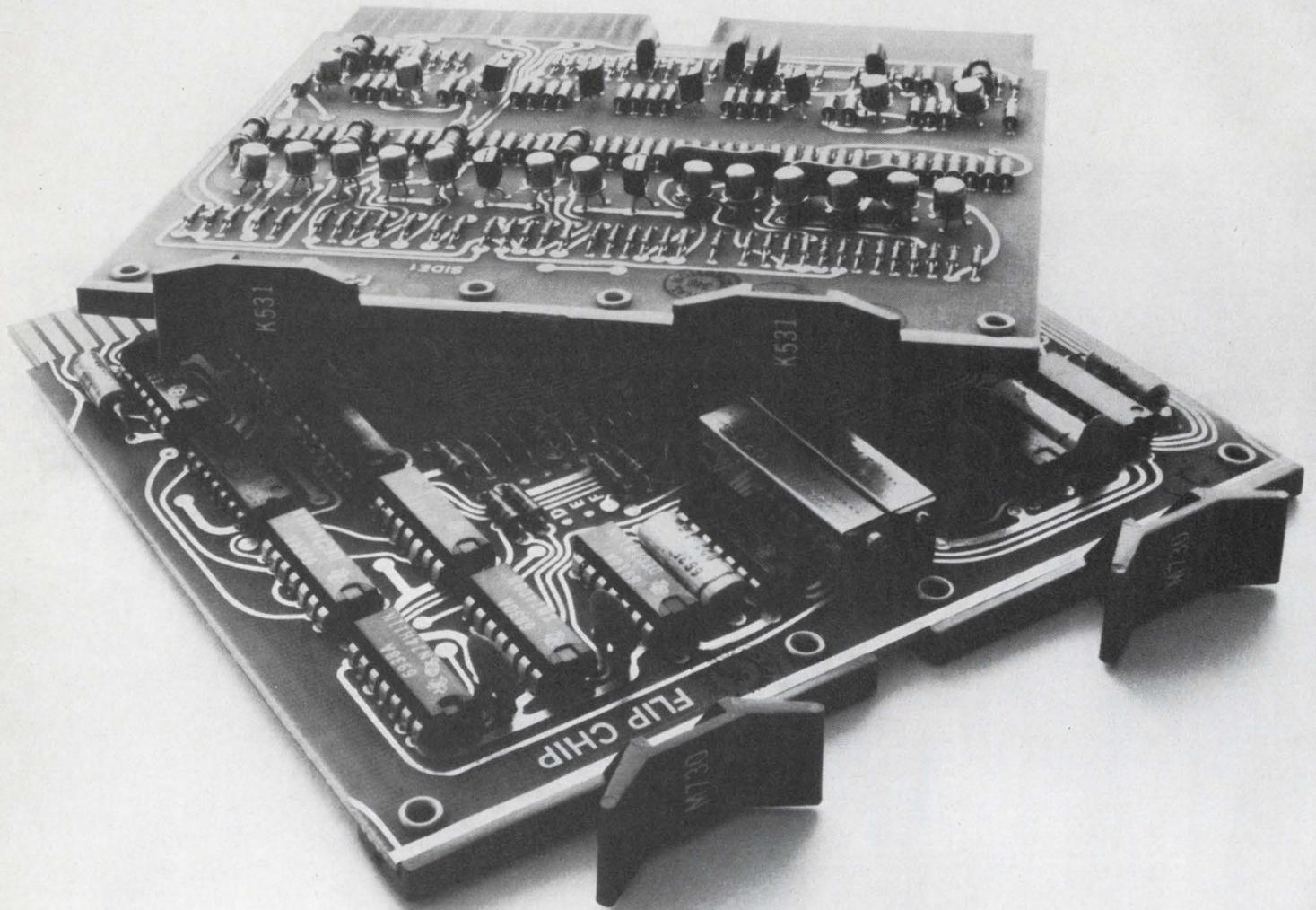
Weight: Twelve pounds.

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

A DIVISION OF LITTON INDUSTRIES

550 Central Avenue, Orange, New Jersey 07050

INFORMATION RETRIEVAL NUMBER 126



The tortoise and the hare

Sometimes, you want all the speed you can get. Interfacing a computer, for instance. Or building an instrument that measures, or tracks, or controls events that require that speed. Digital offers a full line of hare modules... M-series, that fly at 10 MHz.

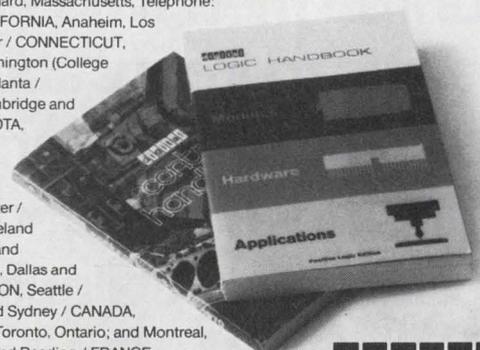
But sometimes, you want something a lot slower. For general laboratory control, or to replace old-fashioned relays, or to control a machine. Designing them slow means that you can also design them immune from electrical noise. Digital has a full line of tortoise modules as well... K-series, that crawl at 100 KHz.

Each series is physically, electrically, and logically compatible. 100 modules in M-series. 70 modules in K-series. Each comes with a full line of hardware, power supplies, plug-in boards, cabinets, racks, and so forth. Each comes with Digital's guarantee. Each comes with the

knowledge that Digital uses them in their own computers and controllers.

Two free books describe them completely—module by module and function by function. Write.

DIGITAL EQUIPMENT CORPORATION, Maynard, Massachusetts, Telephone: (617) 897-5111 / ALABAMA, Huntsville / CALIFORNIA, Anaheim, Los Angeles, and Palo Alto / COLORADO, Denver / CONNECTICUT, New Haven / DISTRICT OF COLUMBIA, Washington (College Park, Md.) / FLORIDA, Cocoa / GEORGIA, Atlanta / ILLINOIS, Chicago / MASSACHUSETTS, Cambridge and Maynard / MICHIGAN, Ann Arbor / MINNESOTA, Minneapolis / MISSOURI, St. Louis / NEW JERSEY, Parsippany and Princeton / NEW MEXICO, Albuquerque / NEW YORK, Centereach (L.I.), New York City, and Rochester / NORTH CAROLINA, Chapel Hill / OHIO, Cleveland and Dayton / PENNSYLVANIA, Philadelphia and Pittsburgh / TENNESSEE, Knoxville / TEXAS, Dallas and Houston / UTAH, Salt Lake City / WASHINGTON, Seattle / AUSTRALIA, Brisbane, Melbourne, Perth, and Sydney / CANADA, Edmonton, Alberta; Carleton Place, Ottawa; Toronto, Ontario; and Montreal, Quebec / ENGLAND, London, Manchester, and Reading / FRANCE, Paris / GERMANY, Cologne and Munich / HOLLAND, The Hague / ITALY, Milan / JAPAN, Tokyo / SWEDEN, Stockholm / SWITZERLAND, Geneva.



digital
MODULES • COMPUTERS

Product Source Directory

Minicomputers

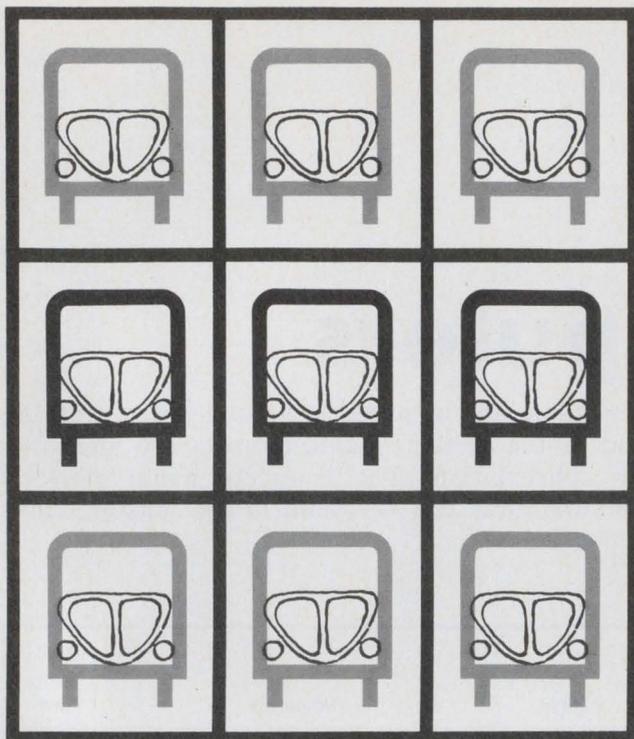
This Product Source Directory covers Mini-computers.

For each table, the instruments are listed in ascending order of one major parameter, that column being color-coded white. All notes used in

this table are in parenthesis and defined at the end of the section. Manufacturers are identified by abbreviation. The complete name of each manufacturer can be found in the Master Cross Index below.

Abbrev.	Company	Reader Service No.
Bendix	Bendix Corp. Navigation & Control Div. Teterboro, N.J. 07608 (201) 288-2000	443
Cincinnati	Cincinnati Milling Machine Co. 4701 Marburg Ave. Cincinnati, Ohio 45209 (513) 475-8100	444
Clary	Clary Datacomp Systems 404 Junipero Serra Dr. San Gabriel, Calif. 91776 (213) 283-9485	445
Comp Systems	Compiler Systems Inc. P.O. Box 366 Ridgefield, Conn. 06877 (203) 438-0488	446
Data Gen	Data General Corp. Southboro, Mass. 01772 (617) 485-9100	447
Datamate	Datamate Computer Systems Box 3106 Big Spring, Tex. 79720 (915) 267-8766	448
DCC	Digital Computer Controls, Inc. 23 Just Rd. Fairfield, N.J. 07006 (201) 227-4861	449
DEC	Digital Equipment Corp. 146 Main St. Maynard, Mass. 01754 (617) 897-5111	450
DSC	Digital Scientific Corp. 14455 Sorrento Valley Rd. San Diego, Calif. 92121 (714) 453-6050	451

Abbrev.	Company	Reader Service No.
Elbit	Elbit Computers Ltd. Elron Inc. 9701 N. Kenton Ave. Skokie, Ill. (312) 676-4860	452
EMR	EMR Computer 8001 Bloomington Frwy. Minneapolis, Minn. 55420 (612) 888-9581	453
Foto-Mem	Foto-Mem, Inc. 6 Strathmore Rd. Natick, Mass. 01760 (617) 655-4600	454
GRI	GRI Computer Corp. 76 Rowe St. Newton, Mass. 02159 (617) 969-7346	455
H-P	Hewlett-Packard Co. 11000 Wolfe Rd. Cupertino, Calif. 95014 (408) 257-7000	456
Honeywell	Honeywell Div. Computer Control Old Connecticut Path Framingham, Mass. 01701 (617) 879-2600	457
Interdata	Interdata Inc. 2 Crescent Pl. Oceanport, N.J. 07757 (201) 229-4040	458
Lockheed	Lockheed Electronics Corp. Data Products Div. 6201 E. Randolph Los Angeles, Calif. 90022 (213) 722-6810	459
Micro Systems	Micro Systems Technology 644 E. Young St. Santa Ana, Calif. 92705 (714) 540-6730	460



BENEFIT ... Through NUCOR power supplies.

ECONOMY

They won't drive you to the Poor House.
(Check our Prices)

RELIABILITY

Our VW Series has been driven to extremes.
(the 95° series meets extreme
military environments)

PERFORMANCE

You can drive them all day at top speed
(Full Load) with no power derating.

CONFIDENCE

A one year warranty with a calculated MTBF of
better than 40,000 hours (per MIL hand books 217 a)

ps

If you prefer a more luxurious way to travel,
Nucor also builds custom handcrafted personal
supplies which can think for themselves as well
as get you where you're going.

For a personal interview please call Mr. Pessolano at Nucor.
Short form catalogs available.



NUCLEAR CORPORATION OF AMERICA
2 RICHWOOD PLACE, DENVILLE, NEW JERSEY 07834
(201) 627-4200 (TWX) 710-9878487

INFORMATION RETRIEVAL NUMBER 129

Abbrev.	Company	Reader Service No.
Motorola	Motorola Instrumentation & Control Inc. Box 5409 3102 N. 56 St. Phoenix, Ariz. 85010 (602) 959-1000	461
Multidata	Multidata 7300 Polsa Ave. Westminster, Calif. 92683 (714) 892-8347	462
Raytheon	Raytheon Computer 2700 S. Fairview St. Santa Ana, Calif. 92704 (714) 546-7160	463
Redcor	Redcor Corp. P.O. Box 1031 Canoga Park, Calif. 91304 (213) 348-5892	464
ROLM	ROLM Corp. 10925 N. Wolfe Rd. Cupertino, Calif. 95014 (408) 257-6440	465
SCC	Scientific Control Corp. 1215 W. Crosby Rd. Carrollton, Tex. 75006 (214) 242-6555	466
Spiras	Spiras Systems USM Corp. 332 Second Ave. Waltham, Mass. 02154 (617) 891-7300	467
Tempo	Tempo Computers 1550 S. State College Anaheim, Calif. 92803 (714) 633-3660	468
Unicom	Unicom Inc. 1275 Bloomfield Ave. Fairfield, N.J. 07006 (201) 228-1696	469
Unicomp	Unicomp Inc. 18219 Pathenia St. Northridge, Calif. 91324 (213) 886-7722	470
Varian	Varian Data Machines 2722 Michelson Dr. Irvine, Calif. 92664 (714) 833-2400	471
Vari Systems	Varisystems Corp. 207 Newton Rd. Plainview, N.Y. 11803 (516) 293-6515	472
Wang	Wang Laboratories, Inc. 836 North St. Tewksbury, Mass. 01876 (617) 851-7311	473
Xerox	Xerox Data Systems 555 S. Aviation Blvd. El Segundo, Calif. 90245 (213) 772-4511	474

YT19 system cabinet, holds all the equipment shown (except teletypewriter) with room to spare.

CD51 controller-digitizer with programmable gain, controls 1024 channels, 10ns aperture time.

TE33 teletypewriter with paper tape reader and punch. (Includes controller.)

CF16 minicomputer with a 4K x 16-bit memory (expandable to 24K) and four different I/O modes. (Includes software.)

Optionally available: MR50 high-level multiplexer and associated channels (approximately \$2400 extra), if you want to mix high and low level signals. Also 10, 12 or 15-bit D to A converters for closed loop systems, and a variety of other off-the-shelf instruments and options to solve virtually any data acquisition problem.

PE20 peripheral controller for CD51/DM40 combination.

OP50 multiplexer switch card contains 8 switches with screw terminals. Each DM40 accommodates up to 16 such cards. Switch cards with other terminal types also available.

OP59 power supply for up to eight DM40s.

DM40 low-level differential multiplexer accepts up to 128 input signals (optionally expandable to 1024) in the range $\pm 2.5\text{mV}$ to $\pm 10\text{V}$ full scale, at a rate up to 20kHz, and with a CMR of 120db at DC.

All instruments and interfaces will be cabinet mounted and functionally tested together prior to delivery. If you're in a hurry, call (213) 679-4511, ext. 3668 or 3391.

XDS
Xerox Data Systems
El Segundo, California

The last reason you should buy our data acquisition system is the price: \$21,600.

	Manufacturer	Model	Price \$	Word Size (bits)	Memory Size (k bits)		Memory Cycle Time (μs)	Instruction Set Size (number)	Software Availability	Interfacing Peripherals
					Min.	Max.				
M C 1	Bendix	BDX-6200	reg	20	4	16	3	95	yes	gen purpose
	Bendix	BDX-8000	reg	16	4	16	3	108	yes	gen purpose
	Bendix	BDX-9000	reg	16	4	32	3	70	yes	gen purpose
	Cincinnati	CIP/2000	2720	8, 9	0	32	0.22, rom	15μ commands	yes	(1)
	Cincinnati	CIP/2100	6162	8, 9	4	32	0.22, rom		yes	(1)
	Clary	404	7450	16	1	65	2	46	assembler	disc, printer, cassette, mag tape
	Comp Systems	CSI-16	10750	16	4	32	1	31	fortran IV (2)	typewriter (2)
	Comp Systems	CSI-24	14950	24	4	8000	1	31	(2)	typewriter (2)
M C 2	Datamate	16	14900	16	4	32	1	100	assembler (36)	teletype (36)
	Datamate	70 Processor	3900	16	(35)	(35)	0.6	50	assembler (36)	teletype (36)
	Datamate	70 Controller	5900	16	0.256	words	0.6 (37)	50	assembler (36)	teletype (36)
	Datamate	70 Computer	7900	16	4	32	1.6 (37)	50	assembler (36)	teletype (36)
	DCC	DCC-112	5900	12	4	32	1.2	n/a	fortran (4)	tape, drum disc, inst.
	DEC	PDP15/10	16500	18	4	131072	0.8	(8)	(8)	yes
	DEC	PDP-12A	29900	12	4	32	1.6	42	fortran (7)	yes
	DEC	PDP-11/20	10800	16	4	32	1.2	55	paper tape (6)	line printer (6)
M C 3	DEC	PDP-8/L	8500	12	4	8	1.6	8	fortran (5)	(5)
	DEC	PDP-8/I	12800	12	4	32	1.5	8	fortran (5)	(5)
	DSC	4001	8750	16	4096	458752	0.9 core	(9)	assembler (10)	paper tape (10)
					1024	4096	0.09 rom			
	Elbit	Elbit 100	4900-7000	12	1	4	2	106	assembler (11)	teletype (11)
	EMR	EMR 6120	7700	16	4	32	1.9	53	assembler (12)	teletype (12)
	Foto-Mem	Centaur 100	3810	4000	4	66	1	78	yes	printer, CRT
	Foto-Mem	Centaur 100	8810	4000	4	66	1	78	yes	disc, teletype
M C 4	GRI	909	8250	16	1	32	1.76	156 (basic)	assembler (13)	paper tape (13)
	H-P	2116B	24000	16	8	32	1.6	70	assembler (14)	paper tape (14)
	H-P	2114B	8500	16	4	8	2	70	assembler (14)	paper tape (14)
	Honeywell	DDP-416	reg	16	4	16	0.96	72	assembler (15)	mag tape (15)
	Honeywell	H316	reg	16	4	16	1.6	72	assembler (15)	mag tape (15)
	Honeywell	H112	reg	12	4	8	1.69	33	assembler (15)	mag tape (15)
	Interdata	13	15100	16	8	65	1.5	64	assembler (16)	teletype (16)
	Interdata	3	8900	16	8	65	1.5	63 (basic)	assembler (16)	teletype (16)
M C 5	Interdata	14	17500	16	8	65	0.98	73 (basic)	assembler (16)	teletype (16)
	Interdata	15	26300	16	8	65	0.98	73 (basic)	assembler (16)	teletype (16)
	Interdata	Mod 4 Processor	10900	16	8	65	0.98	72	assembler (16)	teletype (16)
	Lockheed	MAC16	11950	16	4	65	1	72	assembler (17)	teletype (17)
	Micro Systems	Micro 800	3200	16	0	32	1.1	16 (19)	cross assembler & simulator	teletype (18)
	Micro Systems	812	10000	8	4	32	1.1	105	assembler (18)	teletype (18)
	Micro Systems	810	6900	8	4	32	1.1	89	assembler (18)	teletype (18)
	Motorola	MDP-1000	6900	8	4.096	16.384	2.16	400	assembler (20)	teletype (20)
M C 6	Multidata	A	14995	16	4.096	65.536	0.88	163	assembler (21)	teletype (21)
	Raytheon	703	12750	16	4	32	1.75	74	assembler (22)	teletype (22)
	Raytheon	704	9750	16	4	16	1.5	74	assembler (22)	teletype (22)
	Raytheon	706	19000	16	4	32	0.9	74	assembler (22)	teletype (22)
	Redcor	RC-70	14900	16	65.536	524.288	0.86	35	assembler (23)	teletype (23)
	Rolm	1601	20000	16	4	32	2.6	124	assembler (24)	teletype (24)
	SCC	DCT-132	27950	8	2	4	2	21	(25)	teletype (25)
	SCC	4700	22500	16	4	64	0.95	144	assembler (26)	printer (26)
M C 7	Spiras	SP65	12400	16	4	65	1.8	150	assembler (27)	teletype (27)
	Tempo	Tempo I	13800	16/18	4	65	0.9	100	assemblers (28)	teletype (28)
	Unicom	CP-8A	1800	8	0.512	32	1.75	40	assembler	teletype (30)
	Unicom	CP-8B	2100	8	0.512	32	1.75	40	assembler	teletype (30)
	Unicom	CP-8C	3950	8	1	32	1.75	50	assembler	teletype (30)
	Unicom	CP-8D	4900	8	ina	1000	1.75	50	assembler	teletype (30)
	Unicom	Comp-16	9800	16	4	65	0.9	29	assembler (29)	teletype (29)
	Unicom	Comp-18	10500	18	2	262	0.9	29	assembler (29)	teletype (29)
M C 7	Varian	520/i	6000	8	4.096	32.768	1.5	50	assembler (31)	mag tape (31)
	Varian	620/i	9950	16	4.096	32.768	1.8	100	assembler (31)	mag tape (31)
	Varian	R-620/i	16900	16	4.096	32.768	1.8	100	assembler (31)	mag tape (31)
	Var Systems	PAC-16-1	3000	16	8	520	1.75	61	assembler	teletype (32)
M C 7	Var Systems	PAC-16-4	3850	16	32	520	1.75	61	assembler	teletype (32)
	Wang	3300	4950	8	4	64	1.6	74	assembler (33)	teletype (33)
	Xerox	CE16	9980	16	4	16	8	126-881	assembler (34)	teletype (34)
	Xerox	CF16	7990	16	4	32	2.6	126-881	assembler (34)	teletype (34)

Notes

1. 4k magnetic core memory, cycle time 1.1 μ s. Interfacing peripherals, teletype card reader, CRT, paper tape reader/punch, modems, disc memory.
2. Software, algol, basic fortran IV operating systems. Interfacing peripherals, cassette tapes, high speed tape, disc.
3. Software, disc operating systems, algol-60. Interfacing peripherals, magnetic tape, paper tape, disc, card punch, readers, incremental plotters, a-d/d-a converters.
4. Software, basic system, focal.
5. Software, floating point, macro-8, focal, algol, assemblers on-line editor, mathematical function. Peripherals, 25 available plus 6 processor options.
6. Software, assembler, editor, input/output executive math package, utilities. Peripherals, high speed paper tape, teletype, a-d/d-a converter, dc tape.
7. Software, focal conversational calculator, basic utility, mathematical, demonstration and maintenance package.
8. Memory reference instructions, 13 operating, 12 extended arithmetic, 26 input/output transfer, 5 basic. Software termed compact can be upgraded to the monitor based advanced software system by adding options.
9. Capable of emulating other 16 bit-per-word machines such as the IBM 1130 and 1800.
10. Software, simulator plus software available through simulation. Interfacing peripherals, punch and reader, card punch and reader, magnetic tape, disc, drum and x-y plotter.
11. Software, diagnostics, debugging, editing, multiple arithmetic, utility input/output. Peripherals, tape reader, tape punch, magnetic tape, drum, a-d/d-a converter, card reader, printer.
12. Software, real-time monitor, utilities. Peripherals, paper tape, line printer, disc, communications equipment, d-a converters.
13. Software, editor, interpretive math package, utility routines. Peripherals, magnetic tape, disc, drum, card reader, a-d/d-a converters, relays, time clocks, pulse counters.
14. Software, fortran, algol, basic time shared system, disc operating systems, real time. Peripherals, teletypewriter, paper tape punch and reader, card reader, 7 or 9 channel magnetic tape, mass storage discs, drums, line printer, plotter, time base generator, data phone interphase, d-a converter, general purpose cards.
15. Software, utility routines, arithmetic subroutine library, I/O library, debugging. Peripherals, mass storage systems, line printer, paper tape reader and punch, card reader.
16. Software, fortran, loaders, math routine, debugging. Peripherals, paper tape, mag tape, card reader, a-d/d-a converters, 360, 1108 interface.
17. Software, fortran, input/output, real time simulator. Peripherals, paper tape, drum, mag tape, card reader, line printer and buffered IO channel.
18. Software, operating systems (teletype), diagnostics. Peripherals, paper tape, modem, card reader, input/output expander.
19. This is a micro-programmable minicomputer; as such it has no pre-defined instructions.
20. Software, input/output version, fixed point arithmetic, binary load/dump. Peripherals, document reader, high speed printer, communication modems, data recorder, typewriter.
21. Software, operating system, fortran IV. Peripherals, magnetic tape, paper tape, cassette tape, line printer, card reader, disc, plotter, modems.
22. Software, fortran IV, conversational fortran, real time operating system, editor, math library, sort/merge, diagnostics. Peripherals, disc, magnetic tape, card reader and punch, high speed paper tape, plotter, a-d/d-a, line printer.
23. Software, debug, tape edit, fortran IV, magnetic tape and disc operating system. Peripherals, disc, magnetic tape, line printer, card reader, high speed paper tape, communication interfaces, CRT displays.
24. Software, diagnostics, simulation. Peripherals, paper tape, card, line printer, magnetic tape, disc, plotter.
25. Software, emulators for DCT2000, 2780, user 200, 1004. Peripherals, line printer, card reader, communications couplers, CRT display, card punch.
26. Software, fortran IV, real time monitor, utilities. Peripherals, paper tape, cards, magnetic tape, disc packs, fixed head and disc, typewriters.
27. Software, fortran IV, loader, debug; editor, input/output library, math library, diagnostics. Peripherals, paper tape, magnetic tape, analog front end, plotter, printer, disc.
28. Software, fortran IV, operating system, debug, program up-dater, test and maintenance, math library. Peripherals, card punch and reader, paper tape punch and reader, CRT display, drum, disc, a-d/d-a, magnetic tape, line printer.
29. Software, fortran IV, math routines, floating point up to 7 words. Peripherals, card reader and printer, paper tape, magnetic tape, CRT display, modems, disc, printer.
30. Interfacing peripherals, printer, keyboard, alphanumeric display.
31. Software, debug, math, diagnostic, fortran, binary load dump, peripheral drivers. Peripherals, card punch and reader, disc, drum, paper tape punch and reader, plotter, oscilloscope, line printer.
32. Peripherals, disc, SEL810A, printers, librascope, plotter.
33. Software, compiler and executive for time sharing. Peripherals, cassettes, selectric input/output writer.
34. Software, utilities, math package, diagnostics, fortran IV. Peripherals, a-d/d-a, multiplexers, card reader, disc, magnetic and paper tape, modems.
35. Memory size, basic processor is memory independent, can accommodate a wide variety of memory types, includes LS1, read only, core.
36. Software, loader, debug, input/output systems, diagnostics, fortran, math package. Peripherals, paper tape reader and punch, card reader and punch, line printer, mag tape, disc, drum.
37. Cycle time is memory dependent varies upward from 0.6 μ s.

The Tektronix T4002 graphic computer terminal

Displays high-resolution graphics and alphanumerics
Brings computer access to your desk
Retains the display without high-cost refreshing
Features a Line-Buffer Edit Area on the CRT

When you face the difficult, time-consuming task of analyzing reams of alphanumeric computer print outs, think of *graphics*. Graphics is a format which lends itself to quick, easy, more accurate and complete analysis of data. Don't hamper your decision-making process with reams of alphanumeric print outs when the same data is retrievable faster and easier in clear, concise *graphics*.

The T4002 brings the benefits of local or remote computers to you on an individual basis, in the office, laboratory, production area, or wherever GRAPHIC and alphanumeric computer support serves you best!

The display device of the T4002 is the Direct-View Bistable Storage CRT designed, developed, and manufactured by Tektronix. A few of the more important features of this unique

storage CRT are zero flicker, zero drift, and a density of 39 lines of 85 characters each. But most significantly, it retains displays without costly refreshing.

The T4002 saves Central Processing Unit time through operator use of the Line-Buffer Edit Area, where you edit, compose, erase, retype, verify, or delete. Compose a line of data in the Line-Buffer Area; then transmit it at your maximum baud rate, rather than at the slow manual keyboard rate.

Alphanumeric outputs are displayed at an average rate of 2000 characters per second. Graphic outputs are by any of three programmable modes: Point plot, incremental plot and linear interpolation. The linear interpolate mode draws absolutely addressed vectors in 10 ms or less.

Tektronix has 57 domestic offices located in major cities throughout the United States and 48 foreign offices. For a demonstration or additional information, contact your local office directly. Or call (301) 825-9000 Baltimore; (617) 894-4550 Boston; (415) 326-8500 Palo Alto; or write Tektronix, Inc., P. O. Box 500, Beaverton, Oregon 97005.

T4002 Graphic Computer Terminal \$8,800
U.S. Sales Price FOB Beaverton, Oregon

Call today for a demonstration of the T4002.



Tektronix, Inc.
committed to technical excellence



See the T4002 on-line at SJCC Booth 4900

If Diehl can't solve your high response motor problem...

You've got a problem.

Whether your specs call for a stepper motor or a moving coil motor, you'll find that, we either have or can produce exactly what you need. Our stepper motors are ideal for applications in business equipment, office machines and small peripheral devices for positioning, counting, tape readers, small line printers, etc. Our new moving coil motors are high response D.C. servo motors, ideal for use in high-speed printers, capstan motors and wherever high speed response is needed.



BVE 20 Stepper Motor

- 15° stepping angles compatible with all 24 tooth sprockets
- Bi-directional
- Low inertia
- Permanently lubricated ball bearings
- Stainless steel shaft
- Dampers available. The exact amount of damping required for your specific load and stepping time rate is determined by the Diehl computer program.



Hi-Accel Motor Model HD5520-10-1

- Acceleration better than 140,000 rad/sec² for a 200W motor.
- High efficiency.
- Low armature inertia . . . much lower than normal DC motors.
- Less force cooling required, due to superior motor design.
- Very low inductance.
- Straight line speed-torque characteristics.
- High pulse acceleration torques.
- High overcurrent pulse capability . . . over 10X rated current with no harm to commutator or loss of field flux.
- Output torque, smooth and cogging free.

*High response motor problem? Call your Diehl representative today.
Or call us.*

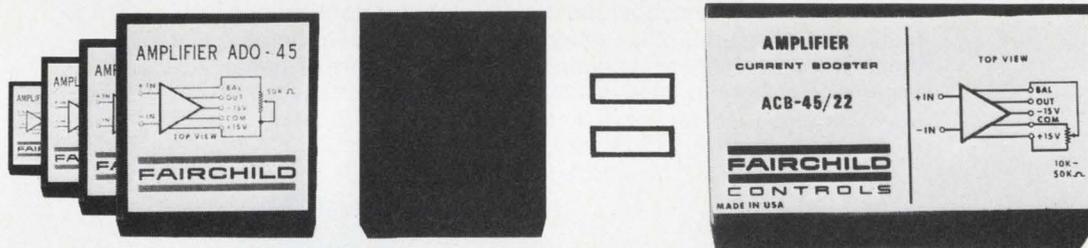
SINGER
DIEHL DIVISION

Finderne Avenue, Somerville, N.J. 08876 / (201) 725-2200 • TWX 710-480-9325

'NEW MATH'

from Fairchild Controls

$$1 + 1 = \text{THE BIG } 1$$



CHOOSE 1 Fairchild Op Amp from our wide range of available amplifiers . . .

ADD 1 current boosting circuit to give you 200 milliamps of output current . . .

AND, you get 1 package containing 2 circuits with the same electrical parameters — the same pin spacing and configuration as the original op-amps. Achieving space and cost savings not available in the use of two circuits to obtain extra output current.

Combining compatible components like these exemplifies Fairchild Controls' dedication to serve your broad scope amplification needs whether they be:

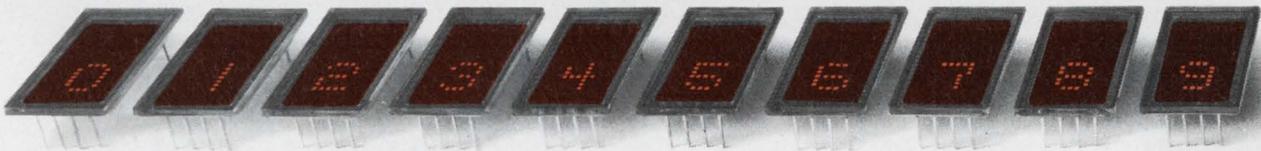
- Total systems.
- Proprietary op-amps.
- Reliable second sourcing the industry's broadest line of standard op-amps.

See your nearest Fairchild rep, or call or write Marketing Manager, at

FAIRCHILD
CONTROLS

423 NATIONAL AVENUE, MOUNTAIN VIEW, CALIF. 94040 (408)962-3833

For \$25 what can you expect from a solid-state display? 10 years of brilliant service.



For \$25 each in 1 K lots, HP sells you a hermetically sealed, IC-compatible display with on-board decoder-driver. You just plug the module in; it accepts direct 4-line BCD input. You also get a 5 x 7 dot matrix character that prevents ambiguous readings and a parallax-free design in a package that's one inch high and practically flat. It's the brightest display idea since the tube.

HEWLETT  PACKARD
SOLID STATE DEVICES

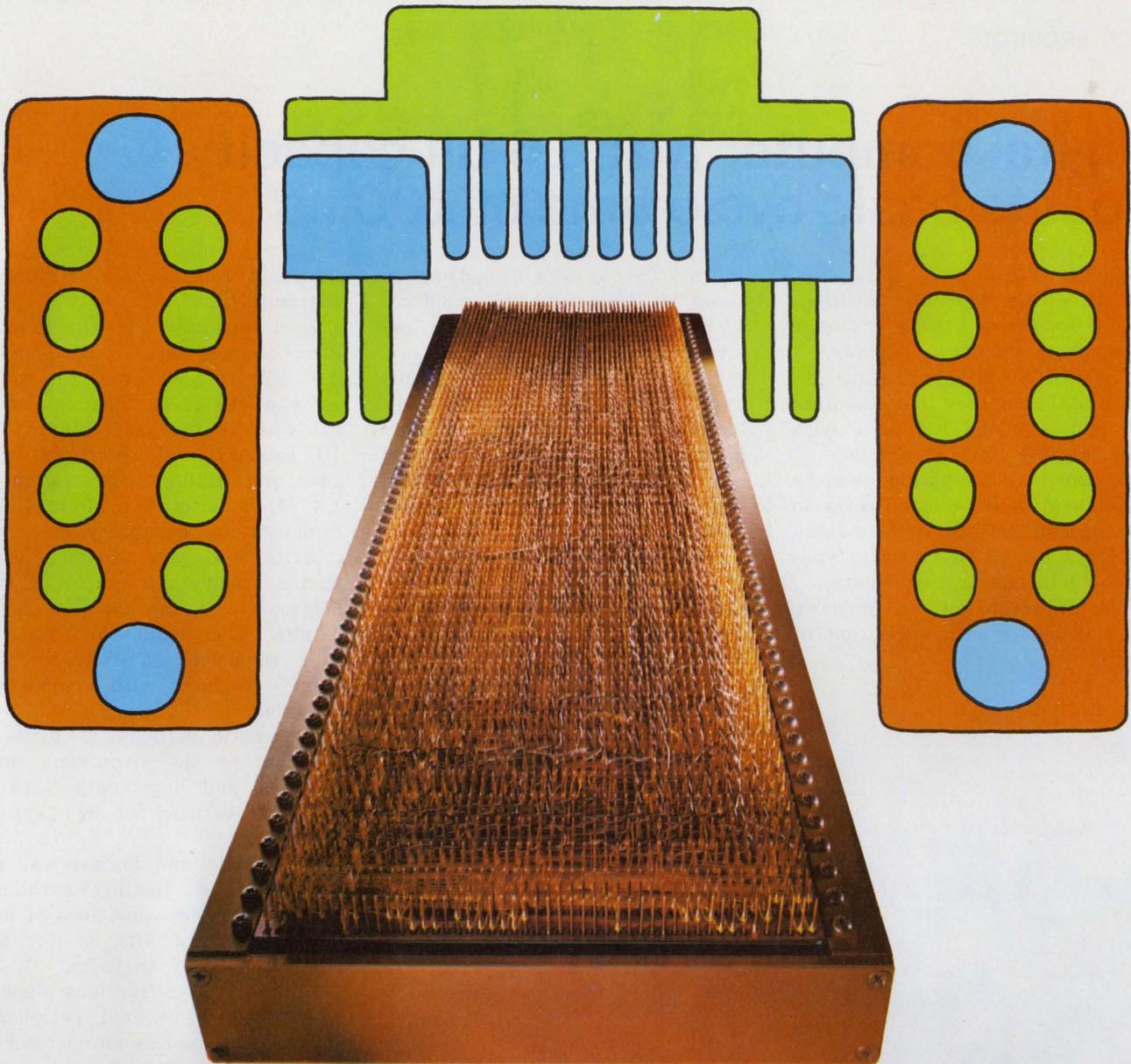
Our reliability study shows that the 5082-7000 numeric display glows on for 24 hours a day, 7 days a week for more than 10 years. Ask your HP field engineer for a copy of the study plus volume price quotes on the biggest all-around bargain you can buy in solid-state displays. Or write Hewlett-Packard, Palo Alto, California 94304; Europe 1217 Meyrin-Geneva, Switzerland.

01005

INFORMATION RETRIEVAL NUMBER 134

Nobody makes all five sense amplifier types. Nobody but Qualidyne. 

QC 1440, 1441, 7520/21, 7522/23, and 7524/25.
Also as 1540, 1541, 5520/21, 5522/23, 5524/25.
Complete line of military and industrial packages.
Compar has them in stock.
Qualidyne Corporation
Specialists in memory, interface circuitry and dual transistor technology
Santa Clara, California (408) 738-0120



Winchester Electronics

— their obsession with precision is solving tomorrow's problems today.

Problems—like connectors requiring post true positioning to within a mere .020 of an inch—won't stump Winchester Electronics. They've been making AccurFrame® as close to perfection as modern wire terminating machines demand.

And this fact proves the point: Of the various types of wire terminating connectors, only the HW Series by Winchester Electronics, positioned in AccurFrame,



**WINCHESTER
ELECTRONICS**

DIVISION OF LITTON INDUSTRIES

consistently meets the contact true position tolerances required by automatic wire terminating machines.

Now, if that doesn't say something for Winchester Electronics' AccurFrame, perhaps you have a connector requirement that does. Want to take us up on it? Write or call Winchester Electronics, Main Street and Hillside Avenue, Oakville, Conn. 06779.



INFORMATION RETRIEVAL NUMBER 136

Digital computer with 16-bit capacity boasts basic cycle time of 100 ns

Computer Signal Processors, Inc., 209 Middlesex Turnpike, Burlington, Mass. Phone: (617) 272-6020. P&A: from \$85,000; 4 months.

The CSP-30 is an ultra-fast 16-bit digital computer that combines its small size and low price with a basic cycle time of 100 ns.

It uses a combination memory of integrated-circuits and cores to optimize the balance between speed and economy. Both memory types can hold instructions and data.

The integrated-circuit memory has a complete basic cycle time of

100 ns. This results in instruction times of 100 ns and up, or 300 ns typically, for over 3 million instructions per second.

The core memory has a full cycle time of 900 ns. But a unique background fetch allows the core latency time to be ignored, so the core can look only 100 ns slower than the IC memory, or only 200 ns in many problems.

A programmer can avail himself of 32 accumulators, of which 14 may be used as index registers. This allows accumulators to quickly

interrupt routines and minimizes overhead time.

Each memory has an optional direct-memory-access port. The IC port allows read or write word-rates of 10 MHz. The core port can operate independently of the IC memory and computer with read and write word-rates up to 1.4 MHz, without a decrease in computational capability.

Arithmetic and logical commands specify the source of two operands and the destination of results. The usual three-instruction sequence of fetch-operate-store is replaced with a single instruction.

Automatic instructions make it possible to do re-entrant sub-routines and interrupts with a complete overhead for an interrupt of 1.2 μ s.

Arithmetic and logical test instructions allow testing for the set or for the re-set conditions of any combinations of bits, or for the relative state of an index.

Unique I/O instructions allow a word from a selected peripheral device to be used as an operand in the next instruction (connect input). They also allow the result of the next instruction to be transferred to a selected output device (connect output).

The I/O subsystem includes both high-speed and party-line channels and provides for externally or program-initiated multiple multi-level priority interrupts. Each channel has status information features that allow simple interfacing with any real-time or conventional peripheral.

A dual-deck magnetic-tape (cassette or cartridge) I/O device and a Teletype KSR 35 are provided with the basic system for simple program entry and off-line storage.

A power-threshold sensor permits major power deviations to cause a program-directed dump of volatile data from the IC to the core memory for later retrieval.

Booth No. 6103 Circle No. 268



Using a combination memory of ICs and cores, a new low-cost high-speed 16-bit digital computer features a basic cycle time of 100 ns.

IMOS:

[THE INDUSTRY'S FIRST ION-IMPLANTED MOS DEVICES]

Because our MOS integrated circuits are ion-implanted, they can handle 20 MHz data. And they're pin compatible with P-channel MOS.

Ion-implantation gives them ultimate automatic gate registration without process complications.

Example: our HDSR2164

dual 64-bit TTL compatible shift register. It's loaded with Tomorrow features. Like greater than 10 MHz operation. Low clock capacitance (typically, 25pf) and low power dissipation (typically 0.1 mW per bit per MHz at operating frequencies over 10 MHz). And it's priced at \$24.95 per unit in quantities over 100 pieces.

For literature, data sheets, and name of nearest distributor, please write: Hughes MOS Division, 500 Superior Avenue, Newport Beach, CA 92663.

HUGHES

HUGHES AIRCRAFT COMPANY
MOS DIVISION

HUGHES STANDARD MOSINC DEVICES

COUNTERS

HCTR0107: Reversible Decade Counter with Seven-Segment Decoder and Drivers @ \$12.50
HCTR0507: Seven Stage Binary Counter, 7 Outputs, @ \$7.00
HCTR0201: RST Flip-Flop @ \$1.65
HCTR0102: Commercial/Entertainment Binary Divider @ \$0.80

STATIC SHIFT REGISTERS

HSSR2016: Dual-16 Bit @ \$5.95
HSSR2064: Dual-64 Bit @ \$16.00

DYNAMIC SHIFT REGISTERS

HDSR3066: Triple-66 Bit @ \$17.50
HDSR4064: Quad-64 Bit @ \$23.50
HDSR2164: 10 MHz/ Dual-64 Bit Dynamic Shift Register @ \$24.95
LISR0064: 20 MHz/ 64 Bit Dynamic Shift Register @ \$35.00 (1 up)

MULTIPLEXERS

HMUX1756: 4 Bit D-to-A Converter @ \$39.80
HMUX1784: 4 Bit D-to-A Converter @ \$39.80
HMUX2542: Dual 2-Bit Commutator @ \$29.95
HMUX2641: 4-Bit Commutator @ \$29.95

LOGIC ELEMENTS

HLOG2304: Triple 3, Dual 2 NOR Gates @ \$4.00
HLOG2306: Dual J-K Flip-Flop @ \$4.00

MULTIPLES

HMUL 1444: General Purpose Quad @ \$10.25
HMUL1445: General Purpose Quad @ \$14.75
HMUL1884: Quad Dual-Switch @ \$16.25
HMUL2661: Six-Channel Switch @ \$15.75

DUALS

HDSW8550: High Level Switch @ \$5.60
HDIG8551: Amplifier @ \$7.45

DISCRETES

HDGP1000: General Purpose Switch @ \$0.70
HDGP1001: General Purpose 30-ohm Switch @ \$0.80
HDIG1030: General Purpose @ \$3.10
HDIG1886: Electrometer @ \$3.55
HDSW2106: Low-Resistance, 20-ohm Switch @ \$4.40
HDSW3005: General Purpose Low-Leakage Switch @ \$3.30
HDSW8318: General Purpose Switch @ \$2.75
HDSW8348: General Purpose 50-ohm Switch @ \$4.10

SUBSYSTEMS

HSUB0525: TV Sync Circuit @ \$15.00
HSUB5021: Differential Digital Analyzer @ \$18.00

COMPLEMENTARY MOS

LCOS4007: Dual Complementary Pair plus Inverter @ \$20.00 (1 up)

Note: All prices for 100 and over quantities except as noted.

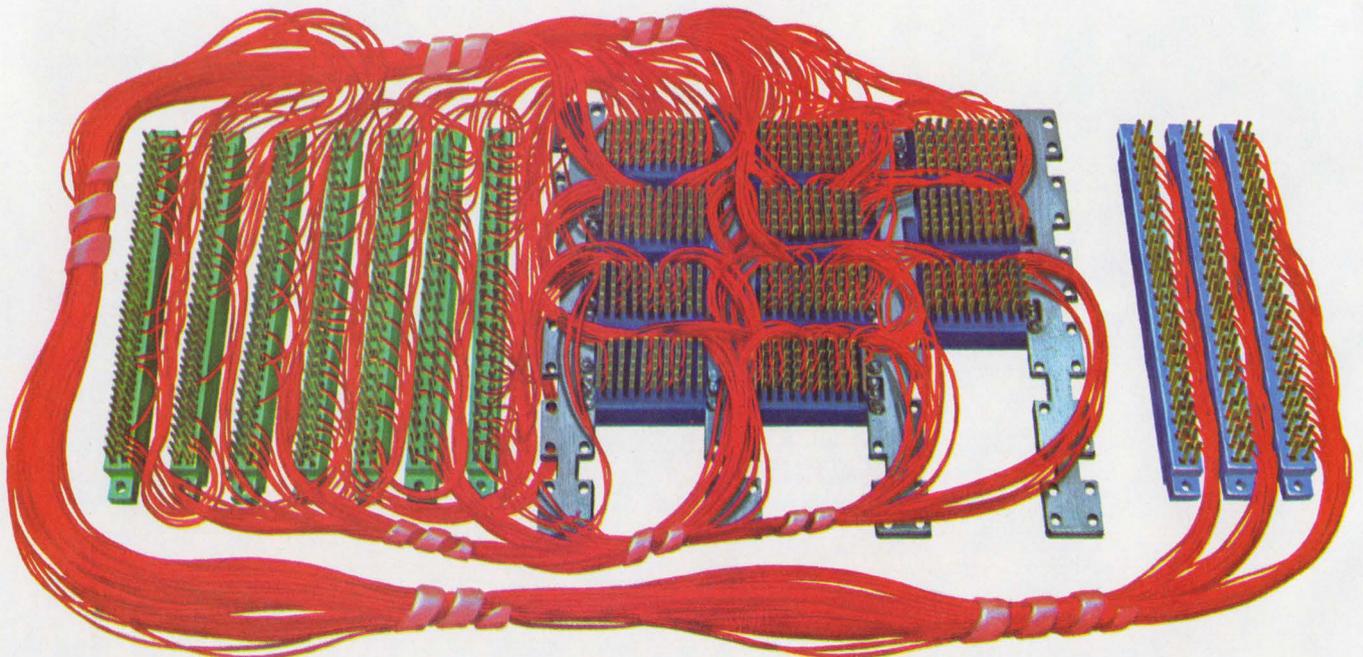
SAMPLE KITS

#1 Electrometers @ \$9.75 each
#2 Switches @ \$21.90 each
#3 Multiplexers @ \$149.75 each
#4 Counters @ \$33.56 each

Now there's a pack Everything includ plant or ours.

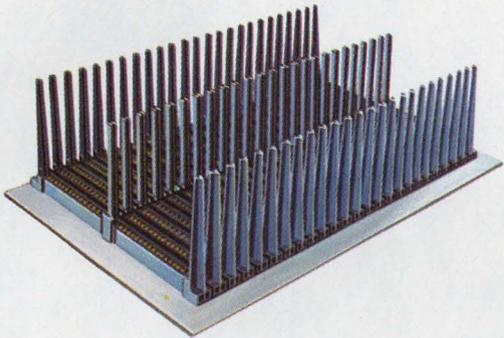
Our plan is whatever you want to make it. It can be everything you need for your panels. Or just some of the things.

We can start serving you at the design stage. Or we can provide components to meet your designs. We can supply all the wiring, too. Our own **TERMI-POINT★** point-to-point automatic wiring system that works with solid or stranded wire, and is easily maintainable. Your capital investment to get your panels wired with our method is zero. Whether you wire in your plant or we do it in ours.

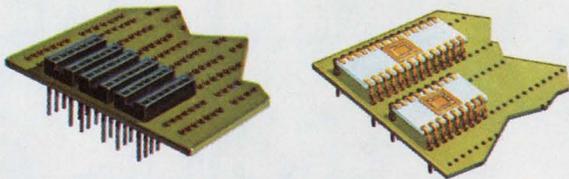


Age plan for panels. ing wiring...in your

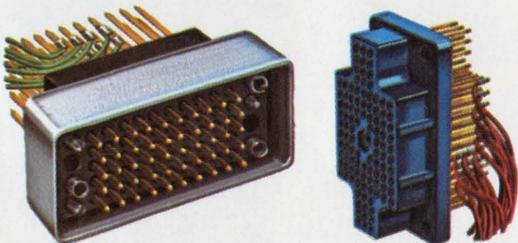
Printed Circuit Connectors. One piece or two piece. In a great variety of sizes that can all be wired automatically on TERMI-POINT or wrap-type posts.



IC Packaging Panels. We can supply header components in a wide variety including Dip Headers, Miniature Spring Sockets, and various IC Sockets. All available with TERMI-POINT, wrap-type or solder posts.



Input/Output Connectors. Both M Series and High Density Rectangular Connectors are available with rear posts for automatic wiring. They can be panel mounted and are obtainable in a host of position sizes. Both are furnished with TERMI-POINT or wrap-type posts.



Your plant or ours. It doesn't really matter which. You can wire with our machines in your plant. Or let us do it for you in our plant. To your specifications, of course.



If you're interested in what else we can do with panels, write for more information to: **Industrial Division, AMP Incorporated, Harrisburg, Pa. 17105.**

See us at booth #5000

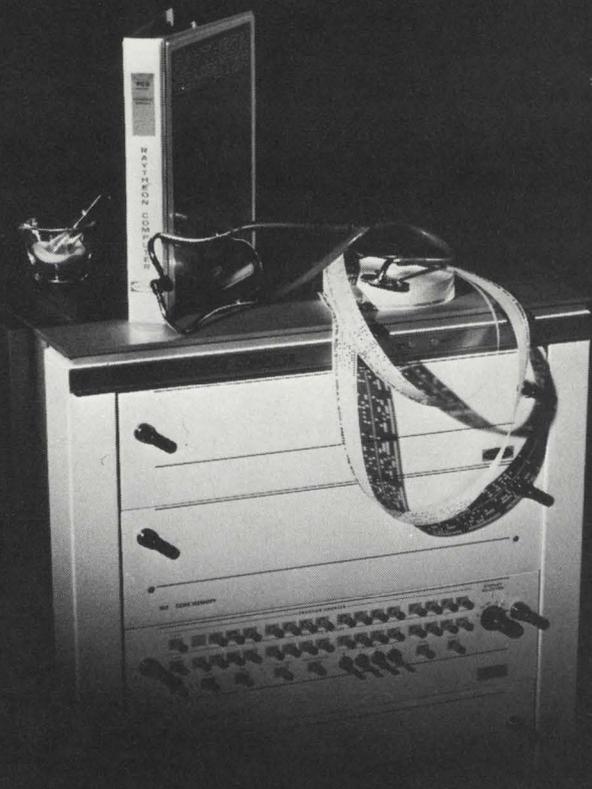
★Trademark of AMP Incorporated

AMP
INCORPORATED

INFORMATION RETRIEVAL NUMBER 138

If you think you need a giant computer for multi-programming, you don't know about Raytheon Computer.

DNA knows.



To get the power of multi-programming without paying the usual premium, Diversified Numeric Applications (DNA) of Minneapolis, Minn., selected one of our 16-bit computers and an auxiliary mass memory for their new Automated Clinical Laboratory System.

Testing has been made faster and more accurate in a versatile system that even allows real-time, on-line system interaction with lab personnel.

You can get the same kind of power into your systems from Raytheon Computer.

Power in hardware. CPU's with cycle times from 900ns to 1.75 μ s. All with direct I/O to the CPU, 4 addressable registers and 74 instructions.

And priced from under \$10,000 to \$19,000.

More power in the options. Hardware multiply/divide. Direct memory access. An Array Transform Processor. All the standard peripherals. And instant Raytheon Computer interfaces for any non-standard equipment your system needs.

And powerful software that bumps the Raytheon Computer 16-bit machines into the large computer class when it comes to doing your job.

Executives and monitors for multi-programming and time-sharing systems. Operating systems for mag tape and discs. A 360-compatible superset of FORTRAN IV. Conversational FORTRAN you can run in just 4k of core. And the fastest, most accurate math library in the 16-bit computer class.

In all, over 400 tested, debugged and proven programs and subroutines. All off-the-shelf today.

So write for all the details. Ask for Data File C-183. There isn't a better price/performance story in the industry.

Raytheon Computer, 2700 S. Fairview St., Santa Ana, Calif. 92704. Phone 714/546-7160.

RAYTHEON



Desktop \$500 data display is self-contained terminal

Hazeltine Corp., Industrial Products Div., Little Neck, N.Y. Phone: (212) 321-2300. P&A: \$500; stock.

Incorporating a keyboard input and a CRT monitor in a single compact desktop package, a new display terminal for \$500 can present 1760 characters on 32 lines of 55 characters each, or 1998 characters on 27 lines of 74 characters each. In addition, model 1760 offers split-screen capability and full editing features.

Characters have a 5x7 dot matrix structure, and character generation is by means of ON/OFF control of a standard 525-line TV raster. Nominal transmission rate for the new terminal is 110 baud, adjustable to 2400 baud or to below 110 baud.

The 1760's editing capabilities include single character insertion and deletion, as well as the insertion and deletion of full character lines. The character repertoire encompasses 64 standard ASCII upper-case alpha, numeric and special characters, or 96 standard ASCII characters exclud-

ing only the lower-case ones.

In addition, selected data transmitted by the computer cannot be modified by the keyboard operator. This data is in the background (protected) and is displayed at a lower intensity than foreground (unprotected) data.

Background and foreground data can also be used to establish fields for use in hardware functions. For example, a tabulation feature allows the cursor to be moved to the first foreground character following the next background field. Only foreground information, which is entered by the operator or is non-protected computer data, can be transmitted from the display.

Additional distinctive advantages of the 1760 include: programmable tabulation, off-line formatting, problem-free interfacing with magnetic-tape and hard-copy system, flicker-free viewing, and fully interactive performance.

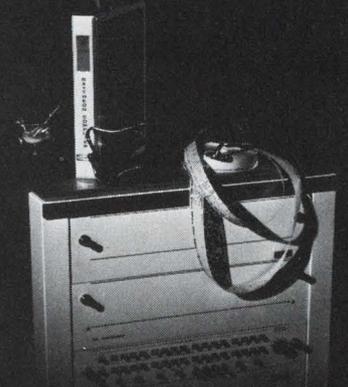
Monitors with 9 and 12-in. screens are available.

Booth No. 49012 Circle No. 265

The only thing
Raytheon Computer does
is your job.

Better.

Visit us at SJCC '70
Booths 5500-5600



RAYTHEON



Modular terminal computers talk to any other system

Victor Comptometer Corp., Business Machine Group, 3900 N. Rockwell St., Chicago, Ill. Phone: (312) 539-8210. P&A: \$7000 to \$100,000; 3 months.

Demonstrating their compatibility with large computers, the series 800 desk-size terminal computers feature the ability to communicate with any other terminal around the country or act as free-standing systems.

They exhibit a unique modularity, large memory capacity, full computer capabilities and fast execution times. Flexibility is afforded with a wide range of peripherals such as cards, paper tape, cassettes, ledger cards and dual-form feed devices.

Beginning with a skeleton mainframe, series 800 components can be added to a simple billing and accounting computer, transforming it into a sophisticated on-line terminal or a magnetic ledger-card computer.

The model 820/03 and 820/04 terminals can transceive any set of control characters in any message size or configuration and any five to nine-level code.

Both vertical and longitudinal parity checking are used. Trans-

mission speeds of 50 to 2400 bits per second, in either synchronous or asynchronous modes, are achieved.

By combining a number of series 800 computers with an 820/51 communications control unit and an 820/56 magnetic-tape unit, up to 32 terminals can be interconnected via direct cable or data set.

The model 820/56, under control of the model 820/51, can read and write standard 1/2-in. tape at packing densities of 200, 556 or 800 characters per second.

Each of the 800-series computers can work independently to perform a complete range of business operations. These include billing, payrolls, accounts receivable and payable and inventory control.

The use of terminals saves over half of a computer system's time, since terminals speed up inputs, check data for error before input, and act as back-ups in case of a central computer breakdown.

The series 800's modularity allows systems from \$7000 to \$100,000 to be formed without the replacement of initial equipment.

The 820/03 terminal can be leased at \$200 to \$650 per month. *Booth No. 5719 Circle No. 267*

Time-shared display trims cost per monitor



Data Disc Inc., 1275 California Ave., Palo Alto, Calif. Phone: (415) 326-7602. Price: \$2500 per display.

A new time-shared graphic display system drops the per-unit cost to \$2500 for each display in a 16-terminal network. Each TV-compatible terminal can display a different picture showing both graphics and alphanumeric on its 512x512-point screen. Over 4000 characters can be presented on each monitor.

Booth No. 111 Circle No. 260

Digital metal cassettes ground static charges



Scovill, Auricord Div., 35-41 29th St., Long Island City, N.Y. Phone: (212) 361-7400.

Able to fit any standard cassette machine, series CM metal digital cassettes eliminate static-charge problems because their metal housing acts as a ground to drain off static charges. In addition, the housing ensures precise dimensional stability and contains ball-bearing tape guides for exact tape location and low internal friction. Screw-together construction allows easy access.

Booth No. 50002 Circle No. 273



Trounce trimmer troubles with Dale Industrial and Commercial T-Pots

RCA's widely-used Spectra 70 computer is a good example of Dale Trimmers' year-in, year-out dependability. The models shown here are from Dale's 2100 wirewound series...sealed to meet tough RCA immersion requirements. Used in a number of Spectra 70 control and voltage reference applications, they're part of Dale's workhorse line of industrial and commercial trimmers. Nothing fancy...but you get what you need, when you need it—and you can use all you receive. Dale trimmers have a record of less than 1% customer rejection for *all* causes. Join the growing number of trimmer users who've found there's less trouble when you specify Dale.

Call 402-564-3131 for complete information or write for Catalog B.

DALE ELECTRONICS, INC.

1300 28th Ave., Columbus, Nebr. 68601
 In Canada: Dale Electronics Canada, Ltd.
 A subsidiary of The Lionel Corporation

COMMERCIAL GRADE ECONO-TRIM T-POTS



WIREWOUND ELEMENT

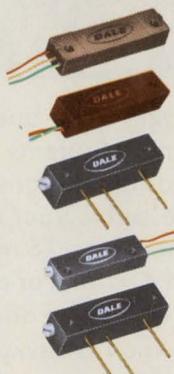
2300 Series: Sealed/Unsealed; 10Ω to 50KΩ, ±10%; 0.5 watt at 25°C, derated to 0 at 105°C; .36 H x .28 W x 1.00 L.

2400 Series: Sealed/Unsealed; 10Ω to 50KΩ, ±10%; 1 watt at 40°C, derated to 0 at 125°C; .31 H x .16 W x .75 L.

FILM ELEMENT

8300 Series: Sealed/Unsealed; 10Ω to 2 Meg., ±10% 100Ω thru 500K, ±20% all other values; .75 watt at 25°C, derated to 0 at 105°C; .36 H x .28 W x 1.00 L.

INDUSTRIAL GRADE T-POTS



WIREWOUND ELEMENT

100, 200, 300 Series: 10Ω to 100KΩ.

100 Series: ±5%; 0.8 watt at 70°C, derated to 0 at 135°C.

200 Series: ±10%; 0.5 watt at 70°C, derated to 0 at 105°C.

300 Series: ±15%; .25 watt at 70°C, derated to 0 at 85°C.

Dimensions: .22 H x .31 W x 1.25 L (also 1.32 L for 100, 200).

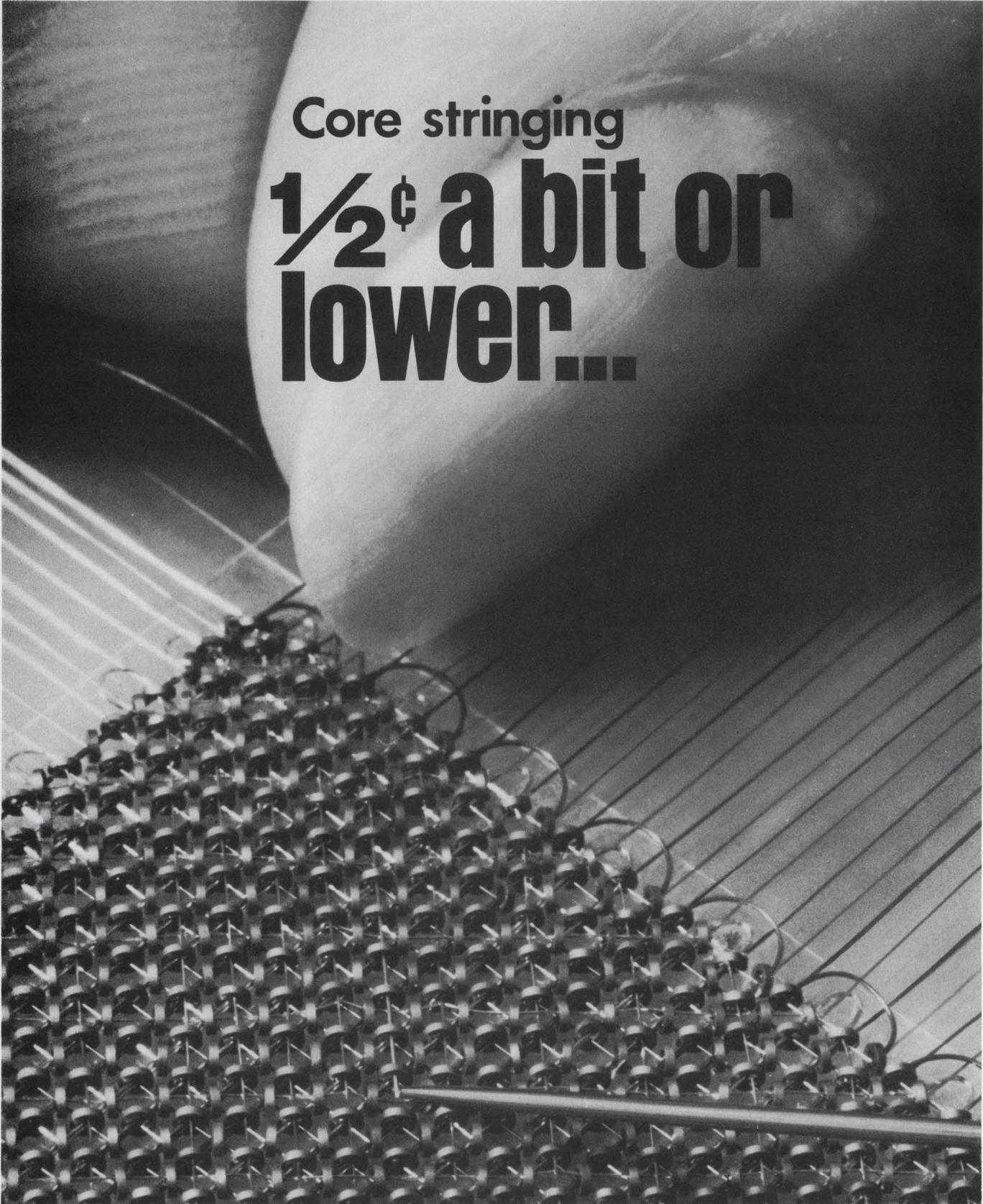
1100 Series: 10Ω to 100KΩ, ±10%; 1 watt at 70°C, derated to 0 at 175°C; .28 H x .31 W x 1.25 L.

2100 Series: Industrial counterpart RT-11; 10Ω to 100KΩ, ±10%; 1 watt at 70°C, derated to 0 at 125°C; .28 H x .31 W x 1.25 L.

2200 Series: Industrial counterpart RT-10; 10Ω to 100KΩ, ±10%; 1 watt at 70°C, derated to 0 at 125°C; .18 H x .32 W x 1.00 L.

FILM ELEMENT

8100 Series: Industrial counterpart RJ-11; 10Ω to 2 Meg., ±10% 100Ω to 500K, ±20% other values; .75 watt at 70°C, derated to 0 at 125°C; .28 H x .31 W x 1.25 L.



Core stringing
**1/2¢ a bit or
lower...**

See us at
Booth 6112,
SJCC

Custom Core stringing is our business, and the entire output was used in our own Memory Systems . . . until we greatly expanded our facility. Now we'll string custom designs of core planes and stacks for anyone . . . tested to your specs with solid delivery schedules. 18 mil cores and up for 2D, 2½D, 3D - 3 and 4 wire. For a quote on your specifications call 201-988-0400 or write.

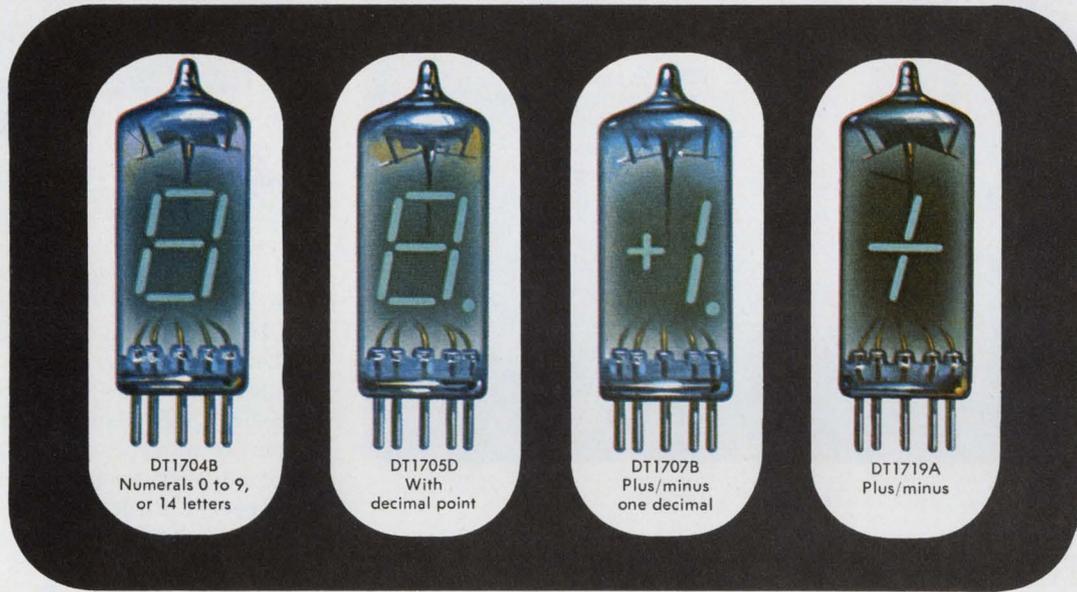


**UNITED
TELECONTROL
ELECTRONICS**

3500 Sunset Ave., Asbury Park, N.J. 07712

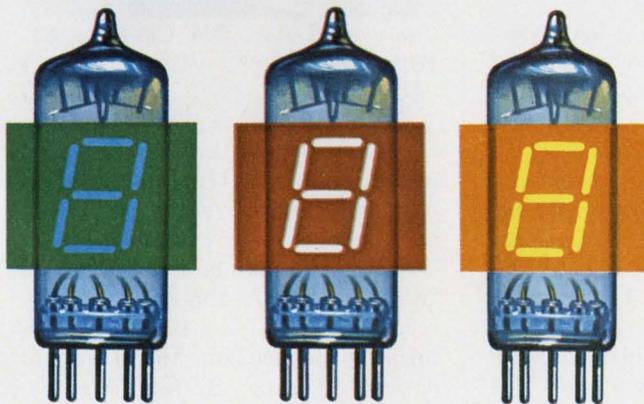
INFORMATION RETRIEVAL NUMBER 142

The Tung-Sol[®] development that created a whole new set of digital display standards



STANDARD CONFIGURATIONS

Low-voltage, low-power drain (25 V and 1.6 V) permits battery-operated applications. Standard miniature tube base. Inexpensive logic/driver requirements. Meets MIL specs. Space-age-type segmented character. Single plane display. Standard alphanumeric, or special symbols. Optimum visibility under ambient light conditions. Common filters provide unlimited color selection for identification, or to heighten contrast. Circuit-board mounting, with solderable-lead option. Write, or phone for detailed technical information and pricing.



Standard filters provide color variation

DIGIVAC S/G^{T.M.}

VACUUM FLUORESCENT DISPLAY

**TUNG-SOL DIVISION
WAGNER ELECTRIC CORPORATION**

630 W. Mt. Pleasant Avenue
Livingston, N.J. 07039
TWX: 710-994-4865
Phone: (201) 992-1100; (212) 732-5426

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

INFORMATION RETRIEVAL NUMBER 143



Off-line/on-line printers improve copy and cut costs

Photon, Inc., Computer Graphics Div., 355 Middlesex Ave., Wilmington, Mass. P&A: \$69,500, \$11,900; 2 months for model 7700.

Two new typographic peripheral printers provide computer data in book-quality printed reports at low costs.

The 7700 (off-line) and the 7445 (off-line/on-line) printers produce completely formatted pages on phototypesetting paper, film or directly on offset masters, ready for production run by any printing process.

Until now, computer centers had to use peripheral line printers that were adequate for limited distribution only, and were limited in producing large volumes of reports for wide circulation.

Furthermore, line printers are usually limited in character design, stilted in format and uneconomical in use of page space.

With the 7700 and 7445 printers, management information systems need not rely on difficult-to-read copies spun out of line printers.

Operating at 300 lines per minute, the 7700 printer offers computer centers a supplementary device that prints readable type directly from a magnetic tape produced by the centers' own computers.

It can mix any two sizes of any two typefaces at any given time. Each typeface offers up to 105 characters consisting of capitals, lower cases, numerals, fractions, punctuation marks, and/or special marks, all in one style.

The 7445 printer is a lower-cost terminal printer that operates at 30 characters per second for on-line operation and 17 characters per second for off-line use.

Optional FORTRAN programs for the 7700 off-line printer enable the user to create additional graphic-arts qualities. These include hyphenless justification, multi-column text arrangements and multi-column justified tab.

Rental and leasing plans are available.

Booth No. 2008 Circle No. 269

CRT display terminal performs at 1200 baud



Computer Displays Inc., 223 Crescent St., Waltham, Mass. Phone: (617) 899-0480. Price: from \$7950.

Intentionally designed to look like a teletypewriter to most computers, a new graphic/alphanumeric CRT display terminal can operate at speeds of 1200 bits per second over telephone lines. When connected directly to a computer, the operating speed of model ARDS 100A increases to 50,000 bits per second. Basic cost is \$7950; average system price is \$10,000.

Booth No. 25003 Circle No. 261

Cassette transport eases error correction



CompuCord Inc., 225 Crescent St., Waltham, Mass. Phone: (617) 891-0080.

The CompuCord 1200 magnetic tape transport is a cassette-loaded incremental/continuous digital unit that permits error correction on a character-by-character basis. The use of redundant data on two tracks eliminates the need for pre-recorded cassettes without requiring dependence on the recorded data for timing. System interfacing is straight-forward.

Booth No. 10005 Circle No. 254

Pick your own happy ending.

All good things, including circuit boards, must come to an end.

That's where we come in. We've got the happy ending patented.

Four times. (Pat. nos. 2,248,686; 2,294,056; 3,182,276; 3,208,026.)

In all the configurations you need. Four plug styles. Ten receptacle styles. For direct staking, or with their own insulator. With or without card guides. With or without guide pins. With any number of contacts (up to 135, on one triple-decker receptacle).

Every one meets Mil-E-5400 including the new revision "K", which makes metal-to-metal contacts mandatory.

Our Varicon™ metal-to-metal contacts are patented — and famous, in their quiet way. Because, in millions of operating hours, not one has failed.

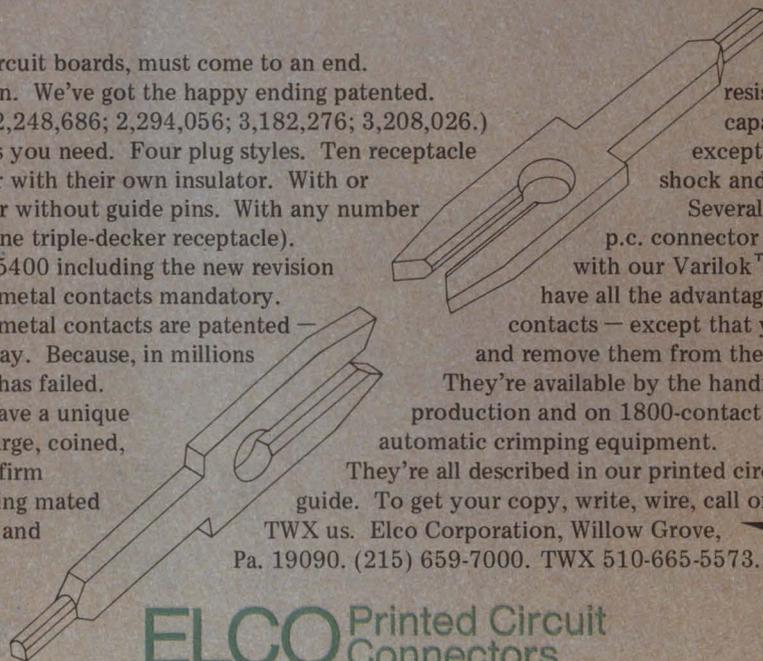
The Varicon contacts have a unique fork-like design, with four large, coined, mating surfaces that form a firm gas-tight seal. Even after being mated for years, they remain clean and unoxidized. They have, and

keep, a low contact resistance and high current capacity. And they're exceptionally resistant to shock and vibration.

Several members of our p.c. connector family come with our Varilok™ contact. These have all the advantages of the Varicon contacts — except that you can insert and remove them from the receptacle yourself.

They're available by the handful for small scale production and on 1800-contact reels for use with automatic crimping equipment.

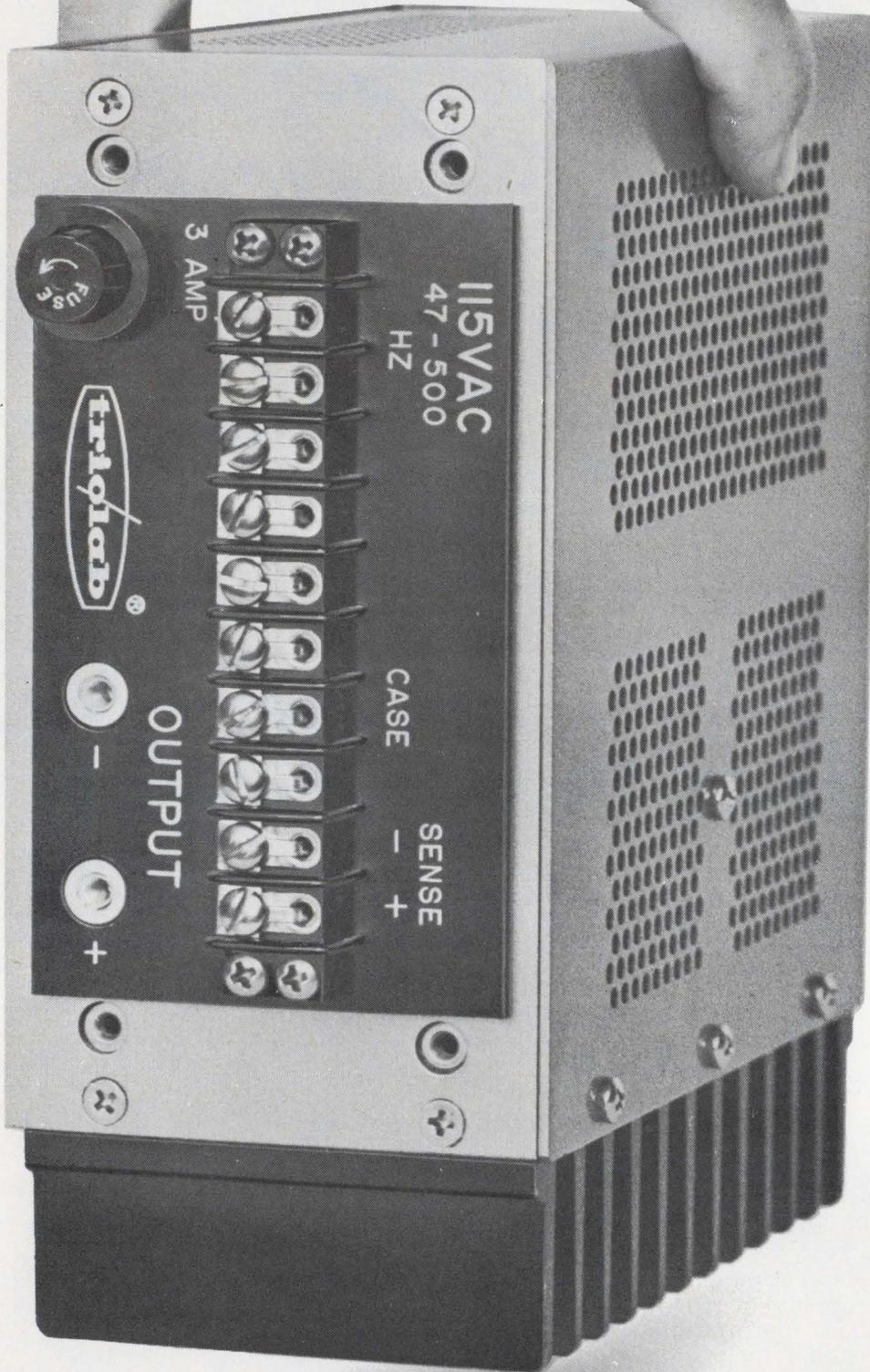
They're all described in our printed circuit connector guide. To get your copy, write, wire, call or TWX us. Elco Corporation, Willow Grove, Pa. 19090. (215) 659-7000. TWX 510-665-5573.



ELCO Printed Circuit
Connectors



Model SP601 shown actual size.



We make it possible by harnessing the space-saving advantages of the switching regulator—but have pulled its RFI fangs (input and output meet MIL-I-6181).

When you read our data sheet carefully, you'll also find it full of hidden features that other manufacturers would loudly acclaim.

Such as an IC regulating amplifier, automatic overvoltage crowbar, self-resetting automatic overload and short circuit protection, and even 30 ms full-load storage after the input voltage disappears.

Efficiency is so high that the very hottest spot on the heat sink has a rise of only 25°C.

You can actually hold our unit after hours of full-load bench operation without smelling burning flesh!

And is there any other unit you've heard about that will continue to deliver full-load at 71°C.—without derating, heat sinking or forced air cooling.

Single, dual, or triple outputs at voltage levels of 3V to 30V can be provided to your specific needs.

By the way, if you think our \$400 price is high, try adding the "optional extras" to anybody else's standard you had in mind.

Trio Laboratories, Inc., 80 DuPont Street, Plainview, L. I., N. Y. 11803. Tel.: (516) 681-0400.

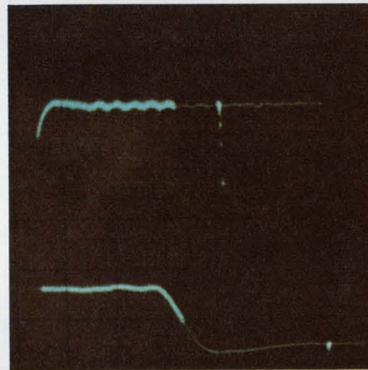
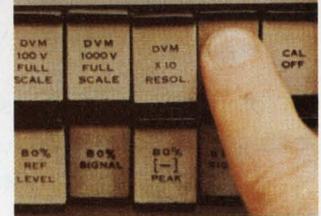
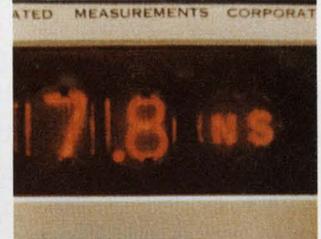
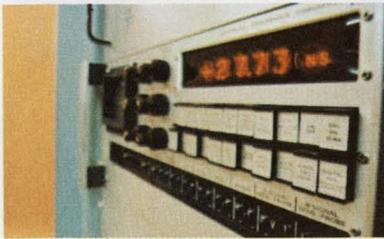
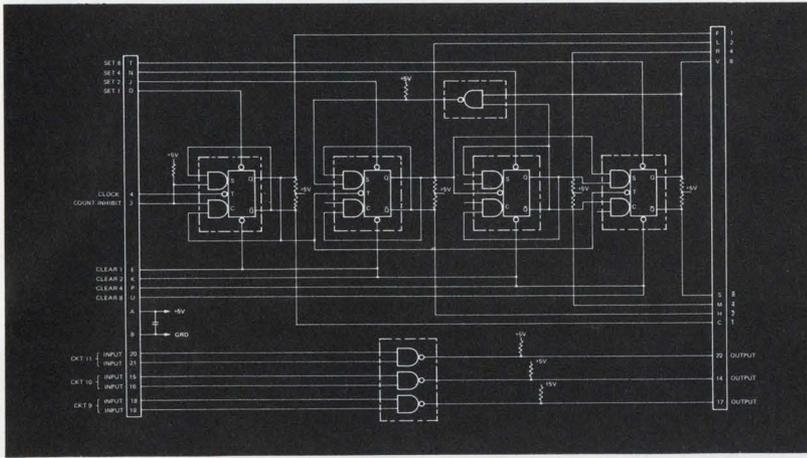
TWX: (510) 221-1861.



Now you can squeeze your 5V/20A power supply down to fit your microcircuitry.

SEE US AT BOOTH 2012 AT THE SPRING JOINT COMPUTER CONFERENCE

INFORMATION RETRIEVAL NUMBER 145



E-H the systematic solution

Whether you need a complete dynamic test system or the ideal components to integrate with your present system, look no further. E-H Research Laboratories, Inc. and its subsidiary, Automated Measurements Corporation, offer you the perfect solution.

For example, the **E-H 1139/1420 programmable timing unit and pulse driver combination** is a new generation in pulse instruments that fits the needs of any systems designer. These two rack-mounted units are so completely programmable that there are no front-panel knobs to twist. They're ideal for any systems applications requiring pulses from 1kHz to 10MHz. And they offer the designer such features as complete waveform control, with programmable width and delay from 10ns to 100 μ s, amplitude from $\pm 3V$ to $\pm 10V$ with programmable attenuation from X1 to X40 and rise and fall times programmable from 5ns to 13 μ s.

The perfect mate to the E-H 1139/1420 is the **AMC Model 1000 Waveform Analyzer**. The AMC 1000 was designed specifically for programmed systems application. It combines in one compact box the functions of sampling oscilloscope, digital counter and digital voltmeter to provide time and voltage measurements of sampled waveforms. The AMC 1000 is the most advanced instrument of its kind, with features including $\pm 1\%$ time measurements all ranges, fastest measurement rates, 10 remote sampling channels, all solid-state construction, serial-by-character or parallel programming, built-in program memories, stored BCD outputs, built-in floating DVM, and digital readout.

This is just a sample of the broad line of E-H and AMC equipment available from your E-H representative. He can offer you a complete system or the most advanced components to give you the systematic solution to your problems today. And tomorrow.



E-H RESEARCH LABORATORIES, INC.

515 Eleventh Street • Box 1289, Oakland, California 94604 • Phone: (415) 834-3030 • TWX 910-366-7258
 In Europe: E-H Research Laboratories (Ned) N.V., Box 1018, Eindhoven, The Netherlands, Telex 51116
 In Japan: Iwatsu Electric Company, Ltd., 7-41, 1-Chome Kugayama Sugunami-Ku, Tokyo 167, Japan

INFORMATION RETRIEVAL NUMBER 146

So what if Grant Slides save hours of down time?

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

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

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

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

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

Write for complete data.

GRANT
PULLEY & HARDWARE CORPORATION

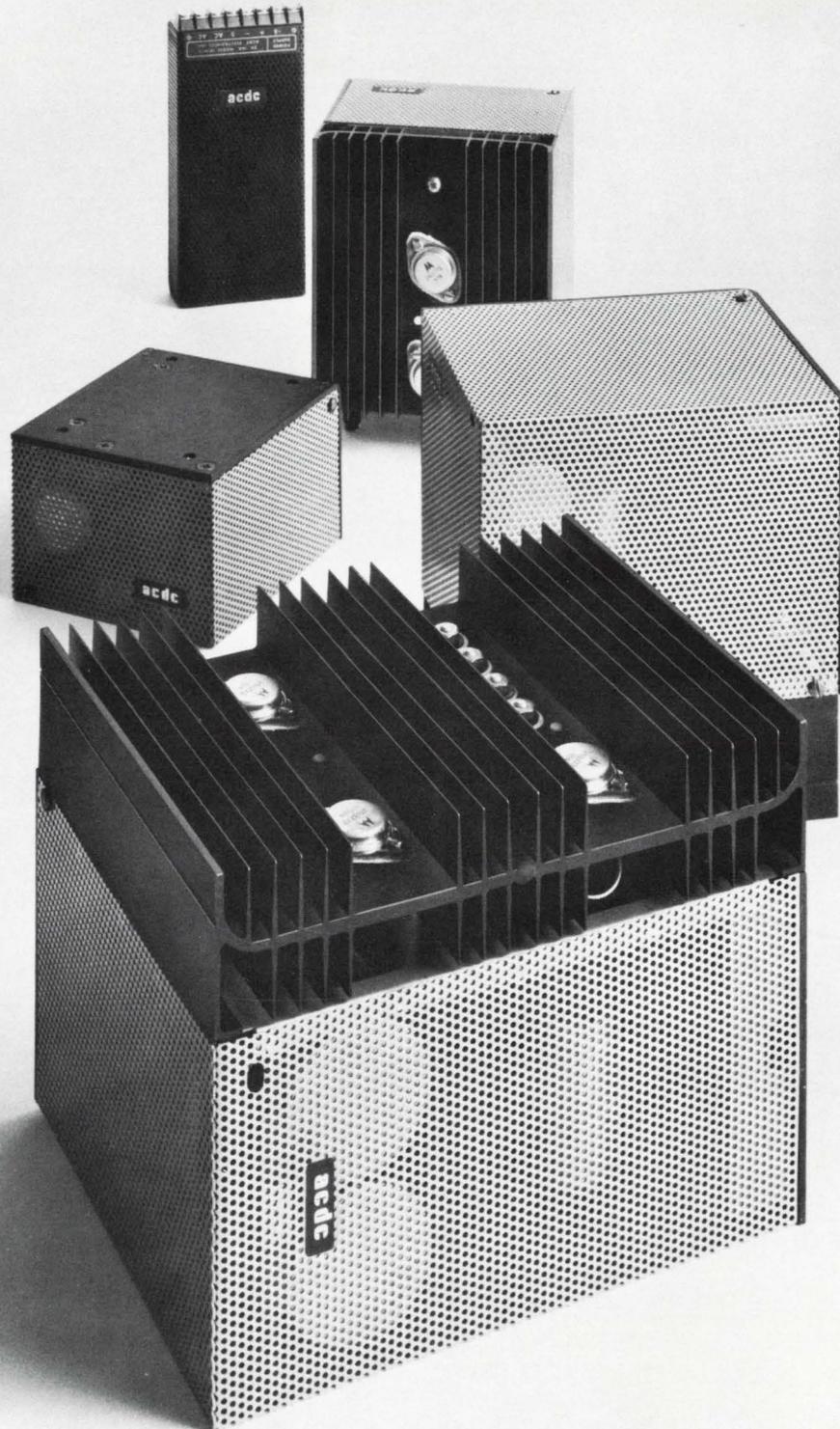
EASTERN DIVISION: 21 HIGH STREET, WEST NYACK, NEW YORK 10994
WESTERN DIVISION: 944 LONG BEACH AVE., LOS ANGELES, CALIF. 90021

INFORMATION RETRIEVAL NUMBER 147

INFORMATION RETRIEVAL NUMBER 148 ►

acdc

electronics inc.



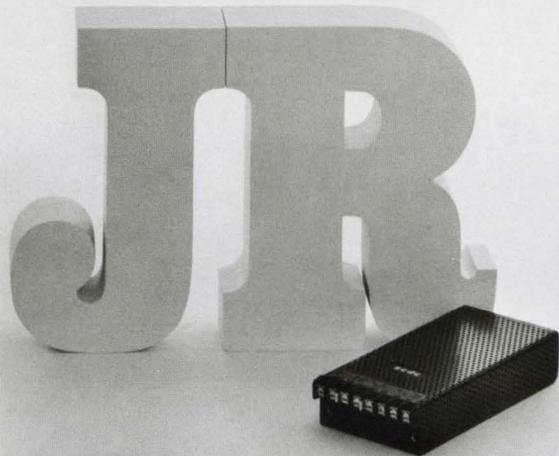
POWER SUPPLIES

ACDC Power Supply Modules

acdc
POWER SUPPLIES

JR — Miniaturized Power Supply Modules

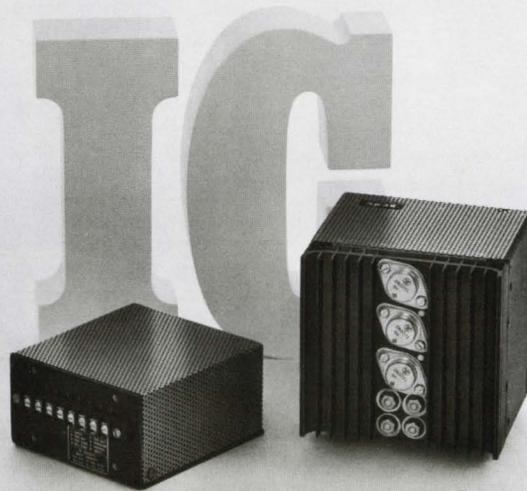
Here's the first precision-regulated DC power supply in a truly miniaturized package. You get AC conversion, isolation, and regulation in a package so slim and light you could actually put five of ours into one of theirs. So you can tuck it into impossible spaces. Yet there's only a modest price differential over conventional units, despite JR's drastically improved efficiency.



Stock Delivery

IC — 5V Power Supply Modules for ICs

The application's in the name — if you're in digital ICs, then this unusually complete line of 5VDC power supply modules has been designed especially for you. Performance, too, has been optimized for the end use and we've multi-rated the power output to make IC ideal for you under every possible condition.



Stock Delivery

BX — Precision Power Supply Modules for all Applications

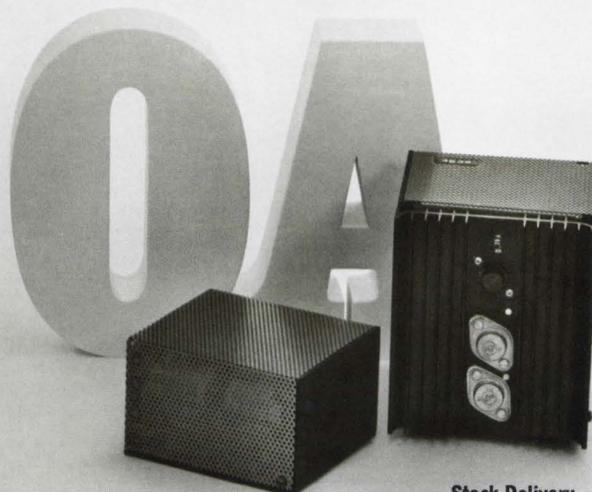
You name it and we'll ship it. From 0 to 28VDC it's off the shelf — higher voltages take just a little longer. When you specify BX, you'll get our best regulated series that's designed to cover every conceivable power supply requirement.



Stock Delivery

OA — Dual Output Power Supply Modules for Op Amps

If you're in op amps, you need power supplies with built-in tracking and long-term stability. That's what you get in our OA line.



Stock Delivery

acdc electronics inc.

Oceanside Industrial Center, Oceanside, California 92054, (714) 757-1880

General Specifications



Stock Delivery

	JR Miniaturized Power Supply	IC Optimized 5V Modules	BX Precision Modules	OA Dual Output Modules
Input	105-125VAC, 47-420Hz, single phase.	105-125VAC, 47-63Hz (usable also to 400Hz — consult acdc for derating). All models of 20A and greater are provided with a 105-125/210-250VAC input.		
Output	Voltage range shown in tables on following two pages is continuously variable between limits by externally accessible screwdriver adjustment of multiturn pot. Output is floating — either positive or negative terminal may be grounded. Current: zero to full load as shown in tables.			
Regulation	0.1% \pm 5mV NL-FL. \pm 0.1% \pm 5mV for \pm 10% input variation.	0.05% for line changes of 10%. 0.05% for NL to FL changes.	0.01% or 0.001 volt for line changes of 10%. 0.01% or 0.002 volt for NL to FL changes.	
Ripple	3mV RMS max (120Hz). 25mV P-P (spikes at 50KHz rep. rate).	2mV RMS and 20mV P-P max.	0.5mV or 0.001% max. RMS (whichever is greater).	
Temperature Stability	Typical 10mV for eight hour period after initial warmup.		Maximum 0.1% or 10mV for eight hour period after initial warmup.	
Transient Response	Typically less than 1 msec in response to an NL-FL step.	Output voltage returns to within regulation limits within 50 μ sec in response to a 50% step change in load current.		
Remote Sensing	Terminals are provided to maintain regulation at the load, compensating for the DC voltage drop in the load cable.			
Remote Voltage Adjustment	Terminals are provided to adjust the output voltage by means of a remote variable resistor. On the wide range models, in addition to being internally adjustable over the full range, remote programming is possible at an accurately adjustable 1000 Θ /V and a separate zero adjustment is provided. Remote voltage adjustment is not provided on dual output models but may be ordered as a special feature.			
Ambient Temperature	Unit must be mounted to allow conductive heatsinking to hold the case temperature below 80°C.	Operating: Full rated output at operating temperatures of 0° to 71°C without forced air or heatsinking. Storage: -55°C to +85°C.		
Mil Specs	The listed catalog models are constructed with the highest quality components and have MTBF ratings in the neighborhood of 50,000 hours per MIL-HDBK-217. acdc will also build supplies to meet specific MIL specs such as MIL-E-4158A, MIL-E-16400, MIL-T-21200, and meet environmental requirements such as MIL-E-5400, MIL-E-5272, MIL-E-4970, and RFI specs MIL-I-26600 and MIL-I-6181. acdc's own environmental laboratory is able to perform qualification testing when required and is used extensively to prove out designs. In order to provide the most efficient design, customer inquiries are invited, outlining exact specifications and environmental conditions required for the end product.			
Weight	Approx. 1½ lbs.	4 to 83 lbs.	1.6 to 46 lbs.	4 to 11 lbs.
Mounting	Fits into 1¾" rack panel assembly.	Unit can be mounted in any position on either one of two sides. Mounting faces have threaded mounting holes.		
Dimensions	H-W-L dimensions for individual models are given in the tables on the following two pages.			
Overload Protection	All models are inherently protected against overload and short circuits of any duration. Except for certain higher voltage units, no fuses or reset buttons are used — automatic recovery is electronically accomplished. On higher voltage units, short circuit protection is furnished by means of an accessible, replaceable fuse.			
Overvoltage Protection (Optional)	A completely independent overvoltage protection module is available and straddles the output terminals. This protection does not depend on the regulating circuitry of the supply. Trip voltage adjustable from 5-30 volts.	Any model, up to 50 volts, can be furnished with overvoltage protection which "crowbars" the output in the event of a rise in the output voltage of 10% or 2 volts (whichever is greater). On dual models, overvoltage protection "crowbars" both voltages to near zero in the event of a rise of one or both of the voltages of 20% or 4 volts (whichever is greater).		
Connector	All cases have barrier strip termination.		Cases A through F are supplied with a solder hook terminal header. Case M1 is furnished with an attached 10 terminal PC edge connector which may be used either as a solder connection or readily removed by the user and mounted in his equipment to provide plug-in convenience. G and H cases have barrier strip termination.	
Construction	Black anodized aluminum case. Unit may be removed from case for complete serviceability.	Modules are constructed of heavy gage aluminum with integral extruded heatsinks; color is black. Removable covers of perforated steel have a light gold enamel finish. Regulating circuitry is mounted on a PC board.		
Output Impedance	(See Regulation and Transient Response).	DC — 1KHz 0.001 R _L or 0.005 ohm max. 1-100KHz 0.005 R _L or 0.3 ohm max (whichever is greater). R _L = rated load.	DC — 1KHz 0.0001 R _L or 0.001 ohm max. 1-10KHz 0.0003 R _L or 0.01 ohm max. 10-100KHz 0.006 R _L or 0.3 ohm max. (whichever is greater). R _L = rated load.	
Temperature Coefficient	0.02%/°C max.	1mV/°C max.	Maximum .015% or 1mV/°C.	

JR

Miniaturized Power Supply Module

Nominal Output Voltage (VDC)	Output Voltage Range* (VDC)	Maximum Current Rating (Amps)	Maximum Dimensions (inches)			Weight approx. (lbs.)	Case Size	Model (Add -1 for Overvoltage Protection)	Quantity	Price (add \$30 for OVP)
			H	W	L					
5	3.0	10	1.375	3.125	6.5	1.5	K1	JR5K10	1-9	\$298
	5.0	10							10-24	291
	5.5	9							25-49	285
	6.0	8							50-99	280
15	12	4.0	1.375	3.125	6.5	1.5	K1	JR15K4.0	1-9	\$298
	15	4.0							10-24	291
	18	3.0							25-49	285
										50-99
25	22	2.5	1.375	3.125	6.5	1.5	K1	JR25K2.0	1-9	\$298
	25	2.0							10-24	291
	30	2.0							25-49	285
										50-99

*Continuously adjustable

IC

5V Power Supply Module for IC's

Nominal Output Voltage (VDC)	Output Voltage Range (VDC)	Maximum Current Rating (Amps)	Maximum Dimensions (inches)			Weight approx. (lbs.)	Case Size	Model (Add -1 for Overvoltage Protection)	Price
			H	W	L				
5	4.75 to 5.25	2.0 @ 71°C 2.5 @ 55°C 2.7 @ 40°C	5.0	2.5	4.38	4	J1	IC5N2.7	98.00 Add \$20 for overvoltage protection
5	4.75 to 5.25	6.2 @ 71°C 8.0 @ 55°C 9.5 @ 40°C	5.0	5.0	5.0	7.5	L1	IC5N9.5	134.00 Add \$30 for overvoltage protection
5	4.75 to 5.25	9.2 @ 71°C 11.5 @ 55°C 13.5 @ 40°C	5.0	5.0	7.5	11	N1	IC5N13.5	186.00 Add \$30 for overvoltage protection
5	4.75 to 5.25	16.5 @ 71°C 21.5 @ 55°C 25.0 @ 40°C	5.0	5.53	11.0	19	P1	IC5N25	258.00 Add \$30 for overvoltage protection
5	4.75 to 5.75	50 @ 71°C 60 @ 55°C 70 @ 40°C	5.25	19.00	14.00	52	S1	IC5N70	529.00 Add \$60 for overvoltage protection
5	4.75 to 5.25	75 @ 71°C 90 @ 55°C 100 @ 40°C	5.25	19.00	21.00	83	S2	IC5N100	835.00 Add \$85 for overvoltage protection

BX

Precision Power Supply Modules for All Applications

Nominal Output Voltage (VDC)	Output Voltage Range (VDC)	Maximum Current Rating (Amps)	Maximum Dimensions (inches)			Weight approx. (lbs.)	Case Size	Model (Add -1 for Overvoltage Protection)	Price
			H	W	L				
2 through 28 in even voltages	± 1 from nominal	0.3	1.88	2.75	4.75	1.6	M1	BX2N0.3 through BX28N0.3	76.00 Add \$20 for overvoltage protection
2 through 28 in even voltages	± 1 from nominal	1.2	5.00	3.12	4.37	4	A1	BX2N1.2 through BX28N1.2	116.00 Add \$20 for overvoltage protection
2 through 28 in even voltages	± 1 from nominal	2.5	5.00	4.37	6.00	8	B1	BX2N2.5 through BX28N2.5	137.00 Add \$20 for overvoltage protection
2 through 10 in even voltages	± 1 from nominal	5.0	5.25	5.00	6.00	11	C1	BX2N5 through BX10N5	184.00 Add \$30 for overvoltage protection
12 through 28 in even voltages			5.00	6.87	6.00	14	D1	BX12N5 through BX28N5	
2 through 6 in even voltages	± 1 from nominal	10.0	6.50	6.62	8.25	18	E3	BX2N10 through BX6N10	274.00 Add \$30 for overvoltage protection
8 through 28 in even voltages			6.50	7.75	8.25	25	F2	BX8N10 through BX28N10	
2 through 14 in even voltages	± 1 from nominal	20.00	5.50	8.00	15.00	42	G1	BX2N20 through BX14N20	395.00 Add \$30 for overvoltage protection
16 through 28 in even voltages			5.50	9.75	15.00	46	H1	BX16N20 through BX28N20	

For applications requiring 0.5% regulation, see BC series, also available from stock.

OA

Dual Output Power Supply Modules for OP Amps

Nominal Output Voltage (VDC)	Output Voltage Range (VDC)	Maximum Current Rating (Amps)	Maximum Dimensions (inches)			Weight approx. (lbs.)	Case Size	Model (Add -1 for Overvoltage Protection)	Price
			H	W	L				
± 12	11-13	0.350 @ 71°C 0.425 @ 55°C 0.500 @ 40°C	5.00	2.50	4.38	4	J2	OA12D0.5	119.00 Add \$20 for overvoltage protection
± 15	14-16							OA15D0.5	
± 12	11-13	0.750 @ 71°C 0.900 @ 55°C 1.1 @ 40°C	5.00	3.12	4.37	5	A1	OA12D1.1	149.00 Add \$20 for overvoltage protection
± 15	14-16							OA15D1.1	
± 12	11-13	3.0 @ 71°C 3.5 @ 55°C 3.7 @ 40°C	5.00	5.25	6.00	11	C1	OA12D3.7	195.00 Add \$20 for overvoltage protection
± 15	14-16							OA15D3.7	

BC—This series of DC power supply modules has 0.5% regulation. 15 voltage ranges 2 to 28VDC, each available in six current ratings from 300mA to 20A. Available from stock.

0.3A	\$ 73.00	5.0A	\$178.00
1.2	\$111.00	10.0	\$265.00
2.5	\$132.00	20.0	\$384.00

30 to 400VDC Modules—Both the BC (0.5% regulation) and the BX series (0.01% regulation) are offered in 22 voltage ranges to meet 30 to 400VDC precision requirements. The 11 ranges from 30 to 50VDC are available with 0.3, 1.2, 2.5, and 5.0A current ratings. Those from 60 to 100VDC are made with 0.1, 0.4, 0.6, and 1.2A ratings. An additional 0.2A rating is offered in the 100VDC range. The 150, 200, 250, 300, 350, and 400VDC range modules are rated 0.1, 0.2, 0.4, and 0.6A. Prices range from \$82.00 to \$282.00.

Wide Range Programmable Modules—These unique ACDC modules are adjustable from zero to full output voltage and will deliver rated current at all voltages. A screwdriver makes both the fine and coarse voltage controls easily accessible. May be used with an external programming resistor. In the 0 to 25VDC range, available with 0.1, 0.4, 1.2, and 2.5A ratings. In the 0 to 50VDC range, the ratings are 0.1, 0.2, 0.6, and 1.2A. From \$119.00 to \$178.00.

Dual Output Modules—ACDC's BX and BC series are also available to meet dual output requirements, in 25 ranges from ± 2 to ± 50 VDC. Each range is offered in four current ratings from 300mA to 2.5A. From \$154.00 to \$275.00.



Warranty

When used within its specified operating environments, ACDC power supplies are unconditionally guaranteed to meet all published specifications for an unlimited length of time. This guarantee covers all parts of the module, including semi-conductors, fuses, and mechanical parts, without regard to the date of purchase or installation. All terms of this guarantee are fully transferable when the power supply is sold as original equipment.

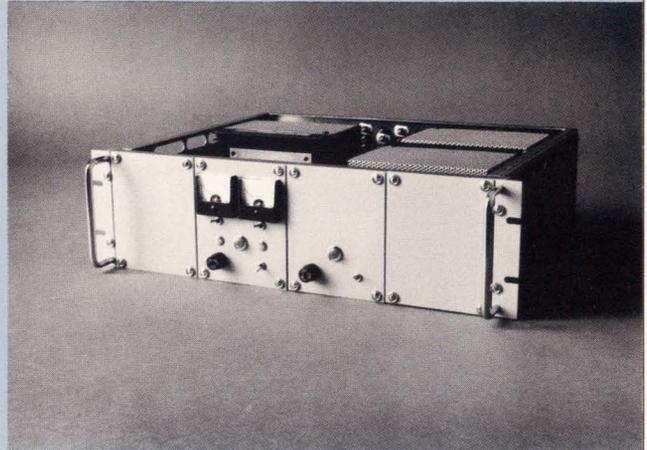
If at any time the power supply is in need of warranty service or calibration it may be returned directly to the factory where, without charge, it will be adjusted to meet its original specifications. ACDC will pay surface freight charges to and from the factory.

New from ACDC! Universal 19" Rack Adapters for mounting any ACDC power supply. Available in 3½", 5¼", or 7" high and 14" or 21" deep. There are no holes to drill, just assemble the power supply mounting plates with the hardware furnished with each Rack Adapter. Front panels are finished in grey enamel and the chassis is cadmium plated. Panel options range from blank front panels to metered control panels.

The 3½" and 5¼" Rack Adapters provide an enclosed wire trough located in the center of the chassis. Feed-through barrier strips can be installed on the back panels to simplify cable terminations. Two cable entrance holes are also provided on each Rack Adapter.

The Switch Panels contain Line Switch, Red Pilot Light and a Fuse Holder. The 3½" Metered Panels provide Line Switch, Red Pilot Light, Fuse Holder, and 1½" Voltmeter and Ammeter. The 5¼" and 7" Metered Panels have in addition two Selector Switches and are designed to monitor two outputs. Buttoned holes allow for customer's installation of remote voltage adjust pots.

When ordering, specify the desired Rack Adapter and specify the number and types of cases which are intended to be accommodated (this provides you with the required special mounting plates and recommended installation drawing shipped free with your order). Choose the desired front panel or panels and possibly a set of slides.



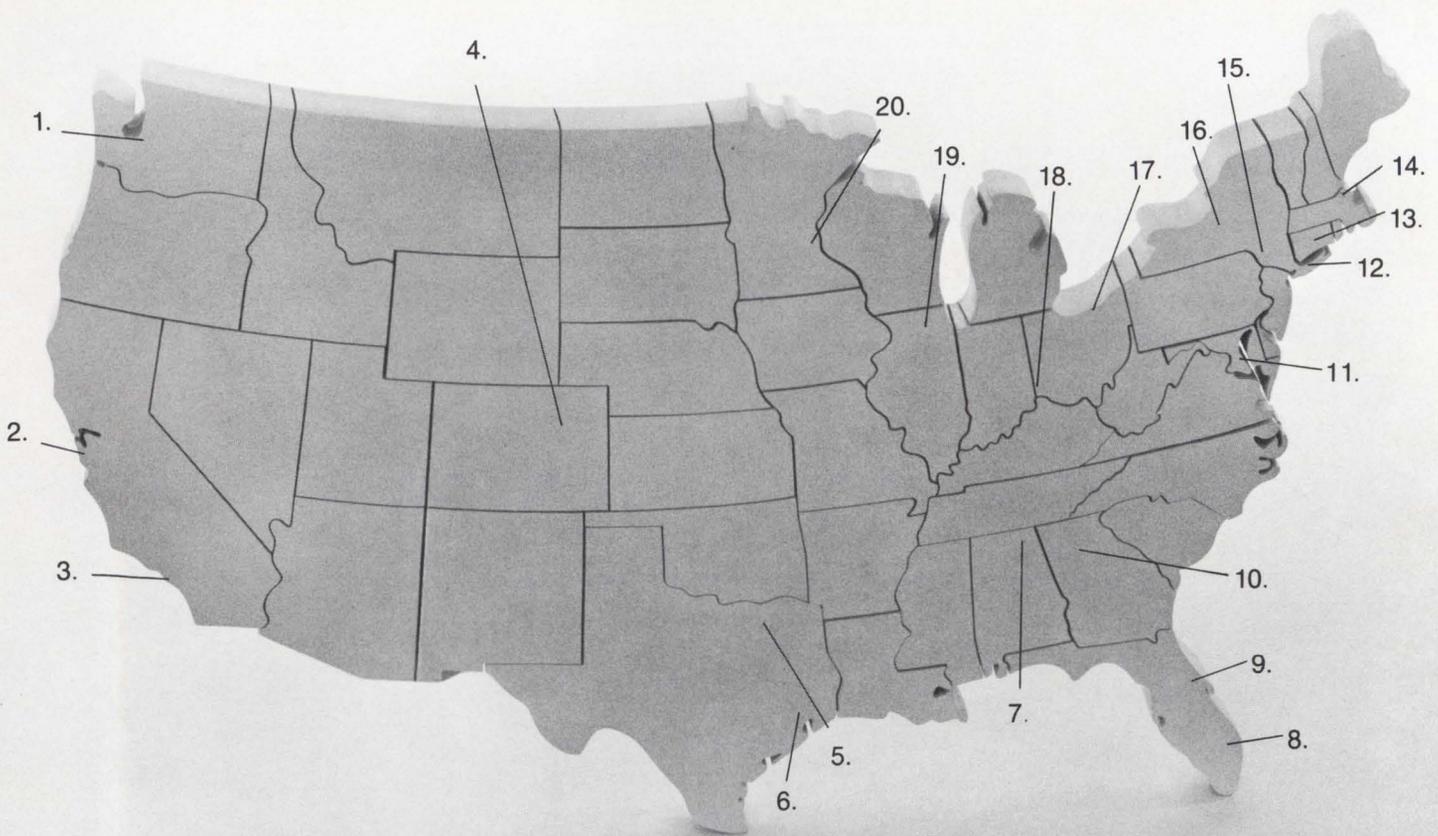
ACDC Case / Rack Chart

The following line-up lists the cases that can be accommodated in each rack adapter. Contact your ACDC representative or the factory for exact total module capacity of each adapter.

3.50" Rack	5.25" Rack		7.00" Rack		
A1	A1	J1	A1	E3	J2
J1	A2	J2	A2	E4	K1
J2	B1	K1	B1	F1	L1
M1	B2	L1	B2	F2	M1
K1	C1	M1	C1	G1	N1
	D1	N1	D1	H1	P1
	D2	P1	D2	J1	

ACDC Case / Rack Chart

	3½"		5¼"		7"	
Basic Rack 14"	RA3X14	\$50.00	RA5X14	\$50.00	RA7X14	\$55.00
Basic Rack 21"	RA3X21	60.00	RA5X21	60.00	RA7X21	65.00
Full Panel	RP3XF	9.00	RP5XF	9.00	RP7XF	9.50
¾ Panel	RP3X3	8.00	RP5X3	8.00	RP7X3	8.50
½ Panel	RP3X2	6.50	RP5X2	6.50	RP7X2	7.00
¼ Panel	RP3X1	5.00	RP5X1	5.00	RP7X1	5.50
Switch Panel (¼)	RP3X1P	18.00	RP5X1P	18.00	RP7X1P	18.00
Metered Panel (¼)	RP3X1M	45.00	RP5X1M	45.00	RP7X1M	45.00
(Specify V/A Ranges)						
Barrier Strip	RH8	1.90	RH8	1.90	RH8	1.90
Barrier Strip	RH8	1.90	RH10	1.90	RH10	1.90
Chassis Slides (14")	RS1X14	48.00	RS1X14	48.00	RS1X14	48.00
Chassis Slides (21")	RS1X21	52.00	RS1X21	52.00	RS1X21	52.00



1. Ruggles Technical Sales
10717 N. E. 4th Street
Bellevue, Washington 98004
Tel: 206-455-2778

2. ACDC Electronics, Inc.
#1 First Street
Los Altos, California 94022
Tel: 415-941-1603
TWX: 910-370-7457

3. ACDC Electronics, Inc.
Oceanside Industrial Center
Oceanside, California 92054
Tel: 714-757-1880
TWX: 910-322-1470

4. Waugaman Associates, Inc.
Suite C, 4643 Wadsworth
Wheatridge, Colorado 80033
Tel: 303-423-1020
TWX: 910-938-0700

5. Roger Martin Associates, Inc.
6211 Denton Drive, Room 103
Dallas, Texas 75235
Tel: 214-358-3704
TWX: 910-861-4200

6. Roger Martin Associates, Inc.
P.O. Box 19291
Houston, Texas 77024
Tel: 713-468-3877
TWX: 910-881-3630

7. Beacon Electronic Associates
3342 Memorial Parkway, S.W.
Huntsville, Alabama 35801
Tel: 205-881-5031

8. Beacon Electronic Associates
651 NE 45 Street
Ft. Lauderdale, Florida 33308
Tel: 305-564-4298

9. Beacon Electronic Associates
540 S. Maitland Avenue
Maitland, Florida
Tel: 305-647-3498

10. Beacon Electronic Associates
2285 Peachtree Road, N.E.
Atlanta, Georgia 30303
Tel: 404-351-3654

11. Sel-Tronics, Inc.
721 Ellsworth Drive
Silver Spring, Maryland 20910
Tel: 301-589-3391

12. Harvey J. Krasner Associates
33 Great Neck Road
Great Neck, New York 11021
Tel: 516-487-0690
TWX: 510-223-0823

13. New England Marketing Assoc.
P.O. Box 151
Branford, Connecticut 06405
Tel: 203-488-7279

14. New England Marketing Assoc.
55 Salem Street
Lynnfield, Massachusetts 01940
Tel: 617-245-9530

15. R. P. Kennedy Company, Inc.
Green Tree Drive North
Hyde Park, New York 12538
Tel: 914-229-2269

16. R. P. Kennedy Company, Inc.
39 Saginaw Drive
Rochester, New York 14623
Tel: 716-271-6322

17. R. G. Sidnell & Co., Inc.
4 Meadowlawn Drive
Mentor, Ohio 44060
Tel: 216-942-3304

18. R. G. Sidnell & Co., Inc.
3300 S. Dixie Drive
Dayton, Ohio 45439
Tel: 513-293-1194

19. R. G. Sidnell & Co., Inc.
6051 Pinecroft
Orchard Lake, Michigan
Tel: 313-851-3518

20. Electro-Products
Griggs-Midway Bldg.
St. Paul, Minnesota 55104
Tel: 612-645-7887

Novel storage terminal slashes graphics costs



Princeton Electronic Products, Inc., P.O. Box 101, North Brunswick, N.J. Phone: (201) 297-4448. P&A: \$3750 or \$4250; 6 to 8 wks.

When equipped with the appropriate associated electronics (like a keyboard, vector generator and CRT monitor), a new storage terminal makes low-cost computer graphics terminals a realizable fact. For an approximate system cost of \$6000, the model 400 terminal is said to give performance comparable to previous systems selling for \$10,000 to \$20,000.

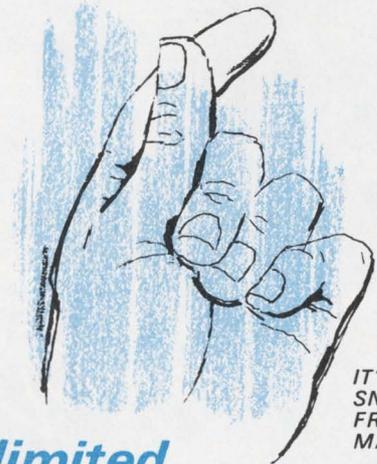
For an 800-line display capability, the new storage terminal costs \$3750; with 1200-line display capacity, it costs \$4250. Prices include the Lithocon silicon-target storage tube (see ED 2, January 18, 1970, page 101, circle no. 250).

Model 400 is also said to claim at least two other firsts. Its 30-MHz video read-and-write bandwidth, which never limits computer data rates, is reported to be the widest recording bandwidth available. In addition, the 400 is thought to be the only storage system, other than a disc, that uses raster scanning, like a TV set, rather than selective (on command) scanning. The new terminal can even be used to convert selective-scan systems to raster-scan ones, thus cutting CRT monitor costs up to 80% and freeing valuable computer time.

Another unique feature of the 400, the ability to subdivide the stored image, allows alphanumeric terminals to offer a scroll effect—displayed lines roll by the viewer. Stored data is not lost, just viewed at different times as one line is added to the bottom of the display and the top line is deleted.

Booth No. 47003 Circle No. 266

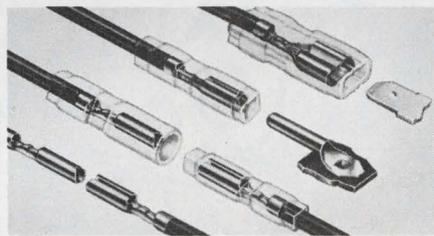
Looking For A Terminal Of Particular Type And Size?



IT'S A SNAP FROM MALCO

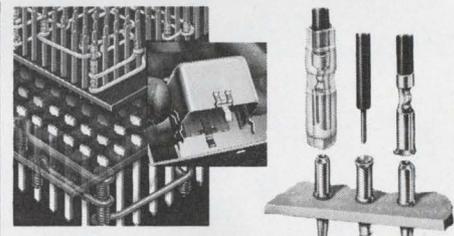
Tooled Parts Unlimited...

We'll give you fast delivery from our total line of circuit hardware and precision stampings. Our high-speed production facilities, precision tooling and quality control assure you parts that consistently meet or exceed industry specifications. And as an added assembly economy, chain style terminals can be applied by Malcomatic Machines.



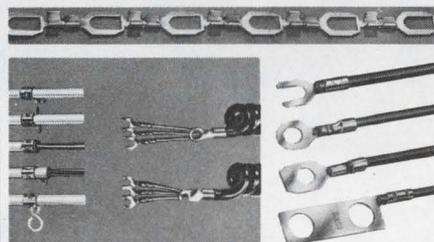
QUICK-CONNECT RECEPTACLES:

A large family of female receptacles for quick-connect male terminals supplied in chain style for automatic crimping. These terminals are available for round, square or rectangular male pins or blades. Terminals crimp to wires from 27-AWG to 16-AWG. REQUEST BULLETIN NO. 611.



PRINTED CIRCUIT HARDWARE:

Feed-Thru Terminals in chain style for automatic insertion in P. C. Cards. Available in a full range of sizes in "Wrap-A-Wire" or round pin styles. Interlock pin, "Wrap-A-Wire" and quick-connect tab lugs for edge-board or terminal strip applications. Spring clips for shielding cans. REQUEST BULLETIN No. 691.



RING AND SPADE TERMINALS:

In chain style, applied by Malcomatic equipment. Available in a variety of sizes and types: hook, ring, spade, flag, either wire/insulation crimp or insulation-pierce crimp. Also, cord clamps for strain relief applications. REQUEST BULLETIN NO. 605.



SOLDERLESS TERMINALS:

Broad range of sizes and types. Available insulated (straight or flared entry) or non-insulated. Made of pure soft copper with special internally serrated barrels for maximum crimp reliability. Full range from AWG 22 to AWG 10. REQUEST BULLETIN NO. 617.

Other Malco Tooled Products: Wasp and Mini-Wasp Fork and Blade Plate Connector Systems, Cardec 200 and Cardec 125 Card Edge Plate Connectors.

Consult our engineering staff about your application and design problems.



PRECISION ELECTRONIC TERMINALS AND CONNECTORS
MALCO MANUFACTURING COMPANY INC
6150 W. ROOSEVELT RD. · CHICAGO, ILLINOIS 60650 · PHONE (312) 287-6700

0625
200V
GE

**Special Film Foil or
Metalized Film Capacitor**
Can be custom designed to
meet customer specifications

69F948G2

**Subminiature Tantalum
Wet-slug Capacitor**
For highest volumetric
efficiency in industrial
miniature applications

- Voltage range . . . Up to 60 VDC
- uf range . . . 3.3 to 450 uf
- Temp. range -55C to 85C

0.33 uF
±100%
400 VDC
GE

**LECTROFILM™-B Polyester
Film Foil Capacitor**
Axial leads for use where
size, weight, cost and
reliability offer advantages
over other capacitor types.

- Voltage range . . . Up to 200 V
- uf range0010 to 1 uf
- Temp. range -55C to 125C

**Aluminum Electrolytic
Computer Grade**

High performance, High
capacitance Capacitor
Used in bulk filtering and energy
storage applications.

- Voltage range . . . Up to 450 VDC
- uf range . . . 75 to 540,000uf
- Temp. range -40C to 65C, 85C

COMES WITH EVERY
GENERAL ELECTRIC
CAPACITOR

Reliability through people

Capacitor reliability is only as good as the people behind the product. At General Electric capacitor reliability is built in, start to finish, by quality-oriented people, assuring the dependability you require in the equipment you produce.

Reliability starts with our Research and Development teams. These inquisitive and creative people, who have greatly advanced electrolytic capacitor technology, are continually exploring materials and methods to develop new and better ways to meet your needs.

It continues with the involvement of scores of men and women who subject capacitors to exhaustive quality control during manufacture, with units receiving hundreds of quality checks.

It concludes with exacting test people who precisely verify capacitor performance through rigorous test procedures.

Reliability comes from people like these . . . in research, design quality control, manufacturing and testing. People who share your pride in producing reliable equipment . . . and do something about it.

To learn more about reliable GE capacitors through people, contact one of General Electric's "problem solvers"—your GE Electronic Distributor or ESCO District Sales Manager. Or write Section 430-42, General Electric Company, 1 River Road, Schenectady, N. Y. 12305

Electronic Capacitor and Battery Dept., Irmo, S.C.

GENERAL  ELECTRIC

Four reasons why Remex readers cost less.

The lower cost of a Remex will show up in its long life. Simplified maintenance. Adaptability. Our Model RRS 3000 photoelectric reader/spooler is a perfect example:



First, there's the fiber optic distributor and sensor fiber optic face plate. No other reader has it. Fiber optics collimate light so that punched tapes of up to 70% transparency can be read without adjustment. That makes Remex the most perceptive. Most sensitive. Most reliable. The eyes of a complex system have to be sharp.



Then only Remex equips its readers with a self-cleaning, vibration-proof quartz lamp. That means unvarying illumination for 15,000 hours. (And that's just a conservative estimate. Actual calculated life is 60,000 hours.) And during this extra-long life span, no costly downtime.

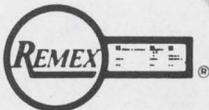


All I.C. circuitry. Power supplies, drive, brake and read components are mounted on two printed circuit cards. Pluggable. In card cages. With card locks and extractors.



More tape capacity (up to 1,240 feet) on 7½-inch reels than on a standard NAB 8-inch reel.

Call us at 213-772-5321 or write for free literature: Remex Electronics, 5250 W. El Segundo Blvd., Hawthorne, California 90250. Designing computers, numerically controlled systems, or automatic test equipment? Give our best to your customers.



REMEX ELECTRONICS

See us at the SJCC Booths 25001-25002

In Europe and the U.K., contact S.p.A. Microtecnica, Torino, Italy



EX-CELL-O CORPORATION
INFORMATION RETRIEVAL NUMBER 151

SJCC PRODUCTS

Cassette tape drive writes 9.6 kbits/s



AmpeX Corp., 9937 W. Jefferson Blvd., Culver City, Calif. Phone: (213) 836-5000. P&A: \$500; 120 days.

Offering a data rate of 9600 bits per second, a new digital cassette tape drive packs up to 350,000 characters on a single standard cassette. The TMC is a serial-by-bit two-track read-after-write unit with a recording speed of 12 inches per second at 800 bits per inch. It provides users with a precision on-line storage device.

Booth No. 3800 Circle No. 256

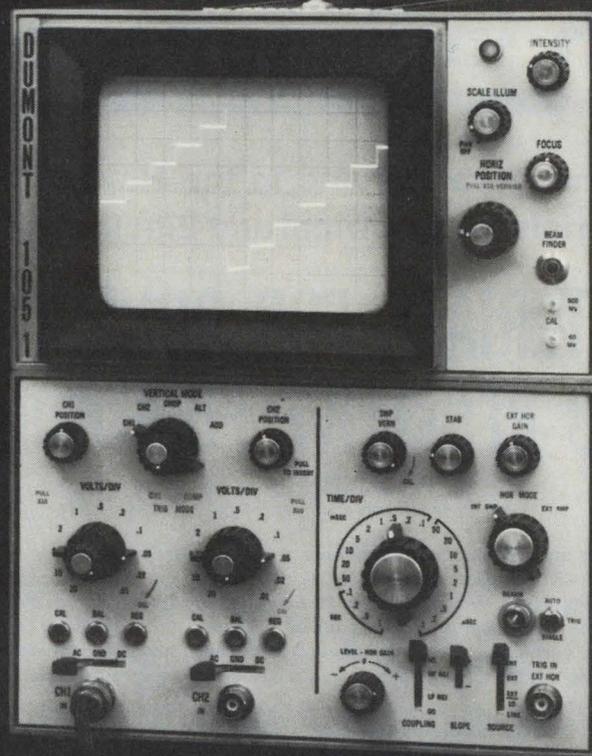
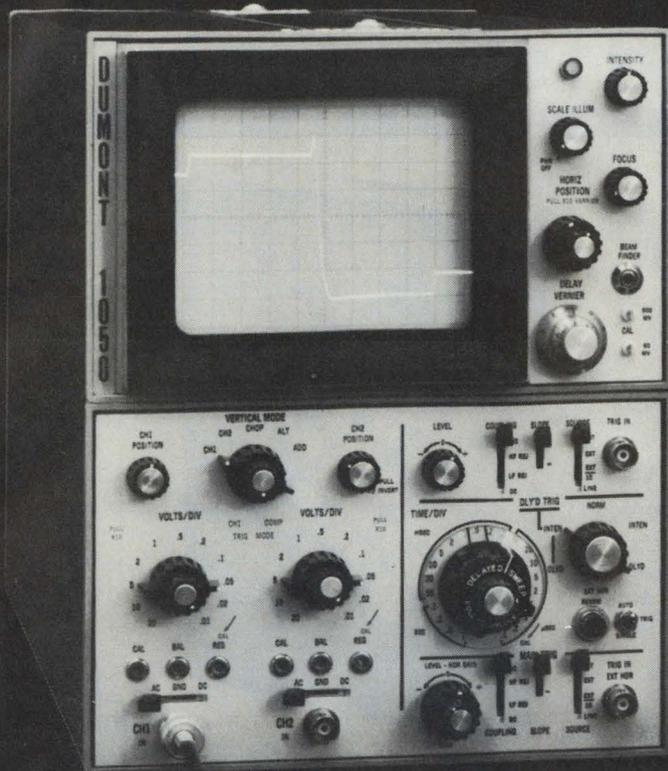
Real-time terminal collects source data



Madatron Corp., sub. of Faradyne Electronics, 110 Route 10, Whippany, N. J. Phone: (201) 887-8874. P&A: \$2500; September, 1970.

Called a source data collection device, a new data terminal permits the entry of data at the source, where it is generated, in any entry format. Data is collected in real time and visually verified via an alphanumeric display. Operation can be either on-line or off-line. Sequential visual instructions assure entry format.

Booth No. 49002 Circle No. 264



**Delayed Sweep
Dumont 1050,
\$2195**

**No Delayed Sweep
New Dumont 1051,
\$1995**

The only difference between the 1050 and our new 1051 is the Delayed Sweep feature. If you need it, buy the 1050. If you can do without it, save yourself \$200 with the new Dumont 1051.

Either way, you'll be buying the finest solid-state high performance oscilloscope ever made . . . a high frequency, dual channel unit that combines a lightweight, portable package with lab scope performance.

With our new triggering capability, you get no loss of trigger, either channel, any position. No trace flicker in dual trace. No trigger level readjusting after repositioning.

Both units also feature large rectangular 8 x 10 cm CRT and superb simplicity of operation for a 50 MHz bandwidth, 1 mV sensitivity 'scope.

Take your pick for unqualified, no nonsense scope performance.

For full information write
DUMONT OSCILLOSCOPE LABORATORIES, INC.
40 Fairfield Place, West Caldwell, N.J. 07006
(201) 228-3665 / TWX (710) 734-4308

DUMONT
OSCILLOSCOPE LABORATORIES, INC.

An indispensable design tool...

the inaugural volume in the Hayden Series in
Materials for Electrical and Electronics Design!

MATERIALS FOR CONDUCTIVE AND RESISTIVE FUNCTIONS

G. W. A. DUMMER, Formerly Superintendent Applied Physics
Royal Radar Establishment, British Ministry of Technology

Written by an internationally recognized authority, this volume satisfies the need for a comprehensive, applications-oriented reference on conductive, superconductive, contacting, and resistive functions. It is exceptionally broad and detailed in coverage, setting forth the basic phenomena for each specific function, describing how the materials for each are used in component parts, and providing sufficient basic data to prepare the reader for problems which may be met in specific applications.

In cases where combined materials are part of the design, such as cables and wires, brief data is given of dielectrics, etc. in order that reasonably complete coverage is available. More than one-hundred-forty charts, tables, and diagrams provide rapid access to properties of materials for a specific requirement. Extensive references are included to facilitate further study.

Thorough descriptive coverage . . . more than 140 charts, tables, and diagrams.

Conductive Functions. Introduction to the Principles of Conduction in Low- and High-Resistivity Metals. Tables of Physical Properties of Conducting Materials. Materials, Applications, and Characteristics of Hook-up Wires, Covered Wires, Bus Bars, Transmission Cable, and Microwires. Materials, Applications, and Characteristics of Magnet Wires. Materials, Applications, and Characteristics of RF Cables, Materials Applications, and Characteristics of Printed Wiring Conductors. Materials, Applications, and Characteristics of Integrated Circuit Conductors. **Superconductive Functions.** Phenomena and Environments Associated with Superconductivity. Superconducting Switching Devices. Materials with High Field Superconducting Capabilities. **Contacting Functions.** Contact Functions and the Physics of Contact Phenomena. Contact Materials, Applications, and Tables of Properties. Basic Connection Methods in Electronics. Make and Break Contacts, Plug and Socket Functions, Switching Functions. Relay Functions. Sliding Contacts, Wear, and Noise Phenomena. **Resistive Functions.** Conductivity, Resistivity, Resistance, and Temperature Coefficient of Resistance. Materials, Applications, and Characteristics of Fixed and Variable Resistors. Materials, Applications, and Characteristics of Resistive Films. **Index.**

G. W. A. Dummer, author and co-author of scores of books on all aspects of electronics, presently devotes all his time to writing and consulting activities. A pioneer in reliability, thin-film circuits, and semiconductor integrated circuits, he initiated much of the British Government's research in microelectronics. His earlier contribution to the development of radar and radar synthetic trainers earned him Britain's award, Member of the British Empire, and America's Medal of Freedom. Mr. Dummer is a Fellow of the I. E. E. E., the I. E. E., and the I. E. R. E.

**Subscribe at 15% savings, or order individual volumes
on 15-day free examination . . . mail this coupon today!**

Subscription terms: Please enter my subscription to the Hayden Series in Materials for Electrical and Electronics Design. Each title will be automatically shipped as published, and billed at 15% discount. This subscription may be cancelled at any time.

Single volume order: 15-day Free Examination. Please send #5636, Materials for Conductive and Resistive Functions, \$13.95, on a 15-day Free Examination basis. At the end of that time I will remit payment, plus postage, or return the book without further obligation. Payment enclosed. (Hayden pays postage with same return guarantee).

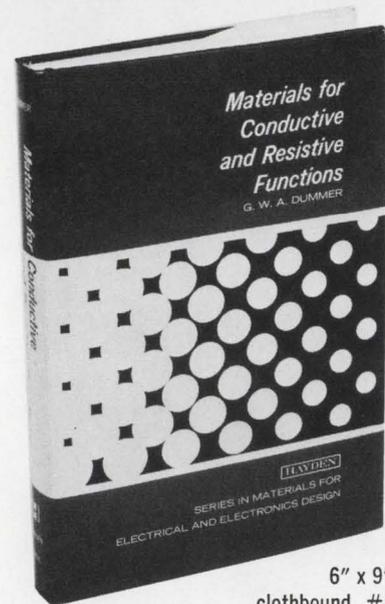
Ship and bill as published those checked:
 #5638 #5635 #5639 #5637 #5634 #5640

Send further information on the series.

On all overseas orders payment in U.S. dollars must be enclosed.



HAYDEN BOOK COMPANY, INC., 116 W. 14th St., N. Y., N. Y. 10011



326 pages,
6" x 9", illustrated,
clothbound, #5636, \$13.95

**Save 15% on this volume!
Enter your subscription to this
valuable new series today!**

Hayden Series in Materials for Electrical and Electronics Design

Alex E. Javitz, Editor-in-Chief

A series of integrated engineering books designed to meet the practical needs of all who design electrical and electronic components, devices, equipment, and systems. Offering a unified approach which treats materials according to functional classes, the books provide an essential background in fundamental principles, combined with immediately workable data and techniques for both conventional and advanced applications. Each volume also discusses the relationship between the fundamental nature of materials (microscopic properties) and their functional performance (macroscopic properties).

Forthcoming volumes in the series:

Materials for Semiconductor Functions, #5638,

E. G. Bylander

Materials for Structural and Mechanical Functions,

#5637, G. Koves

Materials for Magnetic Functions, #5635, F. N. Bradley

Materials for Electrical Insulating and Dielectric

Functions, #5634, H. L. Saums and W. W. Pendleton

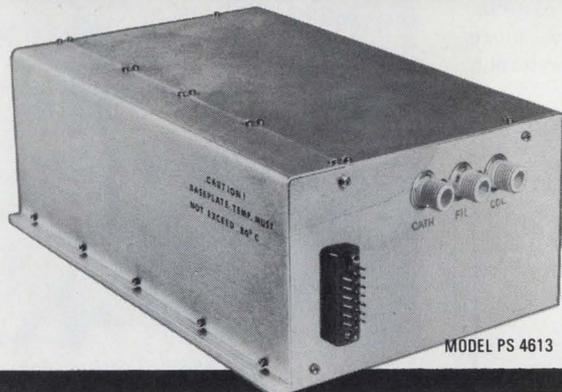
Materials for Combined Functions, #5639, E. Scala

An interdisciplinary volume in the series, **Materials Science and Technology for Design Engineers, #5640**, edited by Alex. E. Javitz, provides an advanced exposition of the basic structure and molecular behavior of all relevant materials. Approximate price of each forthcoming volume, \$18.00.

Alex. E. Javitz, Editor-in-Chief of this series, is currently a technical consultant to industry. Formerly an editor of electrical and electronics magazines, Mr. Javitz is widely known in materials and related fields.

**Add these valuable references to
your library automatically —
enter your subscription today!**

TOTAL POWER SUPPLY CAPABILITY



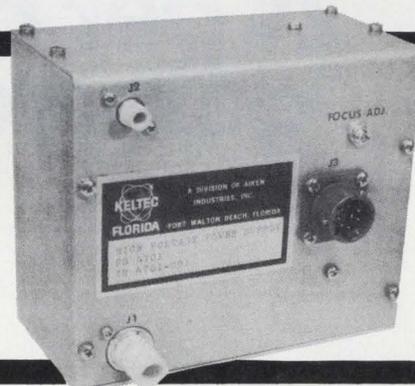
MODEL PS 4613

HIGH POWER TWT POWER SUPPLY

- INPUT POWER** 115 VAC, 400 cps, 3 phase per Mil-Std-704
- OUTPUTS**
1. Helix-Cathode: -4000 to -4800 VDC adjustable at 40 ma
 2. Collector-Cathode: +2750 to +3250 VDC at 400 ma
 3. Filament: 6.3 VAC $\pm 2\%$ at 4.0A (10A turn on surge limiting provided)
 4. Focus Anode: +100 to +300 VDC at 1 ma
- PROTECTIVE CIRCUITRY**
1. Automatic time delay
 2. Helix overload protection
 3. Thermal overload protection
 4. Arc protection (all modes of internal TWT arcing)
- ENVIRONMENT**
1. Temperature -55°C to +71°C ambient (Mounting surface temperature not to exceed 90°C)
 2. Altitude: 50,000 feet
 3. Shock, Vibration, Humidity, Explosion: Per Mil-Std-810
- WEIGHT** 20 lbs. maximum

HIGH VOLTAGE DISPLAY TUBE POWER SUPPLY

- INPUT VOLTAGE** 28 VDC $\pm 10\%$ @ .5 AMP
- OUTPUTS**
1. 20KV ± 1000 VDC @ 200 μ A
Ripple 20 V Peak to Peak max
Load Reg 3% max, full to half load
 2. 2.2 KV ± 500 VDC adjustable @ 75 μ A
Ripple 2.2 V Peak to Peak max
 3. 300 V ± 15 VDC @ 10 μ A
Ripple 300 mv Peak to Peak max
- SIZE** 5.50 x 4.5 x 2.6
- WEIGHT** 3.3 Lbs max
- ENVIRONMENT** MIL-E-5400 Class 2



MODEL PS 4701



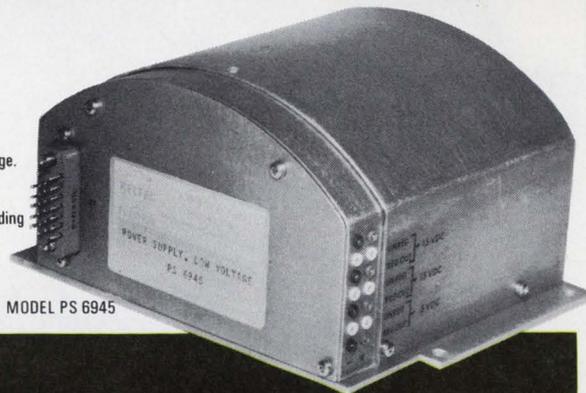
MODEL PS 4621

MULTI-GRID, LOW NOISE TWT POWER SUPPLY

- INPUT VOLTAGE** 103 - 127 VAC @ 50 - 420 Hz
- EFFICIENCY** 40% min
- OUTPUTS**
1. 2750 - 2850 @ 1 MA 3.5 - 3.8 VDC @ 1 AMP
 2. 6 additional grids above the Cathode and 1 below
 3. Max Ripple 200 mv all outputs
 4. 1% Regulation
- SIZE** 5 x 3 x 11
- WEIGHT** 6 Lbs max
- ENVIRONMENTAL** MIL-E-5400 Class 2

COMPUTER LOGIC POWER SUPPLY

- INPUT** 115 VAC, 400 Hz, 3 phase, per MIL-Std-704
- OUTPUTS**
- +28 Volts @ 6 amps -15 Volts @ 5 amps
 - +15 Volts @ 5 amps - 5 Volts @ 5 amps
- REGULATION** $\pm 1\%$ line, load and temperature
- RIPPLE** 25 mv Peak to Peak
- PROTECTIVE CIRCUITRY**
1. Output protection from short circuits for indefinite period without damage.
 2. Over voltage—in the event of regulation failure, supplies are terminated in less than 20 microseconds.
 3. Overload—supply is protected to prevent damage resulting from overloading in any one of the outputs.
- ENVIRONMENT**
1. Temperature -55°C to + 71°C
 2. Altitude 50,000 feet
 3. Shock, Vibration, Humidity and Explosion per MIL-Std-810
 4. Electromagnetic Interference per MIL-1-6181



MODEL PS 6945



KELTEC FLORIDA
 A DIVISION OF AIKEN INDUSTRIES, INC.
 P. O. DRAWER 1348, FORT WALTON BEACH, FLORIDA 32548
 (904) 651-1210 • TWX 510-730-7775

Key-to-tape station checks written data

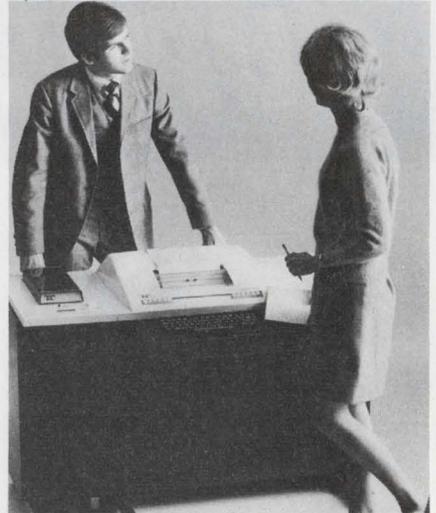


*International Data Sciences, Inc.,
100 Nashua St., Providence, R.I.
Phone: (401) 274-5100.*

Offering simplified and streamlined operation, the Libra I stand-alone key-to-tape data station provides a read-after-write check, selective non-verification and a true English display. The system, in its entirety, occupies no more space than a standard keypunch machine.

Booth No. 43001 Circle No. 280

Tape-cartridge terminal stores 150k characters

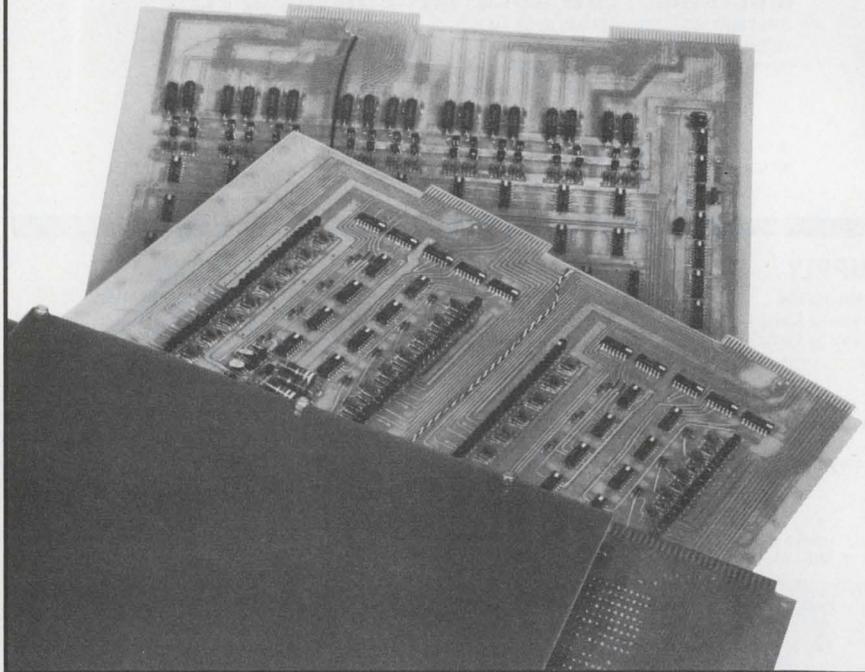


*Teletype Corp., 5555 Touhy Ave.,
Skokie, Ill. Phone: (312) 676-1000.*

Using a compact tape cartridge about the size of a cigarette package, the 4210 magnetic tape data terminal accommodates up to 150,000 characters of information. Because of its high-density data storage (125 characters per inch), the new terminal can operate at slow tape speeds to deliver whisper-quiet performance. A search capability quickly locates specific data blocks on the tape.

Booth No. 1705 Circle No. 253

**Core Memory:
2¢ per bit and
going down**

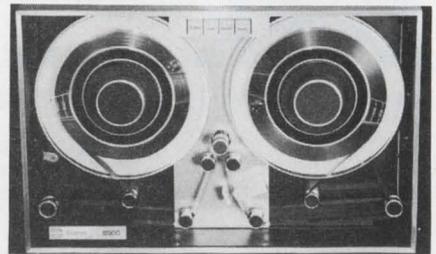


4k x 18 or 8k x 9 core memory systems
at 2 microseconds full cycle.
100 quantity price: \$1,475 ea. See
us at Booth 6112, SJCC or write to:



3500 Sunset Avenue, Asbury Park, New Jersey 07712
201-988-0400

Digital tape recorder has two drive modes

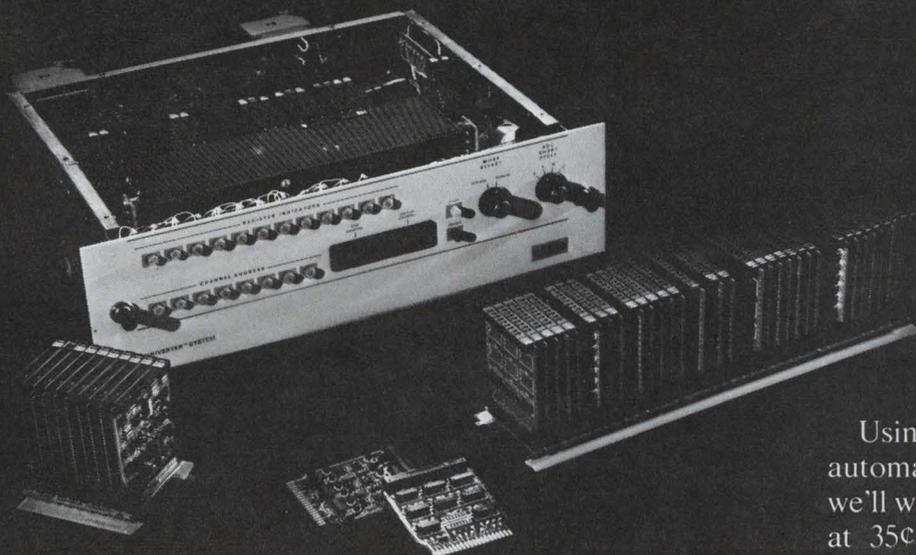


*Datran Corp., 179 West Rocks Rd.,
Norwalk, Conn. Phone: (203) 847-9669.*

The model 8551/8552 digital magnetic tape recorder offers two drive modes—incremental and synchronous. In the incremental mode, data can be written at rates to 1 kHz and at a density of 200, 556 or 800 bits per inch. Incremental reading ranges from 0 to 500 Hz. In the synchronous mode, standard tape speed is 30 inches per second.

Booth No. 6109 Circle No. 250

Tight budgets, tough problems in conversion equipment? Raytheon Computer makes it easier for you.



Before you get caught in another A-to-D or D-to-A squeeze, with the time running out and the dollars draining away, talk to Raytheon Computer.

We'll build your conversion equipment faster and give you the best price/performance ratio in the industry doing it.

First, select your basic elements from the broadest line of conversion and interface equipment available. ADC's, DAC's, Sample-and-holds, Multiplexers. All interfaced to your system. And all more than competitively priced (like our 12-bit, 100kHz multiplexed 8-channel ADC — just \$1,790).

Then give us your logic diagrams and let us tie the whole system together for you.

Using computer-aided design and automatic wire wrapping machines, we'll wire and test all your equipment at 35¢/wire for the first unit, *half* that for succeeding units. (Your own technician costs you at least 50¢/wire. And that's not counting the errors.)

As a bonus, we'll throw in wire lists, test results and technical manuals. Free. You'll get your conversion equipment and documentation faster and cheaper than you could do it yourself.

And if your system needs a computer, use one of ours. Cycle times from 900ns to 1.75 μ s, prices from under \$10,000. And over 400 proven programs off-the-shelf. We'll get your system on-line faster and for less money than anyone else around.

Like we said, we'll give you the best price/performance ratio in the industry. If that's what your systems need, call or write today. Ask for Data File CB-181.

Raytheon Computer, 2700 S. Fairview St., Santa Ana, Calif. 92704. Phone 714/546-7160.



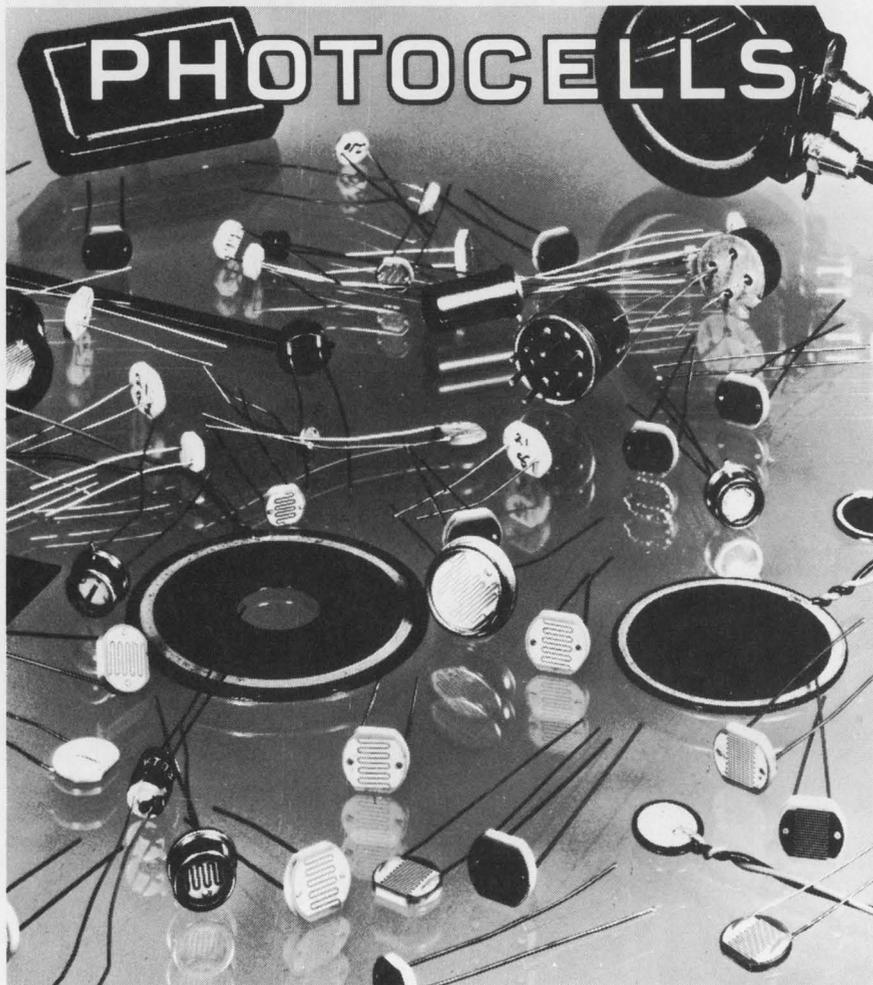
The only thing Raytheon Computer does is your job. Cheaper.

Visit us at SJCC '70, Booths 5500-5600

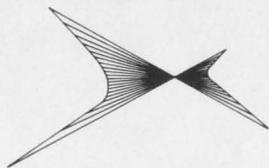
INFORMATION RETRIEVAL NUMBER 156

VACTEC

PHOTOCELLS



The world's most un-diversified company manufactures a standard or custom size and type for every requirement.



VACTEC, INC.

2423 Northline Ind. Blvd.
Maryland Heights, Mo. 63043
Phone (314) 872-8300

Write for Bulletin PCD-4 describing Cds and CdSe cells; for photocell lamp or LED modules request Vactrol Bulletin SPV-4A for Se types; or see EBG under "Semi-Conductors" or EEM Sec. 3700.

INFORMATION RETRIEVAL NUMBER 157

SJCC PRODUCTS

Computer system multiplies uses



Digital Scientific Corp., 11455 Sorrento Valley Rd., San Diego, Calif. Phone: (714) 453-6050.

Besides being able to emulate instruction sets from other computers, the Meta 4 system can also function as a communications line controller, buffer editor and pre-processor. The unit has a read-only memory with a 90-ns machine cycle instruction execution time and an access time of 40 ns. Core memory cycle time is 900 ns and maximum capacity is 65k 18-bit words.

Booth No. 45004 Circle No. 278

Data couplers/modems customize I/O hook-ups



Anderson Jacobson, Inc., 2235 Mora Dr., Mountain View, Calif., Phone: (415) 968-2400. Price: from \$375.

Series 240 couplers, modems and combination coupler/modems allow the time-share equipment user to select the model containing only the outputs and inputs he requires. The output to the switched network complies with tariffs covering acoustic (data-phone compatible) and data-access arrangements. Inputs include the Teletype ASR 33 and/or EIA (RS-232B) device-compatible terminals.

Booth No. 33001 Circle No. 271



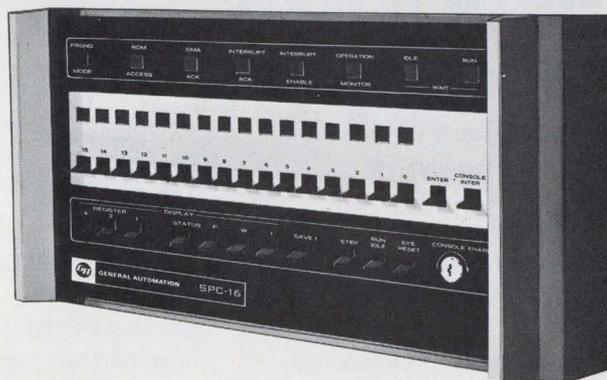
You can increase product yield today... ask about the performance of the SPC-16 industrial automation computer.

SPC-16 gives you big computing power, accuracy, reliability and programming simplicity . . . It's specially designed to work in industrial environments.

You can reduce your operating costs, increase the yield of better quality products . . . you can get your products to the market faster. And you can serve more markets with new levels of reliability.

And the SPC-16 is supported by expert consultation, systems engineering, programming and customer training services.

If you make, move, test or count, SPC-16 is your automation worker . . . ask about its performance today.



Ask about other low-cost computers in the GA family. The SPC-12 for less than \$5000. System 18/30 for under \$20,000.



GENERAL AUTOMATION, INC.

1402 East Chestnut, Santa Ana, California 92701
(714) 835-4804 TWX (910) 595-1780

CALIFORNIA
Los Altos, (415) 941-5966
Orange, (714) 633-0680

TEXAS
Dallas, (214) 358-0271
Houston, (713) 774-8716

ILLINOIS
Des Plaines, (312) 298-4650
(California G.A. Corp.)

OHIO
Cleveland, (216) 351-2275

GEORGIA
Atlanta, (404) 261-6203

PENNSYLVANIA
King of Prussia, (215) 265-6525

MARYLAND
Silver Spring, (301) 587-7090

CONNECTICUT
Stamford, (203) 325-3883

MASSACHUSETTS
Waltham, (617) 899-6170

INTERNATIONAL
G.A.I. 24 Blvd. de l'Empereur
Brussels, 13 78 03

ENGLAND
G.A. Ltd. Wren House
Portsmouth Road, Esher, Surrey
Esher 65764

GERMANY
ERA-Elektronische Rechenanlagen
51 Aachen, Postfach 465
Werk: Verlautenheide
Lindenweg 23
02405-4444

G.A. GmbH
6200 Wiesbaden
Frauenlobstr. 9
06121-83073

See General Automation at S.J.C.C., Booths 4101-4104

INFORMATION RETRIEVAL NUMBER 158

IF YOU'RE WELL REGULATED YOU DON'T NEED US.

But experience has taught us that well-regulated DC power for digital airborne equipment is hard to come by. Since you may have had problems in this area, we thought perhaps we could share our experience with you.

For example, over the years we've produced voltage regulator modules designed to permit an increase in rated current by adding an external higher power pass transistor. We've provided for current limiting and fold back for short circuit protection and for BITE. We've also solved the problems of overload protection and provided for remote voltage sensing to compensate for line drop.

Add to this multiple outputs and special packaging options and it represents a lot of capability Singer can put at your service. But then that's what you expect from the leader in the field, isn't it?

Write for your copy of our catalog and start down the road to a well-regulated system. Singer-General Precision, Inc., Kearfott Division, 1150 McBride Avenue, Little Falls, N.J. 07424.

GENERAL RANGE

Input Voltage Range	26-220V ac or 12-28V dc
Input Frequency	50-500 Hz
Output Voltage	1 to 1000V dc
Output Power	up to 500W
Ambient Operating Temperature	-54°C to +71°C
Typical Regulation Available	.05%
RFI	per MIL-1-6181
Typical Transient Response	less than 50 μ sec.

Military Specs: MIL-E-5400, MIL-E-5272, MIL-E-16400
Typical power/wt. 28w per 1B, nominal efficiency 65%

SINGER

KEARFOTT DIVISION

INFORMATION RETRIEVAL NUMBER 159

SJCC PRODUCTS

Non-impact printer zings 1200 lines/min



*Path Computer Equipment, Inc.,
65 Commerce Rd., Stamford, Conn.
Phone: (203) 348-4244.*

A new-impact communications and computer printer produces hard copy at a rate of 1200 single-spaced lines a minute. Model 1200 prints all 96 standard ASCII characters at a rate of 96,000 characters per minute in the 80-character-per-line format or at 158,400 characters per minute in a 132-character version. Characters are synthesized from operator-changeable typographic fonts.

Booth No. 42000 Circle No. 251

Computer entry system optimizes data transfer



*Addressograph Multigraph Corp.,
1200 Babbitt Rd., Cleveland, Ohio.
Phone: (216) 731-8000.*

The model 6000 computer entry system features a unique on-line computer entry capability providing optimum data transfer without tape reel handling. It consists of a small electronic memory and control unit, which is time-shared by up to six keyboard data entry and display stations. Data entered simultaneously from the keyboards is stored and can be recalled by any operator.

Booth No. 11001 Circle No. 283

Photomechanical reproduction of precision parts is our business

We invented it!



We began precision etching of metal and glass parts for the military during World War II. Today we're the world's largest producer of photo etched metal, glass and electroformed parts. Our new computer-directed automatic plotter is accurate to .001" or better, and it can draw in an hour what would take a draftsman days to do. It's economical, too, because there are no costly dies to make.

METAL ETCHING: We etch round, square, oval or straight holes or lines to tolerances of $\pm .0001$. Currently we are producing shaver grills, hemispheric domes, springs, micro component parts and curved surfaces too complicated for die stamping. We etch mesh, precision circuitry, core loading mats and print out rollers. More than 70 materials have been etched in our plant.

ELECTROFORMING: Our mesh screens go down to four million holes per square inch with accuracy.

Line width tolerances of ± 2 microns are common. Typical production ranges from five to 2,000 lines per linear inch. We electroform copper, nickel, silver and gold. A few standard products include evaporation masks, pin hole apertures, micro-mesh sieves, electron microscope grids, optical wedges, zone plates and a variety of micro-miniature parts.

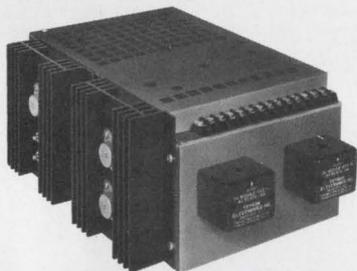
GLASS ETCHING: We use the same photomechanical techniques in glass etching to provide calibrations and other configurations to tolerances of $\pm .0001$. Straight and cross rulings, calibrated dials, concave and convex reticles, scales, prisms and encoder discs are some of the items we produce in volume.

FREE SAMPLE CARD: The metal card shown on the illustration above contains samples of etched parts we can produce. If you would like one, drop a note to Bill Amundson, Industrial Sales Manager, on your letterhead.

PRECISION METAL AND GLASS ETCHING • ELECTRO FORMING • AUTOMATED DESIGN
bmc
SAINT PAUL, MINNESOTA 55101
BUCKBEE-MEARS COMPANY

INFORMATION RETRIEVAL NUMBER 160

TRYGON power supplies are...



the triple output space-savers...

- Takes the place of 3 separate power supplies for IC applications, sequencing, data processing, computer peripherals, and OEM applications. Compact size — only 5" x 8" x 10".
- **Multiple Outputs:** +3.2 to +5.5VDC at 6A; +10 to +26VDC at 1.8A; -5 to -16VDC at 1.5A.
- **Special Control Circuits:** "S" option provides internal sequencing. QM501 accessory incorporates full output monitoring.
- **Rapid Delivery:** Standard off-the-shelf delivery solves your lead time problems.
- **High Reliability:** 0.05% Regulation, 2mV Ripple, 0.05% Stability, Overvoltage Protection standard on IC output, optional on other outputs.
- **Low Cost:** Economical — only \$245 in small quantities and very much lower in larger OEM quantities.
- Rack adaptable with other Trygon Systems/OEM power supplies — Liberator Sub-Rack and TPS Series, for full systems versatility.

Write or call today for our new 16-page New Product Supplement S1169 and select your power supplies for immediate delivery.

 **TRYGON POWER SUPPLIES**

111 Pleasant Avenue, Roosevelt, New York 11575
Tel: 516-378-2800 TWX: 510-225-3664
Trygon GmbH 8 München 60, Haldelweg 20, Germany
Prices slightly higher in Europe.

SJCC PRODUCTS

Acoustic coupler has 3 interfaces



Sonex, Inc., I/Onex Div., 20 E. Herman St., Philadelphia, Pa. Phone: (215) 843-6400. P&A: \$300; stock to 45 days.

Operating as fast as 300 baud with any standard telephone, a new acoustic coupler offers loop current, EIA and IC logic interfaces as standard provisions. Model 30 uses phase-lock-loop detection to assure error-free communications even in high-noise conditions. Operation may be either half or full duplex.

Booth No. 50007 Circle No. 270

I/O scan converter uses standard TV set

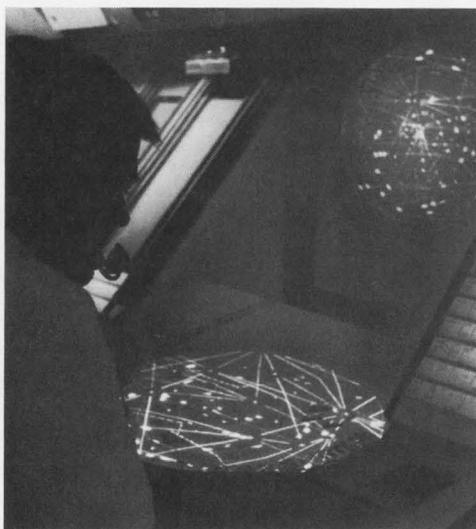


Computer Transceiver Systems, Inc., 317 Route 17, Paramus, N.J. P&A: \$1500; 6 wks.

Labeled the Execuport 220TV, a new lightweight (5-lb) scan converter displays the input and/or output of a data transceiver on any conventional TV set. A second scan converter, the Execuport 220-TVT, is designed for teletypewriter users. Both scan converter units can display 800 characters on the TV screen—40 characters per line on 20 lines.

Booth No. 203 Circle No. 274

Where reliability really counts!



Zenith Flat-Face Metal CRT reliability is demonstrated by their extensive use in enroute air traffic control centers and airports. When safety depends on reliability, Zenith is specified! Shouldn't you take advantage of Zenith CRT quality in your application? Write for details.

ZENITH ZENITH RADIO CORPORATION
THE RAULAND DIVISION
5616 W. JARVIS AVE. • CHICAGO, ILL. 60648 • 312-647-8000

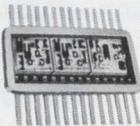
We'll hybrid thick-film your circuit in our new $\frac{1}{4}$ " x $\frac{3}{4}$ " flat pack, and get you into some tight spots.

Getting you into tight spots is one way of getting you out of them. For now you can design your circuit confident that everything will fit. And we can produce that custom circuit flawlessly.

Our exclusive $\frac{1}{4}$ " x $\frac{3}{4}$ " T3 configuration enables you to do just about anything with the available area. First, because of its unique dimensions. Also, because it comes in 3 basic variations.

With all 14 leads coming out of one side, it can lay flat or stand. It is also available with leads on both sides. Or, in a dual in-line configuration. Name it. You've got it. Just about.

But we've got more than just a nice new shape for you. We have the facilities to produce prototypes or



large quantities fast. In a high reliability environment. Our people, materials and equipment conform to the highest standards. For instance, Mil-Std-883. We test, check and counter-check. And our clean rooms provide the optimum production atmosphere.

What's more, if you need it, we'll help you solve design problems.

We can produce your design in our $\frac{1}{4}$ " x $\frac{3}{4}$ " hybrid thick-film flat packs now. Find out how it can fit into your plans. Write or call: Columbia Components Corporation, 60 Madison Avenue, Hempstead, New York 11550 (516) 483-8200. On the West Coast: (213) 272-9525.



COLUMBIA COMPONENTS CORP.

A SUBSIDIARY OF COMPUTER INSTRUMENTS CORP.

Advertisers' Index

Advertiser	Page	Advertiser	Page	Advertiser	Page
ACDC Electronics, Inc.	C50 A-B	Hewlett-Packard	C33	Remex Electronics, A Unit of	
AMP, Incorporated	C38, C39	Hughes Aircraft Company, MDS Division	C57	Ex-Cello Corporation	C54
Amperex Electronic Corporation	C4				
Buckbee Mears Co.	C63	IMC Magnetics Corporation	C67	Singer General Precision, Inc.	
		ISC Magnetics, Division of Instrument		Kearfott Division	C64
		Systems Corporation	C66	Singer Company, The, Diehl Division	C31
Cincinnati Milling Machine Co.	C37				
Columbia Components Corp.	C65	Keltec Florida, Division of Aiken		TEC Incorporated	C66
Computer Microtechnology, Inc.	C16, C17	Industries, Inc.	C56	Tektronix, Inc.	C30
		Kepeco, Inc.	C3	Teletype Corporation	C18, C19
				Trio Laboratories, Inc.	C48
Dale Electronics, Inc.	C43			Trygon Power Supplies	C64
Datascan, Inc.	C2	Malco Manufacturing Company, Inc.	C51	Tung Sol Division, Wagner	
Digital Equipment Corporation	C24	Monroe, A Division of Litton		Electric Corporation	C45
Dumont Oscilloscope Laboratories, Inc.	C55	Industries	C22, C23		
				United Telecontrol Electronics, Inc.	C44, C58
E-H Research Laboratories, Inc.	C49	Nuclear Corporation of America	C26	Vactec Inc.	C60
Elco Corporation	C47	Qualidyne Corporation	C34	Winchester Electronics, Division of	
Fairchild Controls, A Division of Fairchild				Litton Industries	C35
Camera and Instrument Corporation	C32				
		RCA Electronic Components and Devices	C68	Xerox Data Systems	C27
General Automation, Inc.	C61	Raytheon Computer	C40, C41, C59	Zenith Radio Corporation	C64
General Electric Company	C52, C53	Raytheon Company, Semiconductor			
Grant Pulley & Hardware Corporation	C50	Operation	C20, C21		

SPEED-INDEPENDENT MAGNETIC PICK-UP



Output voltage amplitude is independent of external magnetic field rate of change. Ideally suited for use with flow control or computer peripheral equipments in static or dynamic sensing applications.

For Details Contact



ISC * MAGNETICS

Division of INSTRUMENT SYSTEMS CORPORATION
770 PARK AVENUE, HUNTINGTON, NEW YORK 11743

Telephone: (516) 423-6200

INFORMATION RETRIEVAL NUMBER 164

C66

L.E.D. INDICATORS

Solid State— Infinite Life!

Latest state-of-the-art made practical by TEC-LITE ... an easy-mounting line of subminiature indicators and switch-indicators, using the new L.E.D. (light emitting diodes).

The red-emitting L.E.D. light source gives infinite life and reliability, resistance to shock and vibration, avoids catastrophic failure. The lens is available in three colors (clear, amber or red) and designed to diffuse the light for greater angle viewing. Three models including one with switch, operate from a 5 VDC supply and rear mount in a 1/4" hole on 3/8" centers.

For full information on the SS Series — or our complete line of display/control products and systems — write: TEC, Incorporated, 6700 So. Washington Avenue, Eden Prairie, Minnesota 55343.



SSIL



SSBL



SSIM

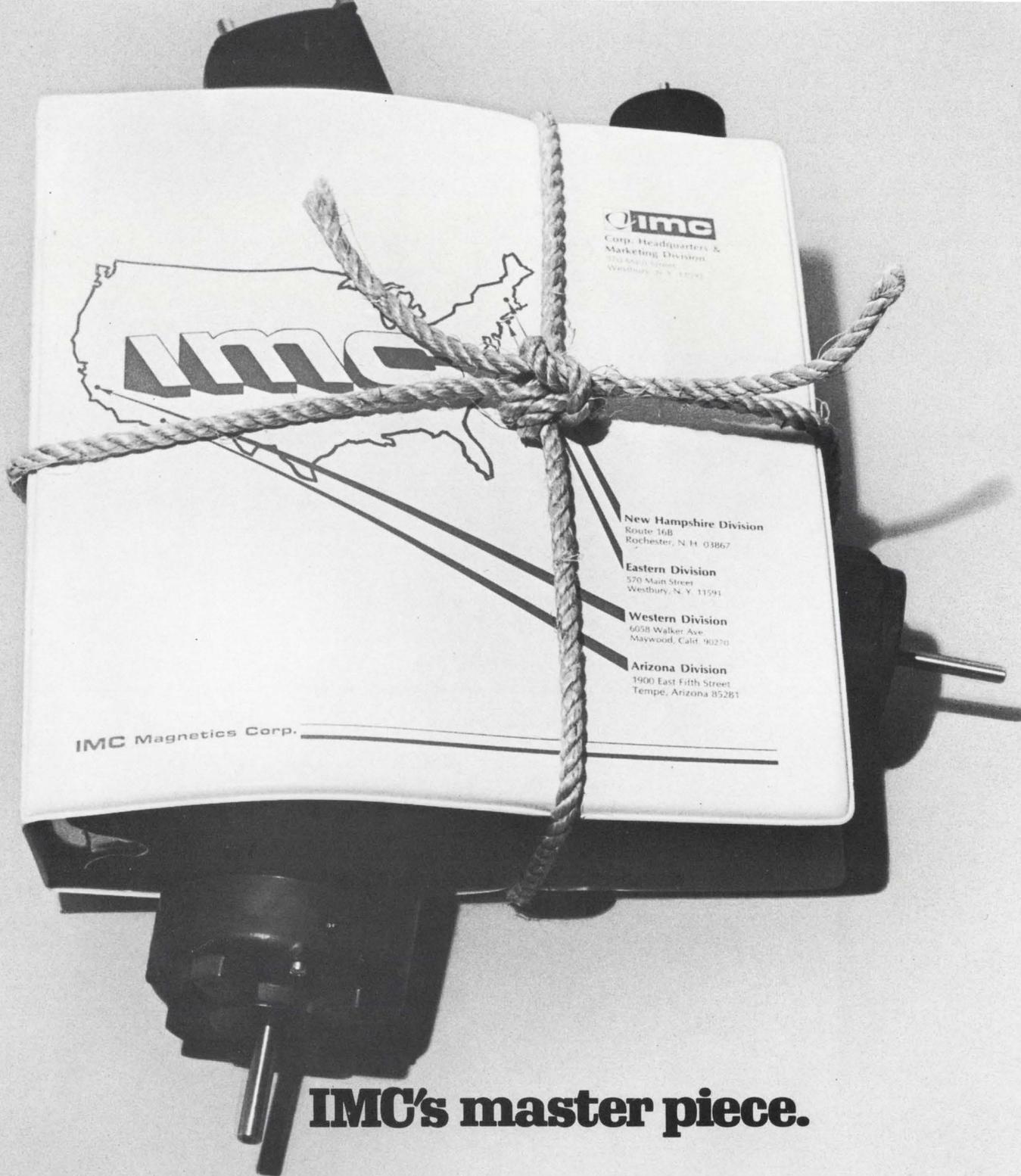
Actual Size



INCORPORATED

INFORMATION RETRIEVAL NUMBER 165

ELECTRONIC DESIGN 9, April 26, 1970



IMC's master piece.

**It's entitled, "The Master Catalog."
We squeezed all our products into it.
This limited edition available only from
your IMC sales representative.**

Arizona Division  Rotary solenoids/Electrohydraulic subsystems/Solenoid valves/Hydraulic and pneumatic components

Eastern Division  Airmovers: centrifugals, fans, tubeaxials and vaneaxials/Motors: induction, synchronous hysteresis, reluctance, polarized, torque and servomotors/Solid-state AC-motor controller systems

New Hampshire Division  Boxer, MiniBoxer, SuperBoxer, IMCair and Condor fans/IMCair centrifugal blowers

Western Division  Tormax stepper motors and controllers/Synchros/Resolvers/Solenoids/Flag indicators

All members of the IMC corporate family  IMC Magnetics Corp., 570 Main Street, Westbury, N.Y. 11591, (516) 334-7195

Just a few paces off the Boardwalk, you can meet reliability face-to-face . . . in the form of the new CIP/2000 minicomputer for dedicated applications . . . and a few of the computer specialists who represent its builder . . . The Cincinnati Milling Machine Co.

Though we're new in mini-computers, we have a 15-year background as a major manufacturer of electronics for control purposes.

Our new computers are

produced in a completely new plant, especially built for electronics production, using sophisticated manufacturing techniques for prompt, volume deliveries of reliable products.

Our small, low-cost mini-computers are fast, reliable, efficient. Using unique

architecture and micro-programming, they use *firmware* to provide execution 5 to 10 times faster than units employing software.

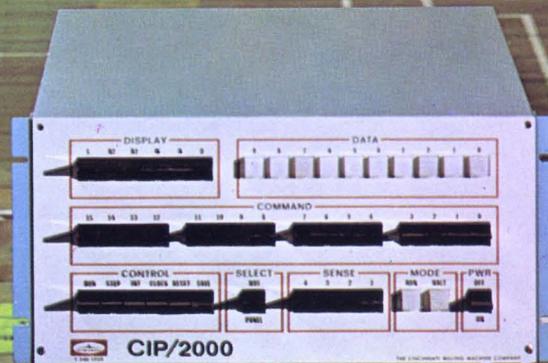
Speed, reliability in production and performance, low cost, dependable new source . . . if these are your buzzwords, turn off Boardwalk to Booth 12008 at the SJCC. Or write for Publication CTL-302. The Cincinnati Milling Machine Co., Dept. R-14, Lebanon, Ohio 45036. **CINCINNATI**

The Cincinnati Milling Machine Co.

INFORMATION RETRIEVAL NUMBER 167

Go directly to Boardwalk

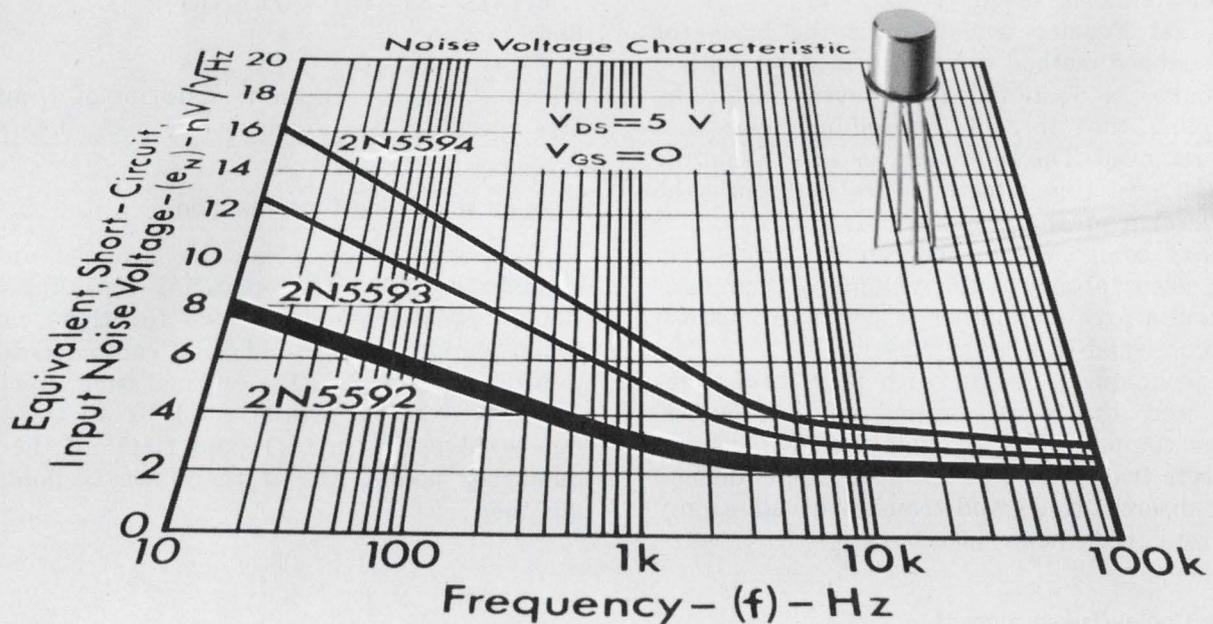
(then proceed to Booth 12008)



I/O
CONTROL
REGISTER

COMMAND
DECODE,
AND
CONTROL

Our
 2N5592 JFET
 has
 33% lower
 1/f noise
 than
 our
 2N5593.



How low can we get?

Only time will tell. Because we're designing an entire family of N-Channel JFET's around a new manufacturing process. And one of the nicest things about this process is that it has low-noise as a natural characteristic. In fact, the 2N5592 is the lowest-noise device of its type. (Maximum noise is $10 \frac{nV}{\sqrt{V}}$ at 10 Hz.) Output admittance is also very low, typical γ_{os}

is $1 \mu mho$. And since it's an N-Channel JFET, you know what kind of gain to expect. (Around $4500 \mu mhos$.) What's more, 2N5592 is available right now. Bet you didn't expect that.

Solitron Devices, Inc., P. O. Box 1416,
 San Diego, California 92112.
 Telephone 714/278-8780.
 TWX 910-335-1221.



Speed up the fast Fourier transform

and reduce memory requirements so that a minicomputer can do the whole job.

Designing complex systems is plagued by the fact that the frequency domain is most convenient for linear analysis, while the time domain is ideal for nonlinear analysis. Yet Fourier transformations, both direct and inverse, can be so speeded up by using a digital computer that frequency and time-domain analysis can be used simultaneously. As a result, a great deal of the designer's time is saved.

The fast Fourier transform is the basis for the specialized method to be described—a method that makes a fast technique even faster by recognizing that it contains redundancies that can be removed. The redundancies arise from the fact that most time functions are real while the general form of the transform is complex. The imaginary component of the complex transform can be used to reduce the volume of computations, and a greater number of computations can be accomplished in a given time.

The technique is useful with both large computers and the more limited minicomputers. Machine computations are restricted, of course, to discrete transforms, which have inputs defined only at discrete times and transform values only at discrete frequencies (see box).

Use the Cooley-Tukey algorithm

The fast Fourier transform is a version of the Cooley-Tukey algorithm.¹⁻⁶ A program of this algorithm in BASIC is given in Fig. 1. All of the computations involved in the conventional transform technique are performed in the fast transform, but symmetries are used to advantage and repetitions are avoided.

The fast Fourier transform is derived by operating on complex functions, and it is linear. If $f_1(t)$ transforms to $F_1(n)$ and $f_2(t)$ to $F_2(n)$, then $af_1(t) + bf_2(t)$ transforms to $aF_1(n) + bF_2(n)$. But the two time functions can be transformed simultaneously by assigning one of them to be imaginary.

Let $f(t) = f_1(t) + jf_2(t)$ where both f_1 and f_2 are real. The transform of $f(t)$ is $F(n) = X(n) + jY(n)$. The real, X , an imaginary, Y , parts can be broken into even and odd parts,

$$F(n) = X_{\text{even}}(n) + X_{\text{odd}}(n) + jY_{\text{even}}(n) + jY_{\text{odd}}(n),$$

and the two transforms can be separated, yielding

$$F_1(n) = X_{\text{even}}(n) + jY_{\text{odd}}(n)$$

and

$$F_2(n) = Y_{\text{even}}(n) - jX_{\text{odd}}(n)$$

where F_1 and F_2 are the transforms of f_1 and f_2 . One operation has given two transforms.

Save by separating time functions

Additional savings can be realized in the specialized method by separating two time functions. Transforms of the two functions can be found simultaneously and then combined to obtain the transform of the original time function.⁵

If, for example, we let $f_1(t)$ be all the even-numbered points in $f(t)$, and $f_2(t)$ all the odd-numbered points, and if there are N points in all, then:

$$\begin{aligned} F(n) &= \frac{1}{N} \sum_{i=0}^{N-1} f(i) e^{-\frac{jn2\pi}{N}} \\ &= \frac{1}{N} \sum_{\text{even } i} f(i) e^{-\frac{jn2\pi}{N}} \\ &\quad + \frac{1}{N} \sum_{\text{odd } i} f(i) e^{-\frac{jn2\pi}{N}} \\ &= \frac{1}{N} \sum_{k=0}^{-1+N/2} f(2k) e^{-\frac{j2kn2\pi}{N}} \\ &\quad + \frac{1}{N} \sum_{k=0}^{-1+N/2} f(2k+1) e^{-\frac{j2kn2\pi}{N}} \\ &= \frac{1}{2} \left[\frac{1}{N/2} \sum_{k=0}^{-1+N/2} f(2k) e^{-\frac{jkn2\pi}{N/2}} \right] \\ &\quad + \frac{e^{-\frac{jn2\pi}{N}}}{2} \left[\frac{1}{N/2} \sum_{k=0}^{-1+N/2} f(2k+1) e^{-\frac{jkn2\pi}{N/2}} \right] \end{aligned}$$

Peter K. Bice, Engineer, Hewlett-Packard Co., Palo Alto, Calif.

Properties of the Fourier Transform

The form of the discrete Fourier transform is:

$$F(n) = \frac{1}{N} \sum_{i=0}^{N-1} f(i) e^{-j i n 2 \pi / N}$$

and its inverse is

$$f(i) = \sum_{n=0}^{N-1} F(n) e^{+j i n 2 \pi / N}$$

where N is the number of samples of the time function available.

This transform pair has the following properties: if one is substituted into the other, an identity results. $F(n)$ is periodic with period N . Substituting $(N+n)$ for n does not change its value. Thus, N values of $f(i)$ result in N values of $F(n)$ before repetition begins. Also, $F(i)$ is periodic with period N . If N time samples are specified, one period of the transform is described. If the time function is real, the real part of $F(n)$ is even in n :

$$\operatorname{Re}(F(n)) = \operatorname{Re}(F(N-n))$$

and the imaginary part of $F(n)$ is odd in n :

$$\operatorname{Im}(F(n)) = -\operatorname{Im}(F(N-n)).$$

The transform and its inverse are very similar. An algorithm for one also performs the other with minor modifications.

For the fast Fourier transform:

1. The number of data points, N , must be a power of 2.

2. Memory must be large enough to store a complex column matrix of N entries.

3. If $f(t)$ is real, $(F(n) = F(N-n)^*)$. Thus, half of the resultant complex line spectrum is redundant.

4. The data is read into the complex column matrix and is operated on until the final result is obtained. The transform values must be rearranged into the proper order. The original data is lost.

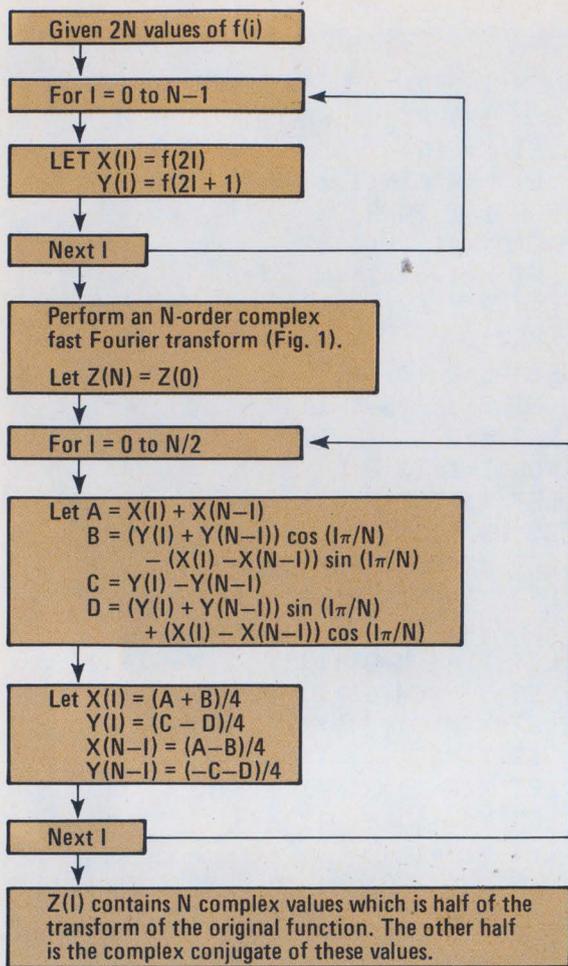
5. The Cooley-Tukey algorithm requires the change of a number into its image (reverse order of bits). It is done in program steps 530-590 of Fig. 1.

```

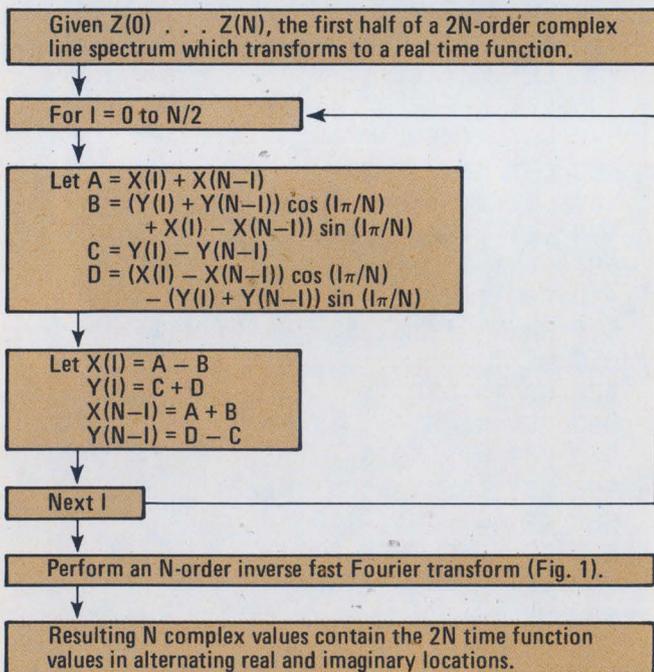
1 DIM X(1024),Y(1024)
100 REM INSERT VALUE OF "G" HERE
110 LET N=2^G
120 LET P=8*ATN(1)/N
130 FOR I=1 TO N
140 READ X(I),Y(I)
150 LET X(I)=X(I)/N
160 LET Y(I)=Y(I)/N
170 NEXT I
180 FOR L=0 TO G-1
190 LET G1=2^(G-L-1)
200 LET M=0
210 FOR I=1 TO 2^L
220 LET K1=INT(M/G1)
230 GOSUB 530
240 LET Y1=COS(P*K2)
250 LET Y2=-SIN(P*K2)
260 FOR J=1 TO G1
270 LET Y3=X(M+G1+1)*Y1-Y(M+G1+1)*Y2
280 LET Y4=X(M+G1+1)*Y2+Y(M+G1+1)*Y1
290 LET X(M+G1+1)=X(M+1)-Y3
300 LET Y(M+G1+1)=Y(M+1)-Y4
310 LET X(M+1)=X(M+1)+Y3
320 LET Y(M+1)=Y(M+1)+Y4
330 LET M=M+1
340 NEXT J
350 LET M=M+G1
360 NEXT I
370 NEXT L
380 FOR I=0 TO N-1
390 LET K1=I
400 GOSUB 530
410 IF K2>=I THEN 480
420 LET K3=X(I+1)
430 LET X(I+1)=X(K2+1)
440 LET X(K2+1)=K3
450 LET K3=Y(I+1)
460 LET Y(I+1)=Y(K2+1)
470 LET Y(K2+1)=K3
480 NEXT I
490 FOR I=0 TO N-1
500 PRINT I,X(I+1),"+J":Y(I+1)
510 NEXT I
520 GO TO 610
530 LET K2=0
540 FOR K=1 TO G
550 LET K3=K1-2*INT(K1/2)
560 LET K1=INT(K1/2)
570 IF K3=0 THEN 590
580 LET K2=K2+2^(G-K)
590 NEXT K
600 RETURN
610 END

```

1. The general fast Fourier transform program is the starting point for a nonredundant approach. Delete lines 150, 160 and change sign on 250 for inverse transform.



(a)



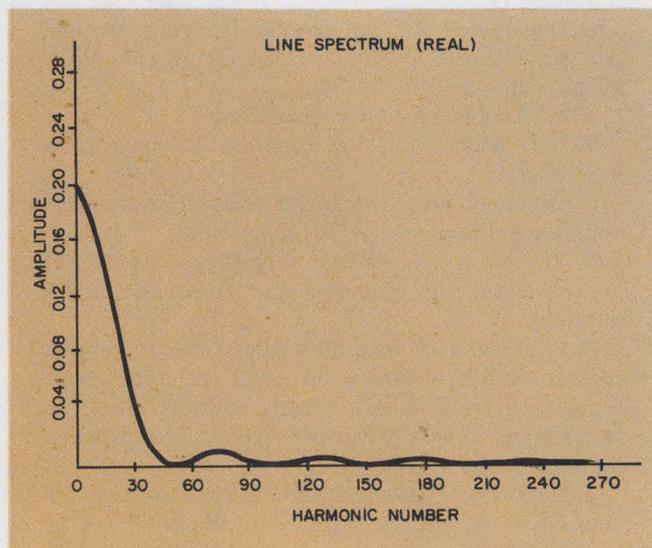
(b)

2. The specialized fast Fourier transform is obtained from the program of Fig. 1 by using these flow charts. The direct transform from real time to complex frequency is given in (a), and its inverse in (b).

The last quantities are exact $N/2$ -order Fourier transforms for which there exists an algorithm. The memory needed for the computations can be halved by using the specialized transform, because the redundancy inherent in real time functions has been eliminated by performing the two transforms simultaneously.

The flow charts of Fig. 2 show how to modify the fast Fourier transform program to transform a real time function consisting of 2^G samples. The even-numbered samples are treated as the real $f_1(t)$, and the odd-numbered samples as the imaginary $f_2(t)$. The transformation routine is then entered and executed. At its conclusion, the resulting complex line spectrum is resolved into the two spectra, one for each time function. They are then added together as shown above, by adding $F_1(n)$ to $F_2(n)e^{-jn2\pi/N}$. The result is the desired complex line spectrum without the redundancy of negative frequencies.

As an example of what can be accomplished a 128-sample time function was transformed three ways using a Hewlett-Packard 2116B mini-computer. The fast, nonredundant technique, expressly for transforming real time functions,



3. The real line spectrum of a triangular wave is plotted from the transform of the time function.

took 46 seconds. The regular fast technique previously described took 87 seconds and required twice as much storage space. The conventional technique, on the other hand, took 16-1/2 minutes and required three times the storage.

Take inverse transforms

The efficiency of the inverse transform (Fig. 2b) can also be improved, but the operations occur in exactly the opposite sequence from those of the direct transform. Begin with a complex $F(n)$ which is nonredundant. Break up the real and imaginary parts into even and odd components and multiply the appropriate pair by $je^{+jn2\pi/N}$. Add the result to the unmultiplied pair of parts, and find the inverse transform of the sum. The result is a column of $N/2$ complex numbers representing the time function. The real parts are the even-numbered samples and the imaginary parts are the odd-numbered samples..

As an example of a fast transform pair, consider a periodic triangular wave with a period of 512 time units, a peak amplitude of 10, and

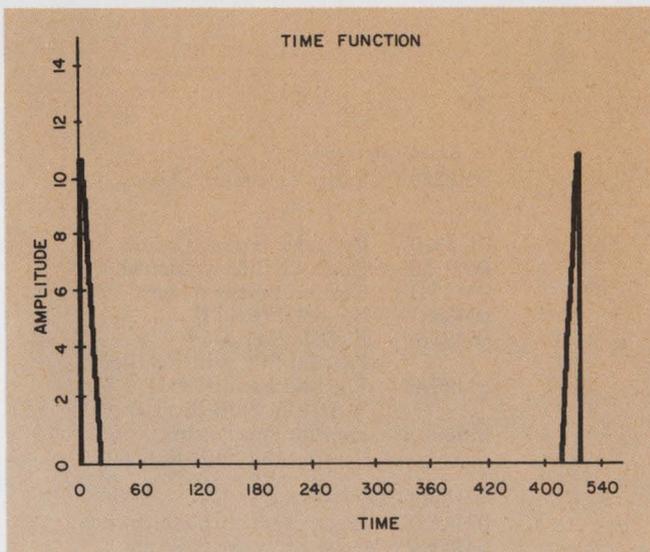
a slope of ± 1 .

The line spectrum shown in Fig. 3 is the result of this transformation. No harmonics beyond #256 are calculated since they would be redundant. Also, since the time function is even, the imaginary part of the spectrum is zero.

This line spectrum is plugged into the inverse transformation routine. The time function shown in Fig. 4 is the result. In all respects, this function is identical to the original input function, as would be expected of a transform pair. ■■

References:

1. Cooley, J. W. and Tukey, J. W., "An Algorithm for the Machine Calculation of Complex Fourier Series," *Math. of Comput.*, Vol. XIX, April, 1965, pp. 297-301.
2. Haavind, Robert, "The FFT Computer: Designer's Missing Link," *Electronic Design*, Dec. 6, 1967, pp. 25-29.
3. Klahn, Richard and Shively, Richard R., "FFT-Short Cut to Fourier Analysis," *Electronics*, Apr. 15, 1968, pp. 124-129.
4. Bergland, G. D., "A Guided Tour of the Fast Fourier Transform," *IEEE Spectrum*, July 1969, pp. 41-52.
5. Singleton, Richard C., "On Computing the Fast Fourier Transform," *Comm. of the ACM*, Vol. 10, No. 10, Oct., 1967.
6. Brigham, E. O. and Morrow, R. E., "The Fast Fourier Transform," *IEEE Spectrum*, Dec., 1967, pp. 63-70.



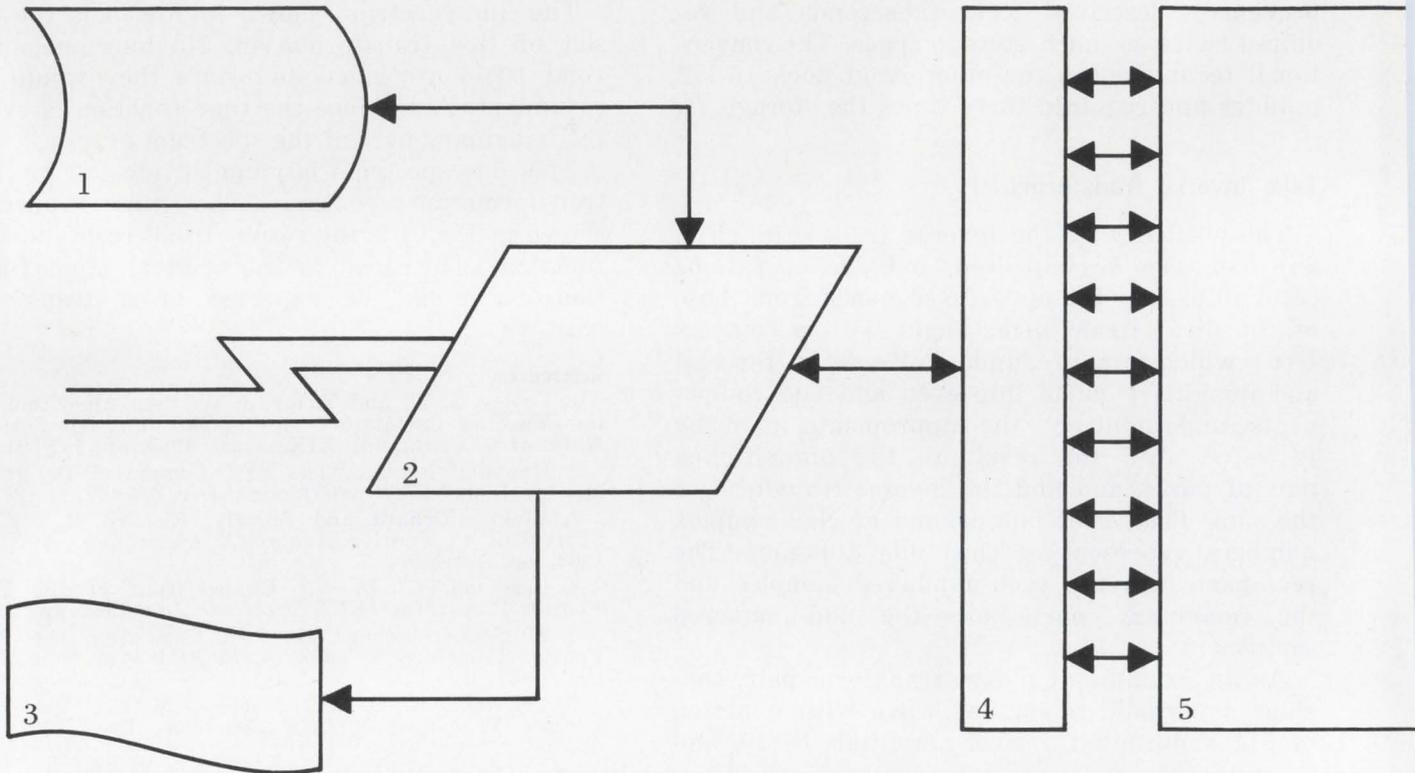
4. The original time function is synthesized from the inverse transformation of the spectrum in Fig. 3.

Test your retention

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

1. What is the link between the time and frequency domains?
2. What is the inverse transform of a complex line spectrum?
3. Why is the conventional Fourier transform inefficient when used in a computer program?
4. What is the advantage of a conventional Fourier transform in machine computations?

In TTL



1. Mass Storage

DM8533N Four-bit Binary Counter
 DM8842N BCD to Decimal Decoder
 DM8200N Four-bit Comparator
 DM8210N Eight Channel Digital Switch

2. Modem

DM8210N Eight Channel Digital Switch
 DM8211N Eight Channel Switch (with Strobe)
 DM8220N Parity Generator/Checker
 DM8830N Dual Line Driver
 DM8842N BCD to Decimal Decoder

3. Tape Reader or Punch

DM8550N Quad Latch
 DM8533N Four-bit Binary Counter
 DM8842N BCD to Decimal Decoder

4. Input Interface

DM8220N Parity Generator/Checker

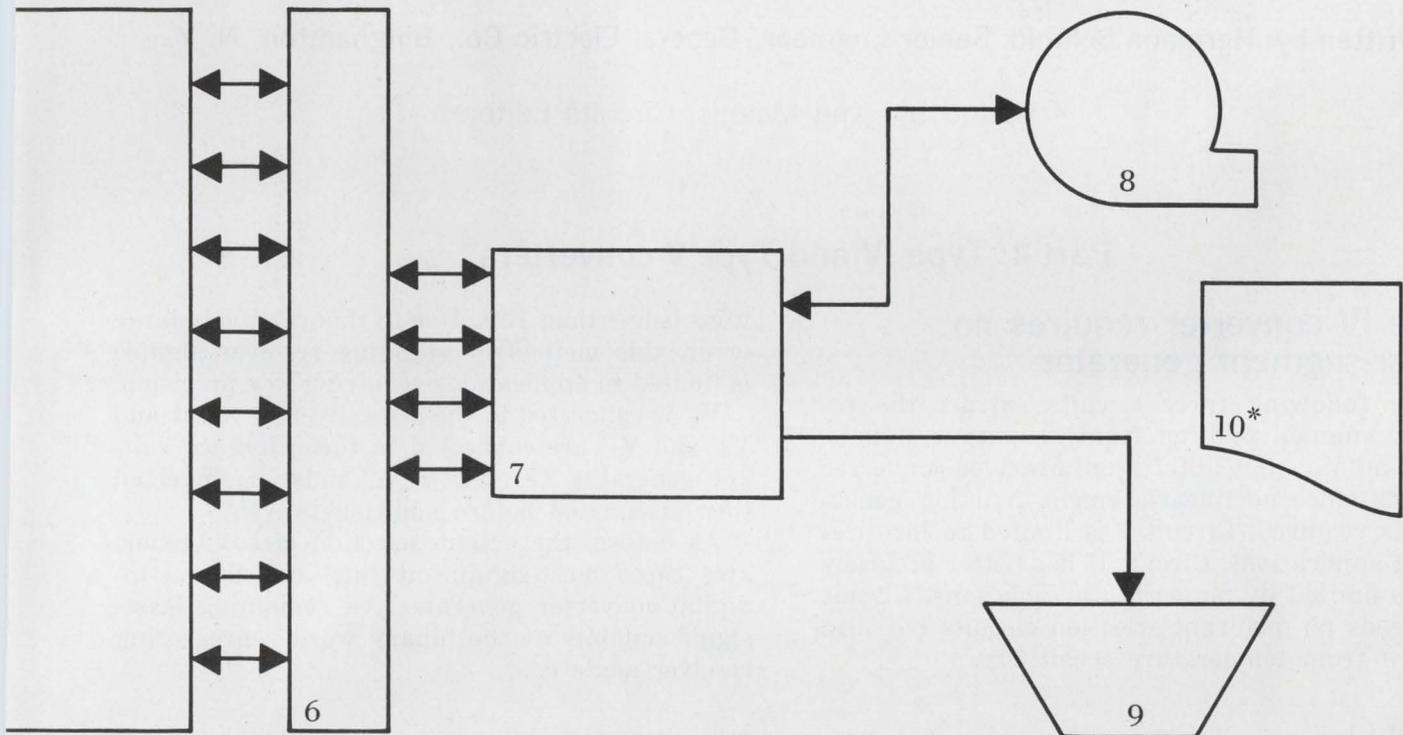
5. CPU

DM8560N Up-Down Decade Counter
 DM8563N Up-Down Binary Counter
 DM8283N Four-bit Binary Adder
 DM8551N Bus-OR'd Quad D
 DM8570N Eight-bit Serial-In Parallel-Out Shift Register
 DM8590N Eight-bit Parallel-In Serial-Out Shift Register
 DM8580N Four-bit Parallel-In Parallel-Out Shift Register

6. Output Interface

DM8210N Eight Channel Digital Switch
 DM8086N Quad Exclusive OR Gate
 DM8220N Parity Generator/Checker

It's MSI



7. Memory

- DM8580N Four-bit Parallel-In Parallel-Out Shift Register
- DM8590N Eight-bit Parallel-In Serial-Out Shift Register
- DM8570N Eight-bit Serial-In Parallel-Out Shift Register

8. Off Line Storage

- DM8200N Four-bit Comparator
- DM8220N Parity Generator/Checker

9. Display

- DM8840N BCD to Decimal Nixie Driver
- DM8842N BCD to Decimal Decoder
- DM8550N Quad Latch

Nixie: Trademark of Burroughs Corporation

*10. Software

Our new 38 page App Note on applications of MSI circuits. Send for it.

(We've got it made)

Shipments from distributor stocks. Plus a complete line of MOS ROMs, shift registers and character generators completing the MSI design package.

National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara,
California 95051 (408) 732-5000 TWX: 910-339-9240
Cables: NATSEMICON Telex: 346-353

National/TTL MSI

An Electronic Design practical guide for synchro-to-digital converters

Written by: Hermann Schmid, Senior Engineer, General Electric Co., Binghamton, N. Y.

Edited by: Don Mennie, Circuits Editor

Part 4: Type IV and Type V converters

Type IV converter requires no linear-segment generator

The following three circuits extract the resolver angular position from its output signals, V_{xac} and V_{yac} , but differ from previous converter designs since no linear-segment function generator is required. Circuit I is limited to low-precision applications. Circuit II has better accuracy but is limited by temperature variations. Circuit III needs no quadrant selection circuits but also suffers from temperature sensitivity.

Circuit I.

This remarkably simple resolver-to-digital-angle converter²² (Fig. 27) solves the equation

$$\theta = \frac{\sin \theta}{\sin \theta / \theta} \approx \frac{\sin \theta}{\cos \theta + K \sin \theta} \quad (57)$$

The circuit contains an octant selector, standard analog-to-digital converter and a special reference voltage generator. The special generator combines the selected resolver output signals ($V_{x'}$ and $V_{y'}$) and produces a reference voltage.

$$V_R = V_{x'} + K V_{y'} = \cos \theta + K \sin \theta. \quad (58)$$

The difference between θ and its approximation, $\sin \theta / (\cos \theta + K \sin \theta)$, is plotted in Fig. 28 as a function of the angle θ for $K = 0.25$. From zero to 45° , the error between these two func-

tions is less than 1.2° . Due to this relatively large error, this method of encoding resolver signals is limited to applications requiring low precision.

$V_{x'}$ is connected to the a/d converter input and $V_{x'}$ and $V_{y'}$ are connected to the reference voltage generator (Fig. 27). $V_{x'}$ must be inverted then attenuated before addition to $V_{y'}$.

As before, the octant selection circuit generates three most-significant bits and the ac-to-digital converter generates the remaining least-significant bits of the binary word representing resolver angle θ .

Circuit II.

Theoretically, a more precise resolver-to-digital angle converter* can be built if the following approximation is used:^{23,24}

$$\theta_A \approx 45^\circ + \frac{180^\circ}{\pi} \cdot \frac{\sin(\theta - 45^\circ)}{0.66 + 0.34 \cos(\theta - 45^\circ)} \quad (59)$$

The error between θ and this approximation is less than one minute of arc (1 part of 21,600) for θ between 0° and 90° (Fig. 29).

Equation 59 must be modified before use since the resolver outputs are $V_x = K \cos \theta$ and $V_y = K \sin \theta$, whereas the terms required in Eq. 59 are $\sin(\theta - 45^\circ)$ and $\cos(\theta - 45^\circ)$. However, since

$$\sin(\theta - 45^\circ) = 0.707(\sin \theta - \cos \theta) \quad (60)$$

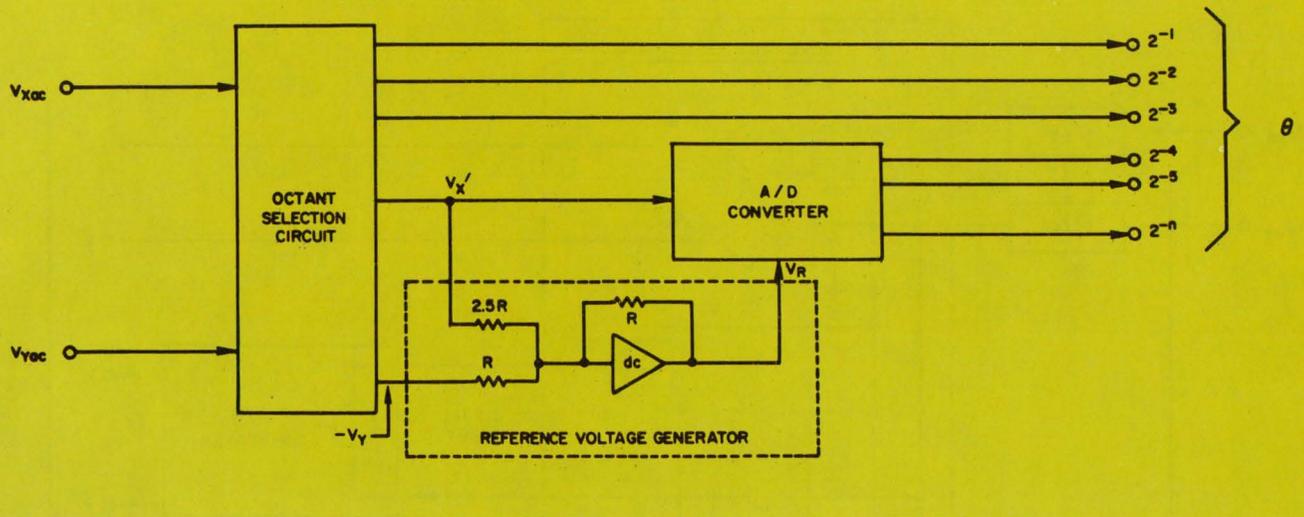
and

$$\cos(\theta - 45^\circ) = 0.707(\cos \theta + \sin \theta), \quad (61)$$

Eq. 59 can be modified to

Adapted from ELECTRONIC ANALOG/DIGITAL CONVERSION by Hermann Schmid, Copyright © 1970 by Van Nostrand Reinhold Company, by permission of Van Nostrand Reinhold Company.

* Extracted from "An Electronic Angle Encoder," 1966 National Telemetry Proceedings by permission from G. B. Gilbert, Jr., Towson Laboratories, Inc., Baltimore, Md.



27. The Type IV converter—Circuit I—does not need a linear-segment function generator, but large error

limits this method of encoding resolver signals to low precision applications.

$$\theta_A 45^\circ + \frac{180}{\pi} \cdot \frac{\sin\theta - \cos\theta}{0.93 + 0.34(\sin\theta + \cos\theta)} \quad (62)$$

It is desirable that the analog-to-digital converter generate digital output signals in the offset-binary form, so that

$$\begin{aligned} +90^\circ &= + \text{full scale} && = 1 \ 1 \ 1 \ \cdots \ 1 \ 1 \ 1 \\ +45^\circ &= \text{half full scale} && = 1 \ 0 \ 0 \ \cdots \ 0 \ 0 \ 0 \\ 0^\circ &= - \text{full scale} && = 0 \ 0 \ 0 \ \cdots \ 0 \ 0 \ 0 \end{aligned}$$

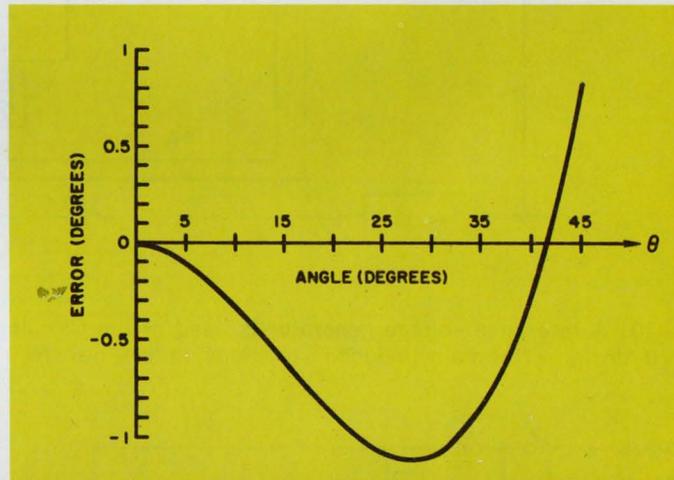
Therefore, the equivalent analog input voltage to the converter must be biased with the equivalent of -45° and normalized by dividing by 45° . Incorporating this into Eq. 62 gives

$$\frac{\theta_A - 45^\circ}{45^\circ} = \frac{\sin\theta - \cos\theta}{0.73 + 0.268(\sin\theta + \cos\theta)} \quad (63)$$

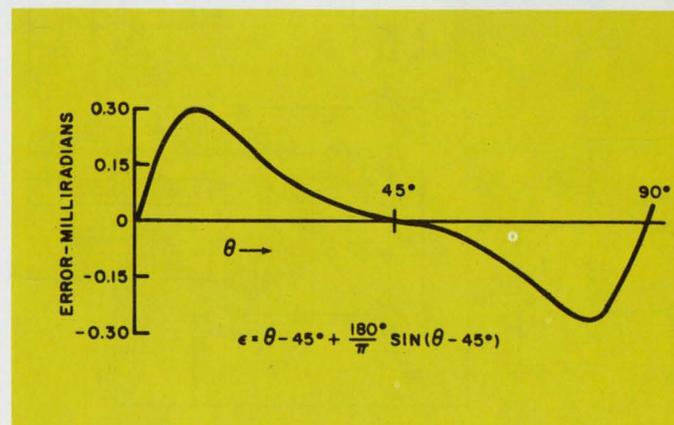
This equation can be implemented in the proposed converter by connecting a voltage to the converter's signal input (proportional to the numerator of Eq. 63) and by connecting a negative voltage to the converter's reference input (proportional to the denominator of Eq. 63). The dc-to-digital converter output is then proportional to the angle θ .

For second, third and fourth-quadrant resolver signals, the polarities of the V_X and V_Y terms in Eq. 63 must be changed to account for resolver output polarity change. This is performed by the quadrant selection circuit. The required V_X and V_Y polarities for generation of the converter-input signal V_S and the reference voltage V_R for the quadrants are:

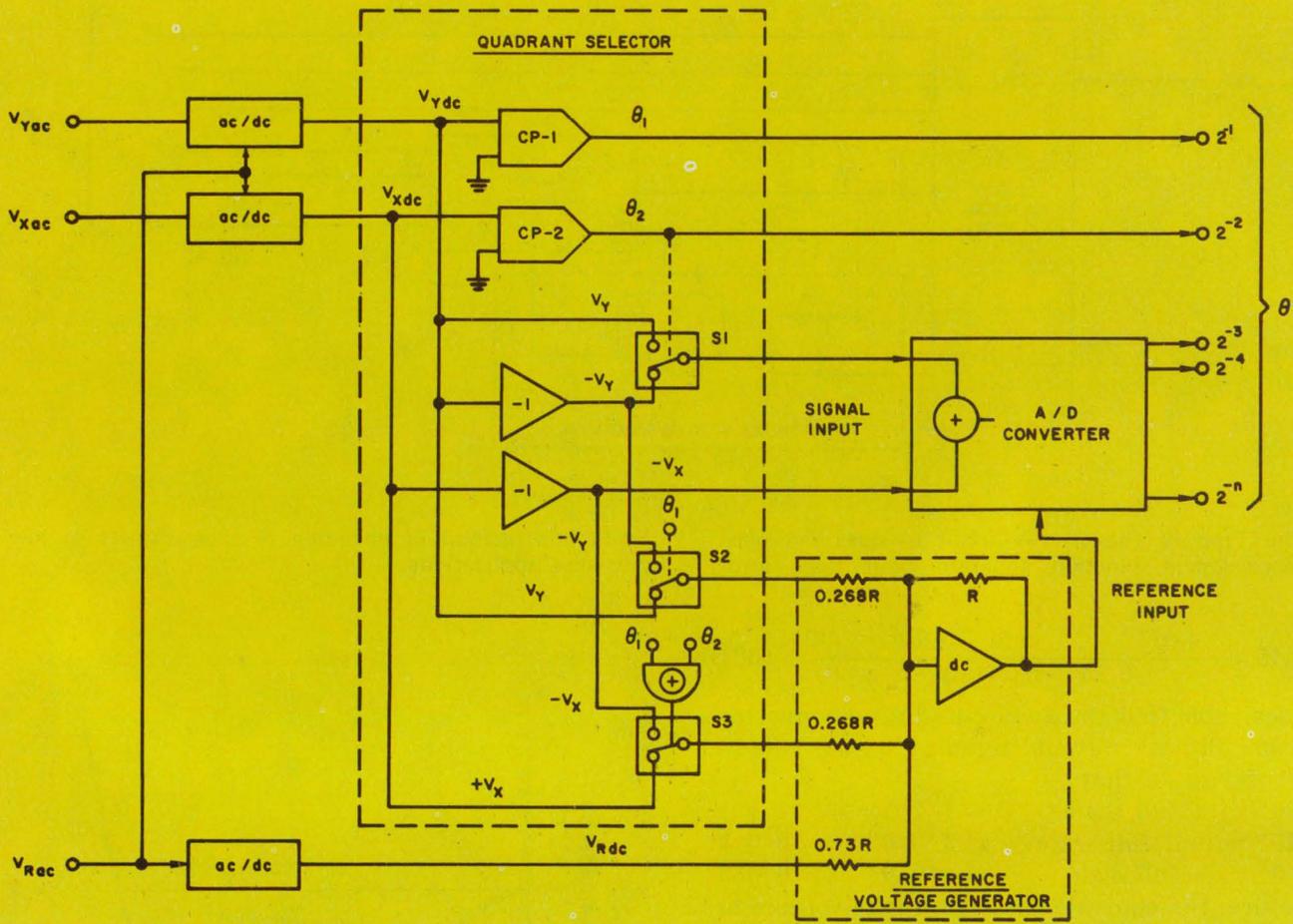
Quadrant	Digital Output		Converter Input		Converter Reference	
	2^{-1}	2^{-2}	V_S	V_R	V_S	V_R
I	0	0	$+V_Y$	$-V_X$	$+V_Y$	$+V_X$
II	0	1	$-V_Y$	$-V_X$	$+V_Y$	$-V_X$
III	1	0	$+V_Y$	$-V_X$	$-V_Y$	$-V_X$
IV	1	1	$-V_Y$	$-V_X$	$-V_Y$	$+V_X$



28. The accuracy of Circuit I is the difference between θ and its approximation, $\sin\theta/(\cos\theta + K \sin\theta)$. Maximum error from 0° to 45° for $K = 0.25$ is $< 1.2^\circ$



29. Greater precision is theoretically available from the Type IV converter—Circuit II. Error between θ and its approximation (Eq. 59) from 0° to 90° is < 1.0 minute of arc.



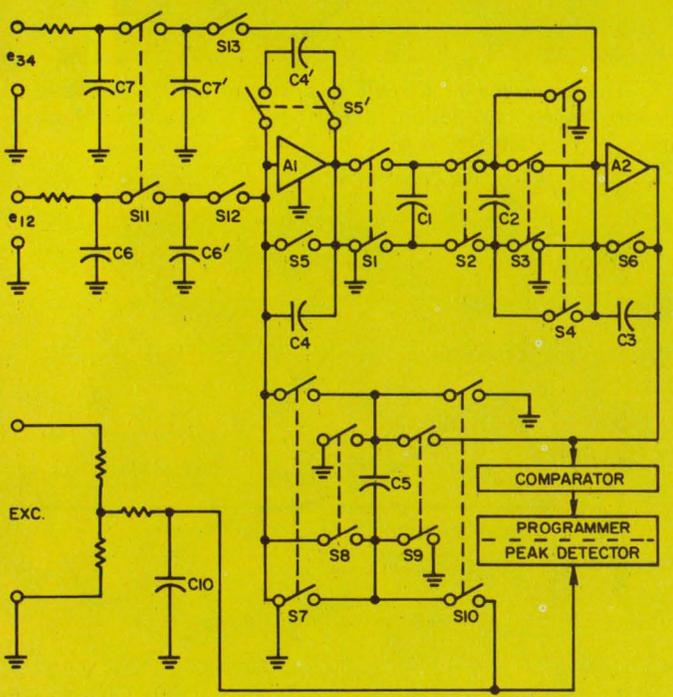
30. A reference voltage generator is used in the Circuit II design. Thermally induced variations in the transfor-

mation ratio between V_{Rac} and V_{Xac} present a major accuracy problem.

Figure 30 illustrates a conventional resolver-to-digital-angle converter using this principle. It is built with three ac to dc converters, a quadrant selector, a standard dc-to-digital converter and a special-reference voltage generator.

The three ac-to-dc converters generate dc voltages from the resolver output signals, V_{Xac} , V_{Yac} , and from the resolver excitation voltage, V_{Rac} . The quadrant selector accepts bipolar dc voltages V_{Xdc} and V_{Ydc} , and produces the desired combination for the signal and reference inputs of the a/d converter as follows.

The two comparators, CP_1 and CP_2 , are connected so that the outputs, θ_1 and θ_2 , are ZERO when the inputs, V_{Xdc} and V_{Ydc} , are positive (resolver is in the first quadrant). The comparator outputs θ_1 and θ_2 , which are the two most-significant outputs of the resolver-to-digital-angle converter, control the S_1 , S_2 and S_3 selector switches. S_1 and S_3 are controlled by θ_2 and S_2 by θ_1 . Two conventional operational amplifiers are connected as unity-gain inversion amplifiers to produce $-V_X$ and $-V_Y$. In accordance with the table above, the a/d converter signal input becomes $-V_X$ and $+V_Y$ or $-V_Y$, depending on whether θ_2 is ZERO or ONE, respectively. The inputs to



31. The Type IV converter—Circuit III—requires stable, precisely related capacitor values. Like Circuit II, this design is accuracy-limited by transformation ratio variations.

the reference voltage generator are $+V_Y$ when θ_1 is ZERO or $-V_Y$ when θ_1 is ONE, and $+V_X$ when $\theta_1 = \theta_2$ or $-V_X$ when θ_1 is not equal to θ_2 .

The converter in Fig. 30 has one serious disadvantage. The voltage representing the factor 0.73 in Eq. 63 (generated directly from V_{Rac}) is not attenuated by the transformation ratio of the resolvers, as are all other voltages. In most resolvers, the transformation ratio between V_{Xac} and V_{Rac} , as well as between V_{Yac} and V_{Rac} , varies as much as 4% initially from unit to unit and as much as 3% over the temperature range. Unit-to-unit variation could be compensated for, but there are no practical circuits to correct thermal variations in the transformation ratio (between -55°C and $+85^\circ\text{C}$).

Circuit III.

A simplified diagram of a complete four-quadrant resolver-to-digital angle converter is given in Fig. 31. This circuit does not require external ac-to-dc converters or quadrant selection circuitry. This design is comprised of a charge-equalizing a/d converter, an input circuit for quadrant selection, conventional comparison and logic circuits and circuitry for generating constants from the reference voltage. A complete description of operation has been published.²⁴

The analog portion of this converter comprises 11 precision capacitors, 10 dpst switches, four spst switches and two operational amplifiers. The capacitors must have high stability and precise magnitude ratios, but they need not have tight absolute-value tolerances. The analog voltage switch must display low leakage currents, small feedthrough capacitance, moderate turn-ON and turn-OFF times, and low ON resistance.

The converter design of Fig. 31 has the same disadvantages as the converter of Fig. 30. Neither approach can compensate for resolver transformation ratio variations.

Type V converter uses harmonic oscillator

Another technique of encoding resolver output signals uses a harmonic oscillator²⁵ such that initial conditions are made proportional to the amplitude of the resolver output signals, V_X and V_Y . The time required for the oscillator to provide resolver shaft angle information is proportional to the resolver shaft angle magnitude. A resolver-to-digital converter built on this principle²⁶ is simple, but it has significant accuracy limitations.

In the harmonic oscillator, two integrators and one inverter form a closed loop (Fig. 32). The

operation of the oscillator is defined by the differential equation

$$\dot{X} = -X \frac{R_4/R_3}{R_1 C_1 R_2 C_2} \quad (64)$$

Solutions to this differential equation are the two integrator outputs:

$$V_1(t) = E \cos \omega t \quad (65)$$

$$V_2(t) = E \sin \omega t \quad (66)$$

where

$$E = \sqrt{(V_{10})^2 + (V_{20})^2}, \text{ and} \quad (67)$$

$$\omega = 1/\sqrt{R_1 C_1 R_2 C_2} \quad (68)$$

V_{10} and V_{20} are the integrating capacitor voltages when $t = 0$ (initial conditions). The oscillator's output amplitude, E , can be controlled by charging C_1 and C_2 to specific values prior to $t = 0$. Note that amplitude is independent of the time constants $R_1 C_1$ and $R_2 C_2$. By contrast, the output frequency is a function of the integrator time constants and is independent of initial conditions.

The two integrator outputs are the X and Y components of an imaginary vector \bar{R} , which rotates with the constant velocity $K\omega$. The time, t_θ , required to rotate this vector \bar{R} from its initial position (Fig. 33) to a position where V_Y is zero is directly proportional to the vector angle. Since the angle is $\theta = K\omega t$ the time is

$$t_\theta = \theta / (K\omega). \quad (69)$$

The diagram (Fig. 34) shows that the proposed converter is a harmonic oscillator controlled by a 12-bit master counter and a zero detector. Type V converter operation is divided into three modes (Fig. 35) where:

1. During T_1 the initial conditions are set by integrating the rectified resolver output signals, V_{Xdc} and V_{Ydc} .

2. During T_2 the vector \bar{R} , represented by its components, V_X and V_Y , is rotated until the output of the second integrator, V_2 , crosses zero.

3. During T_3 the two integrators are reset to zero by closing a switch connected across the integration capacitor.

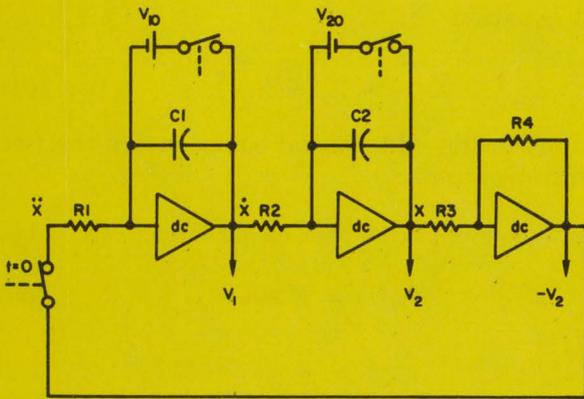
Specifically, the initial conditions, V_{10} and V_{20} , are obtained by connecting V_{Xdc} and V_{Ydc} to the integrators with switches S_1 and S_2 during period T_1 . Therefore,

$$V_{10} = -1/(R_1 C_1) \int_0^{T_1} V_X dt = (-V_X T_1)/(R_1 C_1) \quad (70)$$

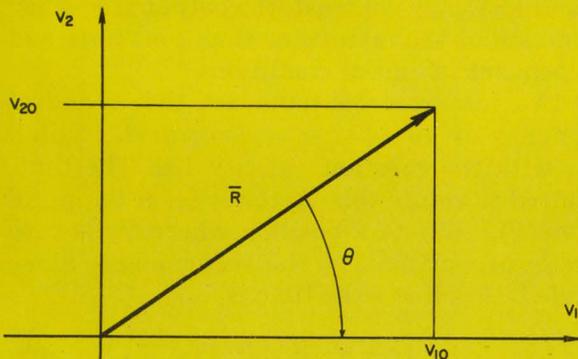
and

$$V_{20} = -1/(R_2 C_2) \int_0^{T_1} V_Y dt = (-V_Y T_1)/(R_2 C_2). \quad (71)$$

During period T_2 , the oscillator loop is closed



32. The harmonic oscillator used in the Type V converter solves differential equations of the form $\ddot{X} = KX$ (K =constant terms).



33. The imaginary vector \bar{R} has the two integrating capacitor voltages V_{10} and V_{20} as components. \bar{R} rotates with a constant velocity, $K\omega$.

by placing S_1 and S_2 at position A. The two integrators integrate each other's output, $V_1(t)$ and $-V_2(t)$, defined in Eqs. 65 and 66. Starting with the initial conditions set during T_1

$$V_1(t) = V_{10} - 1/(R_1C_1) \int_0^{t_A} -V_2(t) dt \quad (72)$$

and

$$V_2(t) = V_{20} - 1/(R_2C_2) \int_0^{t_A} V_1(t) dt. \quad (73)$$

Since $V_1(t)$ and $V_2(t)$ are sine and cosine functions, Eq. 73 can be solved for t_A by setting $V_2(t)$ equal to zero

$$V_{20} = 1/(R_2C_2) \int_0^{t_A} \cos \omega t dt \quad (74)$$

Substituting Eq. 71 into Eq. 74 and solving the integral in the latter gives

$$-(V_Y T_1)/(R_2 C_2) = \sqrt{R_1 C_1 R_2 C_2} / (R_2 C_2) \sin \omega t_A. \quad (75)$$

If $R_1 C_1 = R_2 C_2$, then

$$-\sin \omega t_A = (V_Y T_1)/(RC) \quad (76)$$

which can be verified by examining the waveforms in Fig. 35.

Similarly Eq. 72 can be set equal to the maximum possible value, which is

$$1 = -(V_X T_1)/(R_1 C_1) + 1/(R_1 C_1) \int_0^{t_A} \sin \omega t dt \quad (77)$$

which can be solved for $\cos \omega t_A$, since

$$1 = -\frac{V_X T_1}{R_1 C_1} + 1 - \frac{\sqrt{R_1 C_1 R_2 C_2}}{R_1 C_1} \cos \omega t_A \quad (78)$$

$R_1 C_1 = R_2 C_2$, hence

$$-\cos \omega t_A = (V_X T_1)/(RC) \quad (79)$$

Dividing Eq. 76 by 79 gives

$$\tan \omega t_A = V_Y/V_X \quad (80)$$

or

$$t_A = (1/\omega) \tan^{-1} (V_Y/V_X) \quad (81)$$

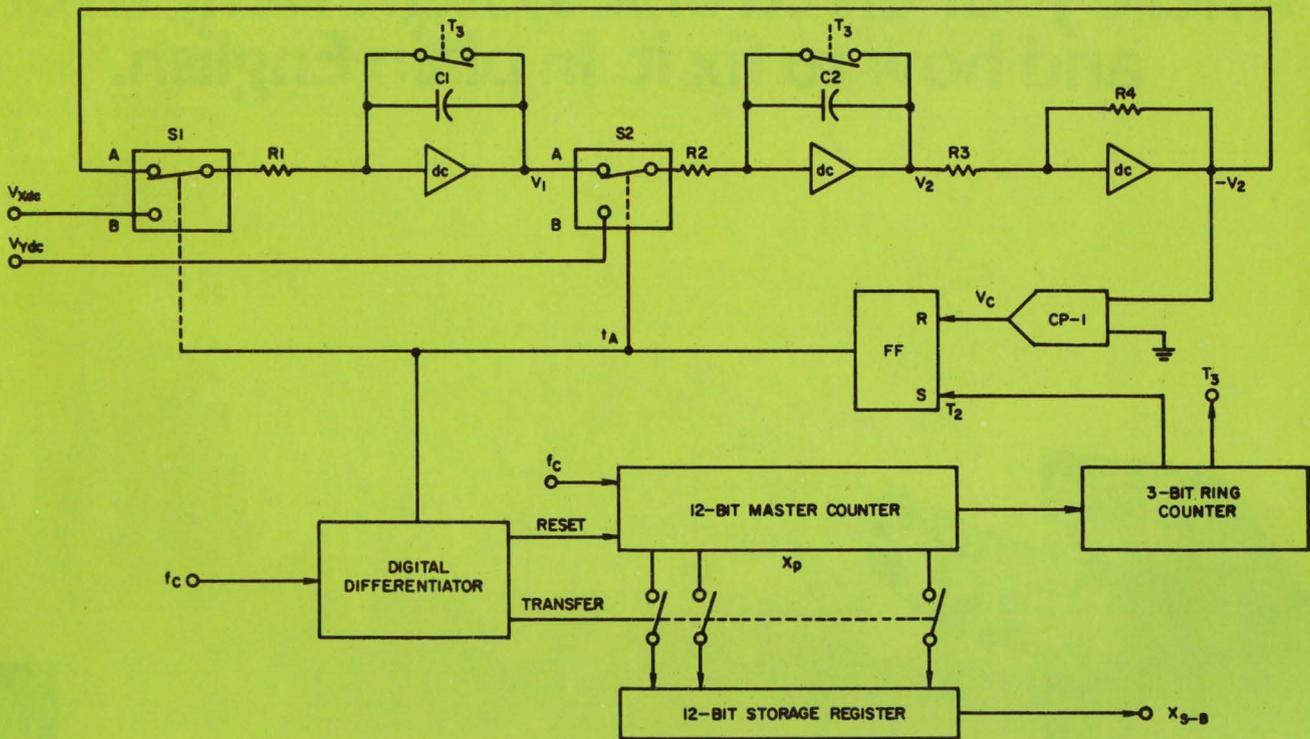
As in any other resolver-to-digital angle converter, t_A is independent of reference voltage. But, unlike other converters, the circuit in Fig. 34 has no reference supply. Signal t_A is also independent of period length $T_1 = 2^n/f_c$, but this provides no advantage since the digital output signal, $X = t_A f_c$, is now a function of clock frequency f_c , which must be stable for good converter accuracy.

Of more concern is circuit dependence on the value and stability of integration time constants $R_1 C_1$ and $R_2 C_2$, since t_A varies with $\sqrt{R_1 C_1 R_2 C_2}$. This means the resistors and capacitors used with the integrators must be precise and stable. Integration time constant dependence poses a severe accuracy limitation for this converter, which overshadows circuit simplicity and low component count.

The above description assumes both resolver output signals are positive dc voltages (the resolver angle lies in the first quadrant). The dc signals, V_{Xdc} and V_{Ydc} , obtained from a set of phase-sensitive demodulator outputs, are selected for the first quadrant (per method in Fig. 30). The converter can accept input signals in all four quadrants if a second zero crossing detector is provided and additional logic circuits are employed to assure proper converter operation.

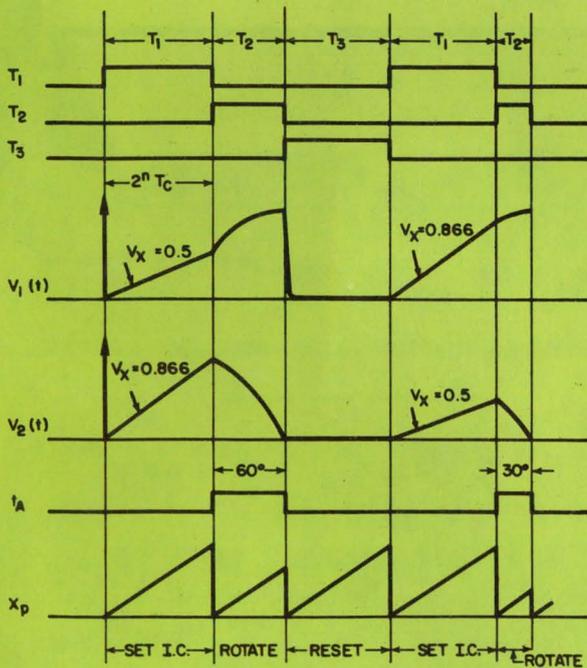
A device similar to that in Fig. 34 is presently sold by Kearfott's Product Division^{11, 27} under the trade name TRIGAC. TRIGAC differs from Fig. 34 since it integrates the resolver output signals, V_{Xac} and V_{Yac} , directly for one half the carrier frequency period, thus eliminating the need for phase-sensitive demodulators.

The integrating resistors and capacitors in the



34. The Type V converter is controlled by a 12-bit master counter. Integration time constant dependence

poses severe accuracy limitations on this design, overshadowing the low component count advantage.



35. Operation of the Type V converter is divided into three modes. T_1 sets initial conditions, T_2 rotates vector \bar{R} , T_3 resets integration capacitor voltage to zero.

TRIGAC are selected for zero temperature coefficient. The two time constants are trimmed to an accuracy of 0.03% during manufacture. ■ ■

References:

22. Zimmerman, I. J., "Synchro to Digital Converter," Boeing Company Report No. D2-82562-1, Seattle, Wash., Jan., 1966.
23. Broughton, M. B., "A Feedback Method for Obtaining a Synchro Output Signal Proportional to Input Angle θ for Large θ ," IRE Transactions on Electronic Computers, Sept., 1960, pp. 359-362.
24. Gilbert, G. B., "An Electronic Angle Encoder, Proceedings of the National Telemetering Conference, 1966, pp. 282-285.
25. Fifer, S., Analog Computation, McGraw-Hill Book Co., New York, 1965, Vol. 1, Chapter 4.
26. Schmid, H., "Integrated Circuits Replace the Electro-mechanical Resolver," Electronics, Jan. 10, 1966, pp. 90-94.
27. "Navigation Converter Talks Two Languages," Electronics, Feb. 5, 1968.

Part 5: Conclusion

The final section of this Practical Guide for Synchro-to-Digital Converters will appear in our next issue, ED 10, May 10, 1970. This portion will describe the mathematically exact Type VI converter and then discuss multispeed converter design.

**Our new automatic test equipment tells you
where your electronic system went wrong,
and how to fix it. In plain English.**

SCATE MK V READY
TYPE NAME AND SERIAL NUMBER OF UNIT UNDER TEST
NAME:

AN/ARC SN#1948J

AN/ARC CONFIDENCE TEST
CONNECT INTERFACE CABLE WITH TO J3 OF SCATE
ADJUST AUDIO AND SIDETONE LEVEL CONTROLS FULLY CW.
TYPE "CONTINUE" WHEN READY

CONTINUE:

LSB RECEIVE TEST
LSB AUDIO OUTPUT IS 1.27V FAILED TEST
USB RECEIVE TEST
USB AUDIO OUTPUT IS 6.5V PASSED TEST
REPLACE IF TRANSLATOR MODULE A6
TYPE "CONTINUE" WHEN READY TO RETEST.

POWER

LAMP

ON
OFF

ON
OFF

PAPER

(PUSH TO RELEASE
LIFT TO LOCK)

LINE FEED

SINGLE ↔ DOUBLE

1 2 3 4 5 6 7 8 9 0

FIGS " ' : ; ? @ N M LTRS LINE FEED
A B C D E F G H I J K L CAR RET

NORM CRYPTO

BREAK SEND REC

WA
OPERA
ABC
OP

TRN
FOR

Each new generation of electronic systems used to bring along its own maintenance and support problems. Because each new type of electronic equipment needed new testing procedures, new training and some new test equipment.

For the Army, the problem is even greater. Because its field maintenance and support equipment has to be mobile. And it has to be relatively simple to operate.

That's where our SCATE® MK V comes in.

General Dynamics' Electronics division went to work on this problem: creating a computer-controlled automatic test system light enough to be mobile, simple enough to be operated without complex training, adaptable enough to be used for all the Army electronic systems into the mid-1980's.

The answer is SCATE MK V, a unique electronic diagnostic tool.

SCATE MK V talks English.

SCATE MK V talks your language. The man who operates it, in the field, needs no advanced training. If he can read or write English, he can be trained to use this equipment in a matter of weeks, not months.

Once an operator is trained, he does not have to know how the unit under test works. SCATE MK V already does. Its computer is programmed for that.

Because the program is in English and on line, the programming costs and time are reduced by as much as 50% compared

to other automatic test equipment.

SCATE gets things down to size.

SCATE MK V is about one-third of the size of any similar existing equipment. It can be mounted in a portable shelter on the back of a truck. Or it can be delivered to the field by helicopter.

The reason for the smaller size of SCATE MK V is that its computer is used more extensively in the measurement function as

well as the control function. This eliminates the need for special and redundant test equipment. **One answer for nine commodity areas.**

The Army has identified a requirement for computer-controlled automatic test equipment (CATE) in nine commodity areas: radio communications; wire and

carrier communications; army avionics; fire control equipment; engineering survey and map equipment; missile systems; combat surveillance; laser systems; and communications security.

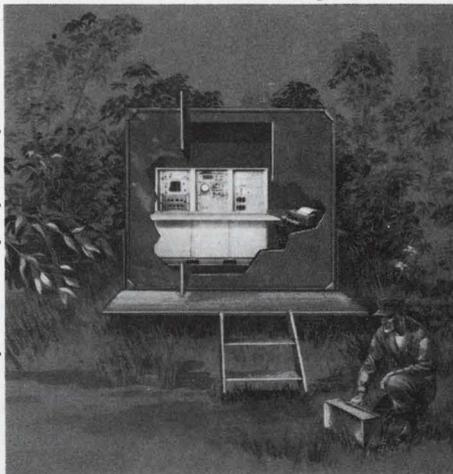
SCATE MK V can be programmed to provide support in any of these materiel areas.

SCATE MK V is a good example of what we do best.

At General Dynamics we put technology to work solving problems from the bottom of the sea to outer space...and a good bit in between.

GENERAL DYNAMICS

Additional technical information is available on SCATE MK V on request. Write: General Dynamics, Dept. 850, 1 Rockefeller Plaza, New York, N.Y. 10020.



Choose magnetic deflection for CRT displays that require small spot sizes and large deflection angles. Here are some circuit-design tips.

Magnetic deflection offers several advantages in display-system performance over its electrostatic counterpart, and it should be seriously considered for new display designs.

Of major benefit is the fact that it is inherently incapable of disrupting the beam-shaping process within the CRT. Since beam shaping is an electrostatic process, eliminating the large voltage swings encountered in electrostatic deflection systems allows reduced spot size and thus provides a brighter display.

A second advantage of magnetic deflection is that it provides large deflection angles more easily than an electrostatic system can. This is particularly important with alphanumeric displays because of the demand for ever-larger tube faces in this area.

Magnetic deflection is a current-controlled phenomenon, and this gives it several additional advantages over the voltage-controlled electrostatic approach:

- System reliability is increased because high-voltage component stresses are avoided.
- Since solid-state amplifiers are much more suited to handling large currents than large voltages, the marriage of these amplifiers to magnetic deflection yokes is a happy one.
- Finally, eliminating high voltages means reducing the shock hazard to operating personnel—an important consideration.

Frequency limitation is not a problem

Magnetic deflection works very well at low frequencies. Above about 3 to 5 MHz, however, the resonances of the deflection yoke come into play, making it necessary for the gain of the deflection amplifier-yoke combination to begin rolling off. Otherwise, the feedback loop used to control the yoke current will become unstable.

This frequency limitation is not very important because most display systems—other than high-performance scopes—operate at lower fre-

quencies. Alphanumeric displays, for example, are usually speed-limited by their character generators.

What can be a problem in some demanding alphanumeric display applications is pincushion distortion. This type of distortion is caused by the nonlinear relationship between deflection current and spot deflection distance. It causes the character size and shape to vary somewhat with screen position.

The key parameter in a magnetic deflection system is the magnetic flux generated by the yoke. This is what actually interacts with the electron beam and deflects it.

If the permeability of the yoke is constant, and if resistive losses are ignored, the flux generated by the yoke is related to the voltage across it by

$$E = N (d\phi/dt) \quad (1)$$

where E is the voltage across the yoke, N is the number of turns ϕ is the flux in webers and t is the time in seconds. Clearly, if a voltage step is applied to the yoke, the resulting flux will be a linearly increasing function of time given by $Et = N\phi$.

The assumption that the permeability of the yoke is constant is a good one so long as the maximum deflection current is kept below the saturation value. However, the effective series resistance of the yoke cannot be ignored. The yoke is actually a series R-L circuit that charges exponentially with a time constant $\tau = L/R$, where L is the inductance of the yoke and R is its series resistance.

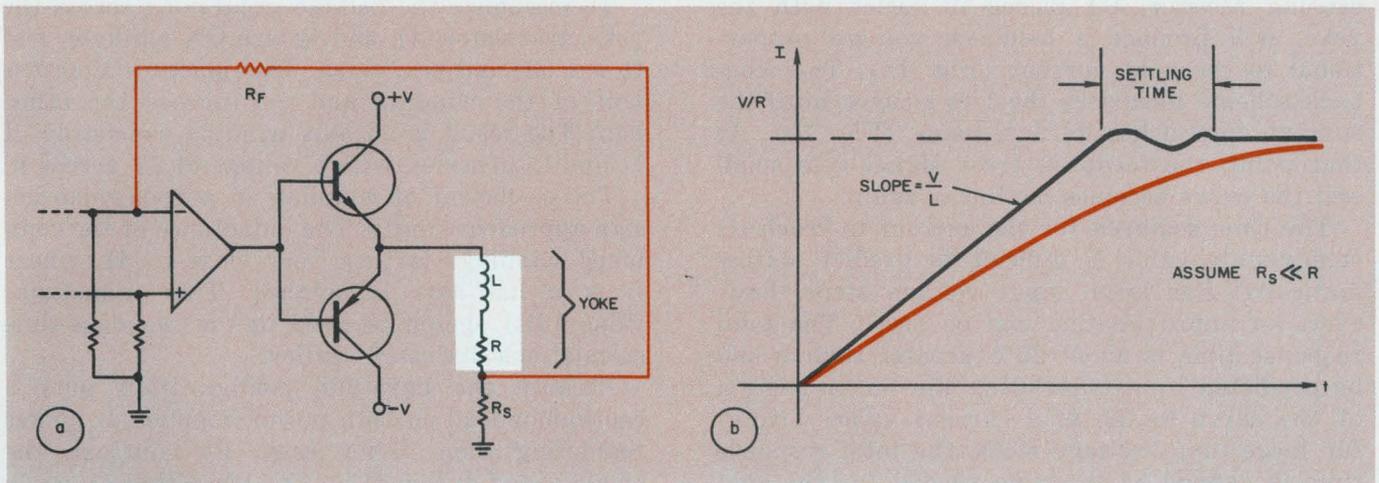
If a voltage step is applied to a real yoke, therefore, the current will be given by

$$I = (E/R) [1 - \exp(-Rt/L)]. \quad (2)$$

Since the generated flux is proportional to yoke current, it is clear that the flux is not a linear function of time. The resistance causes flux-rate distortion and limits the voltage across the yoke.

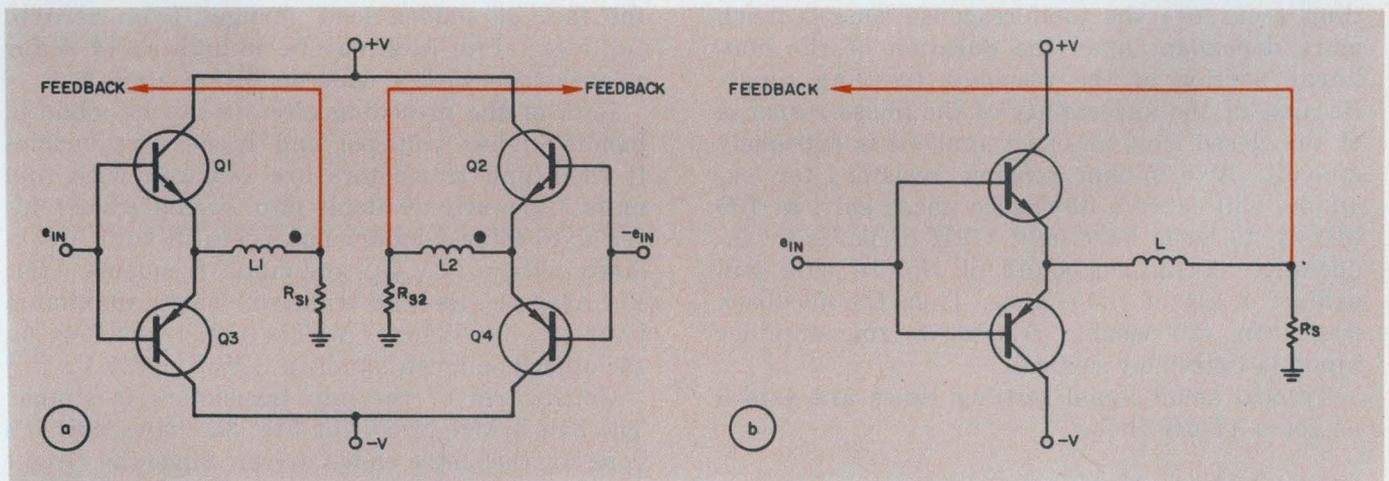
Feedback to the rescue

To overcome the distortion caused by the series resistance and to shorten the time needed for the current (flux) to come to its final value, a feedback technique can be employed. A small



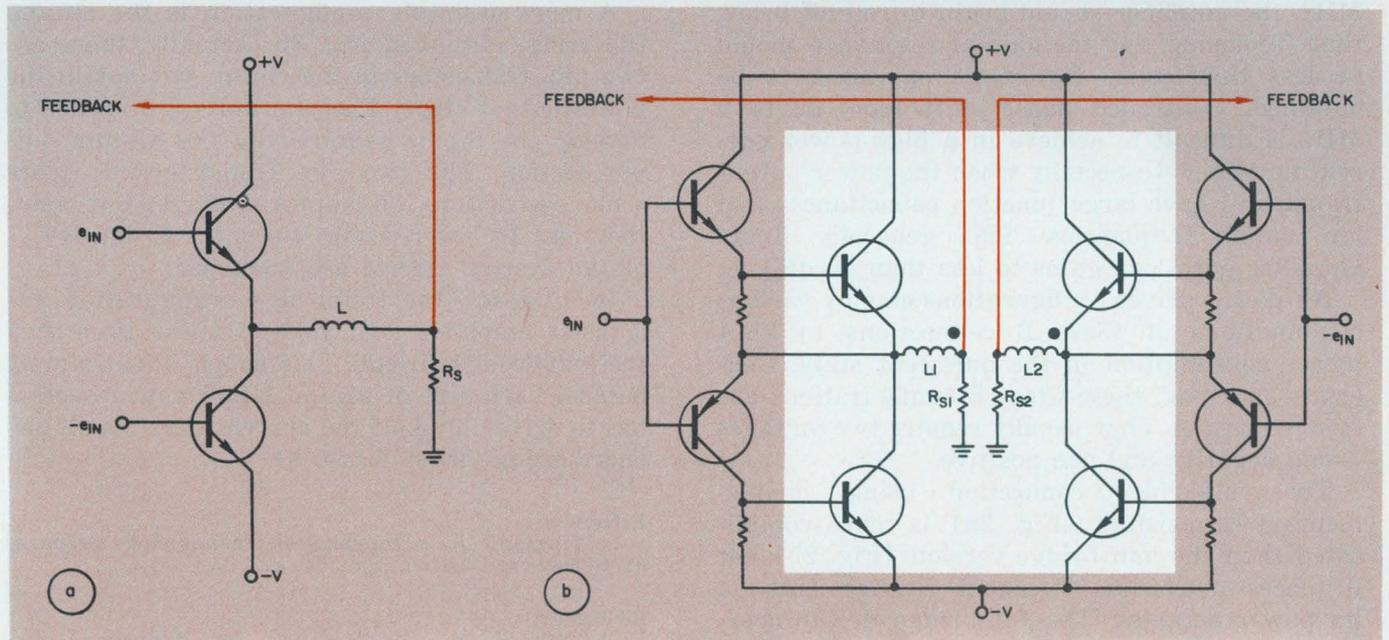
1. Sensing resistor R_S feeds back a signal voltage proportional to the yoke current (a). The feedback scheme

changes the I -vs- t curve (b) from a slowly rising exponential (in color) into an essentially linear curve.



2. Much less stringent requirements are placed on the power supply by the full-bridge circuit (a) than by the

half-bridge circuit (b). Both circuits suffer from the limitations of the pnp transistors they employ.



3. These all-npn driver circuits avoid the drawbacks of the complementary transistor circuits of Fig. 2. The half-bridge configuration (a) is not recommended. The full-

bridge circuit (b) is preferred; it does contain two pnp transistors, but they have been kept out of the critical power-output section (highlighted in white).

sensing resistor, R_s , placed in series with the yoke, will produce a feedback voltage proportional to the yoke current (Fig. 1a). The feedback scheme linearizes the I-vs-t curve until the current approaches its final value (Fig. 1b). At that point, the feedback error signal gets small and the curve becomes nonlinear again.

The time required for the current to reach its steady-state value is difficult to predict mathematically. For large input voltage steps, however, an approximation can be used: The total response time is about 25% greater than would be predicted by extrapolating the linear portion of the curve to the final current value. (Note: for large input voltage steps, the total response time is defined as the time needed for the spot to have settled to less than 1% of a screen diameter from its final position.)

For small input signals (requiring 0.1% settling accuracy) the total response time is much more dependent upon the duration of the nonlinear portion of the response (settling time). Because of the uncertainty of the phase response of the closed loop, an exact analysis is extremely difficult. A 0.25-ohm sensing resistor, for example, will cause a 45-degree phase shift at 100 kHz if its leads have only 4 μ H of parasitic inductance. A 12-inch length of No. 16 wire will exhibit 4 μ H of inductance. Thus the feedback lead from the sensing resistor to the amplifier input is extremely critical.

Typical small-signal settling times are 4 to 6 μ s for a 17- μ H choke.

Improving the power drive

Because yoke resonances are typically 3 to 5 MHz, the amplifier should begin to roll off below that frequency, and the gain at resonance should be less than unity for stable operation to be obtained. Controlled phase shift from dc to 5 MHz is difficult to achieve in a high-power current amplifier—especially when the power output transistors have large junction capacitances and low cutoff frequencies. This generally limits amplifier open-loop gains to less than 50 dB.¹

All-power driver configurations employ various combinations of Class B connections to limit power consumption in the quiescent state. Generally speaking, these Class B configurations are bridge designs. They usually require two voltages—one negative and one positive.

The full-bridge connection using complementary transistors (Fig. 2a) is more complicated than the half-bridge version (Fig. 2b) but it places much less stringent requirements on its power supplies. The full-bridge driver operates in push-pull to drive the two halves of the yoke. (Each of the inductors L_1 and L_2 is half of a single axis winding on a push-pull yoke.)

To maximize the voltage excursions across the yoke, transistors Q_1 and Q_4 are ON while Q_2 and Q_3 are off, and vice versa. This places +V across half of the winding and -V across the other half. The result is an axis winding consisting of L_1 and L_2 in series, with a voltage of 2V across it.

The coefficient of coupling in a good yoke design approaches unity. The inductance of the combined windings is then very close to 4L where L is a half-axis inductance. This inductance value (4L) should be used in the response-time calculations discussed earlier.

Because the push-pull configuration puts a continuous load on both power supplies, it makes regulating them fairly easy. By contrast, the single-ended driver (Fig. 2b) has either Q_1 or Q_2 conducting while the other transistor is off. Thus the power supplies for the half-bridge circuit must maintain their voltage regulation even in the face of sudden load changes from zero to full load. (Full load may be as high as 14 A for a large tube with a wide deflection angle.)

Both of the preceding circuits can be made to handle higher voltages and higher frequencies if their pnp transistors are replaced with npn units. Currently available pnp transistors are inferior to corresponding npn types in both breakdown voltage (BV_{CEO}) and cutoff frequency (f_T). For example, the pnp transistor sets a maximum limit of -50 V for -V. The npn transistor, on the other hand, can handle a +V of +125 V.

Getting rid of the pnp transistors is simple. The half-bridge circuit of Fig. 3a shows how it's done for the single-ended driver. Since the circuit suffers from all of the supply-voltage shortcomings of the complementary half-bridge circuits, it is not recommended.

A more desirable configuration is the all-npn full-bridge circuit of Fig. 3b. Actually, there are two pnp transistors in the circuit but not in the power-output stage. The pnp units are needed to develop the inputs required by the all-npn output section. The two pnp transistors do place some restrictions on supply voltage, but since they may be lower-power types, the f_T and BV_{CEO} of the over-all circuit are increased.

In all cases, the full-bridge configuration has a faster amplifier (not yoke) settling time than the half-bridge circuit. This comes about simply because each side of the push-pull power section has to drive only half the current that the single-ended bridge must drive. ■■

Reference:

1. Wileman, R., Unpublished manuscript prepared at Stromberg-Carlson, San Diego, Calif.

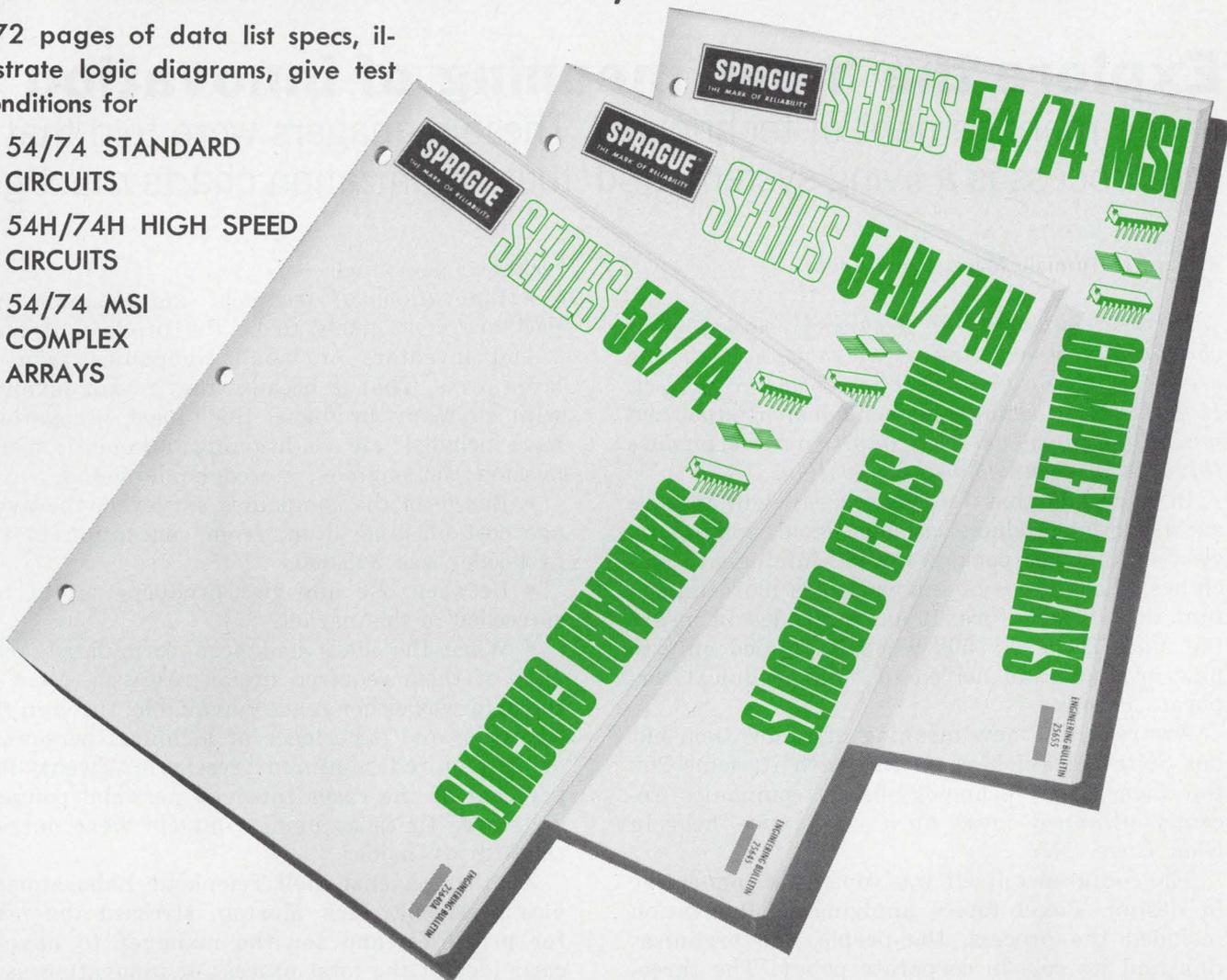
Bibliography:

Hildebrant, A. M., "Go Push-pull for Magnetic Deflection," *Electronic Design*, ED 2, Jan. 18, 1970, pp. 70-74.
Papodi, A. E., and Williams, R. M., "Use Magnetic Deflection to Iron out Problems in Display Systems," *Electronic Design*, ED 6, March 15, 1966, pp. 210-215.

FREE ALL YOU NEED TO KNOW ABOUT SERIES 54/74 TTL CIRCUITS.

272 pages of data list specs, illustrate logic diagrams, give test conditions for

- 54/74 STANDARD CIRCUITS
- 54H/74H HIGH SPEED CIRCUITS
- 54/74 MSI COMPLEX ARRAYS



WANT THEM RIGHT AWAY? FILL OUT AND MAIL THE COUPON TODAY.

YES! Send me the 54/74 handbooks I've checked.

Standard Circuits—88 page handbook EB25640A.

High Speed Circuits—88 page handbook EB25645.

MSI Complex Arrays—96 page handbook EB25655.

Name _____

Title _____

Company _____

Address _____

City _____

State _____ Zip _____

MAIL TO:
TECHNICAL LITERATURE SERVICE
SPRAGUE ELECTRIC COMPANY
347 MARSHALL STREET
NORTH ADAMS, MASS. 01247



Circle Reader Service Number 882 for 54/74 Standard Circuit Handbook

Circle Reader Service Number 883 for 54H/74H High Speed Circuit Handbook

Circle Reader Service Number 884 for MSI Complex Array Handbook.

Explore the 'now' meaning of innovation

in the management of technology. These managers were told that the process is a living system, and that organization charts must go!

Richard L. Turmail, Management Editor

Because methods of technical management change almost as often as technology itself, we are presenting a three-part series on the subject. It has covered changes in management style and managing the generation gap. Now we explore the area of technological innovation.

In a decade that forecasters say will feature such exotic products as household computers, electronic power packages, and "intelligent" machines, the process of innovation is more important than ever before. It has expanded in meaning since the early 50s when it applied only to new products and helped to build technical corporate empires.

Aware of the new meaning of innovation, but not quite certain how to deal with it, some 200 top men from technology-based companies recently swapped ideas at a conference held in Glen Cove, N.Y.

The conference itself was somewhat innovative in design. Panel topics applying to innovation included the process, the people, the organization and its role in corporate policy. The three-day workshop, sponsored by Technology Communication, Inc., was specifically fashioned to feed as much data as possible to those who attended. A closed-circuit video system televised the panelists to meeting rooms occupied by the ten discussion groups. Group leaders used direct phone lines to pose group questions to the panelists. Later, panelists circulated among the various groups to answer further questions.

Guidelines for innovation

Guidelines for the seminar were set by Donald Marquis, director of the Project on Research and Technology, Sloan School of Management, MIT. He defined innovation as "the carrying on of an idea from its inception to the first sale." To establish a background for his subject, Marquis presented survey-based data that included the following observations:

- Only 5% to 10% of the staff of technology-based companies, regardless of size, consists of

technical personnel.

- Innovations of technical and economic impact are more likely to be the product of individual inventors or small companies than of large firms. That is because they're not involved with so many products. Such past innovations have included: air conditioning; automatic transmission; jet engines; stereophonic sound.

- Based on the companies surveyed, the average cost of innovation, from conception to the first sale, was \$45,000.

- Between one and two products out of ten succeeded in the market.

- When the ideas had been formulated, only 10% of them required major research. Most of the data was either readily available, through the education and experience of technical personnel, or it required minimum research. Twenty-five per cent of the cases involved personal contact, and three times as many contacts were outside the firm as inside.

Another panelist, Bell Telephone Laboratories' vice president, Jack Morton, stressed the need for priorities, and for the manager to have a clear idea of the total process of innovation as it applies to research, production and marketing.

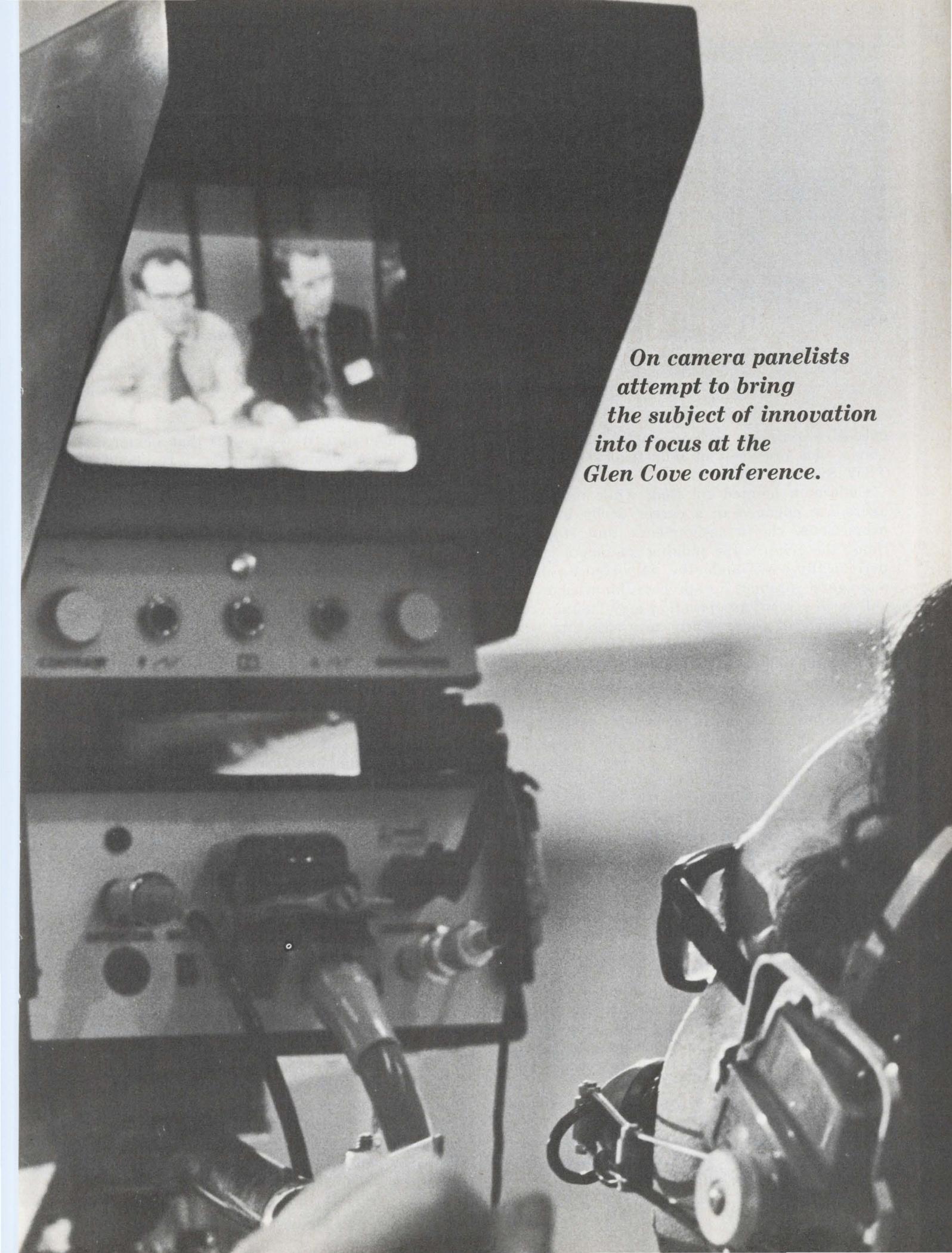
"The tough task," Morton emphasized, "is to get the various specialists to work toward a set of priorities to accomplish a given task. People do not organize themselves automatically into such complex structures. They do not couple and divide the way biological cells do. The manager must organize them."

He said that it is the manager's responsibility to see what specifications are needed, to increase them when required, and to make sure that, as the specializations take place, the parts are better connected.

"Today," Morton said, "we're dealing with a living management system—not a machine system. Organizational charts have to go!"

People are part of innovation

The subject of people as a resource for innovation was discussed at one of the seminar sessions by management consultant Saul Gellerman,



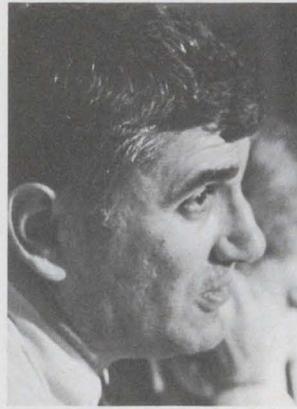
*On camera panelists
attempt to bring
the subject of innovation
into focus at the
Glen Cove conference.*



Hogan



Morton (on camera)



Davis



North

executive recruiter David North, and Sheldon Davis, vice president of industrial relations for TRW Systems, Inc.

Gellerman pointed out that, while most managers are engaged in a career derby involving promotions, choice assignments, and stock options, the criteria for judging managers change periodically. Although the importance of the managers' product or process knowledge and ability to control an operation may fluctuate, the importance of their ability to assess and teach people usually remains constant.

What do today's executives want? They want more authority to act independently at a younger age than ever before.

Concerning technical company employment practices it has been David North's experience that these companies have not been recruiting innovatively. Of every five jobs open in companies seeking recruits, North has discovered that one can be filled within the company; two are either luxuries or obsolete and can be merged with other positions; and two are downright undesirable.

Rounding out the panel on people, Sheldon Davis reported that until recently there had been no technology to implement his company's motivational policies. Now, he said, they are using an emerging technique called "organization development" or "team-building," which in many quarters is referred to as sensitivity training. They call in a consultant to interview members of a project management team about the project, the manager, their co-workers and other related subjects.

"We have found," Davis said, "that the people want to talk to rid themselves of frustrations and job hang-ups. The technique works because when people want to talk, what they have to say is important not only to themselves

but to the project. We've noticed that a change of only 5% in a person's attitude as a result of the interviews can make a positive difference in relationships."

It's a game of chance

The panel reporting on technological innovation as a factor in corporate policy included President C. Lester Hogan of Fairchild Camera and Instrument Corp. His own particular expertise in innovation helped to reverse the company's losses of \$4,325,000 in 1968 to a profit of \$985,000 in 1969. Hogan said recently that the FC&I turnaround was due mostly to management realignment.

Hogan spoke of innovation in the electronics industry in gambling terms. "The rewards that the semiconductor industry offer those who manage it vary with time," Hogan said. "One of our biggest problems is the proper selection of choices open to us in research, in marketing and in production."

He cited the example of Texas Instruments, an electronics company that selected a couple of right cards from its deck to play in the game of transistors back in the 50s. Because it made the right selection from a myriad of choices, TI dominated the transistor industry as no other company has before or since.

But Hogan said the technology is so diffused now that if you call the wrong signals you can reverse your field, run, and catch up."

The planar process (1960) has been the only subsequent fundamental breakthrough. "Fairchild built its entire position on that leap," Hogan said. "Since then," he continued, "we've gone a step at a time. The steps were obvious in 1955. Now we have so many choices open to us that there is no company I know of that has



Marquis (on camera)



Frey



Peterson



Gellerman

either the people or the financial resources to cover all possible bets. So we have returned to very careful selection.

"There is no right choice," Hogan continued. "There's more than one. There must be, however, one set of cards you can play, considering the people and resources you have, that is better than any other set of cards."

As to why the process of innovation is non-existent or second-rate in many companies, Peter Peterson, president of Bell and Howell Corp., pointed out one reason: many in top management have limited talent in technology, and they become a bit overwhelmed or frightened by high technology input and tend to abdicate and withdraw. Top management has to play a decisive role and not delegate authority to any other function of the business.

Another reason for skimpy innovation, Peterson said, is a shortage of talent.

The probability of finding the ingredients of marketing and technological conceptualism in the same man are pretty low, and yet, he said, "we behave as if we have plenty of such people."

According to Peterson, Bell and Howell brought together the marketing conceptualists with the technological conceptualists and came up with a slide projector that previews what slide is coming up—in case the customer wants to skip a few of lesser quality when showing his Florida vacation.

What are the chances of talent-poor companies recruiting top young talent?

One answer to that question came from the third panel member, Donald Frey, president of General Cable Co. He said he had conducted a survey among college students asking them what they think are the ten most innovative and the ten least innovative of 500 major U.S. companies. He asked the students if they would work

for any of the ten least innovative companies, assuming they would be given a \$5000 raise.

"By and large," Frey said, "they wouldn't even take an interview with the companies they considered to be noninnovative."

Round-robin questioning

Questions phoned in to this panel by discussion group leaders included the following:

1. How do you spot innovative people?

Peterson: By watching how they react to a given problem. Among ten in a room, the innovative person is the one who works until he comes up with an answer to the problem while the others are still talking about the innovative process. Innovators are where the action is.

2. How do you build company image?

Hogan: It's almost more important to have an innovative image inside your company than outside, so that your creative employees will know there's a chance to air their ideas. It's important to talk about innovative ideas rather than expense accounts when you talk to one of your people. Encourage him. Let him know he has your backing.

3. How do you go about innovation?

Peterson: The way to innovate is to do it instead of talk about it. Avon changed the marketing face of the cosmetic industry by selling door to door to a segment of the market that wanted convenient shopping.

Perhaps the most realistic and possibly prophetic comment about innovation was made by TRW's Sheldon Davis, who said:

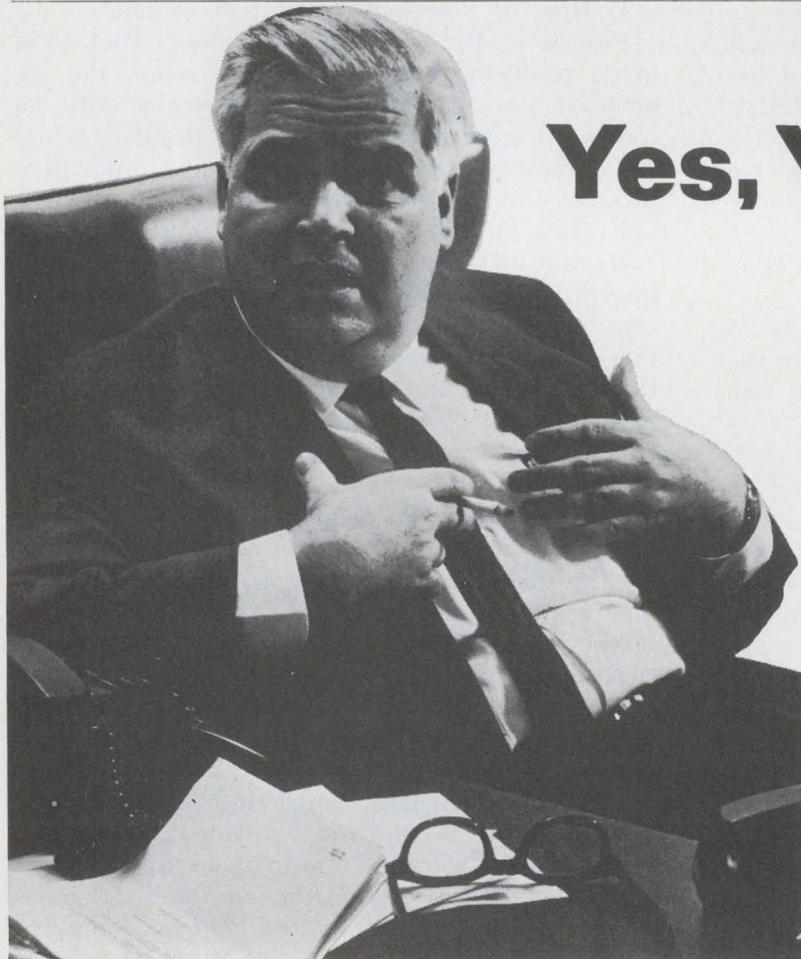
"The trouble with improving innovation is that everyone is 'waiting for Godot.' Each one is waiting for someone else to speak up and start doing something. It's incumbent on each manager to do his own talking and his own doing." ■■

BRAND POLYESTER FILM
Scotchpar[®]

WE WANT OUR NAME
ON THE TIP
OF YOUR TONGUE!



INFORMATION RETRIEVAL NUMBER 55



Yes, YOU...

you can reduce your risk of heart attack by following these simple rules, with the advice of your physician:

- Eat foods low in saturated fat and cholesterol
- Stop smoking cigarettes
- Reduce if overweight
- Exercise regularly, moderately
- Control high blood pressure
- See your doctor periodically

Here's another good rule for reducing your risk—Support your Heart Association's program of research, education, and community service.

GIVE...
so more will live
HEART FUND



Contributed by the publisher

Great Milestones in Packaging

43RD IN A "PEOPLE PACKAGING"
SERIES DRYLY APPROVED BY
JONATHAN MANUFACTURING COMPANY



Long, long ago, in the early awakenings amongst the Isles, a happy accident happened.

A grape, then a series of grapes were squashed in such a peculiar way that, fermentation being what it is, someone sensed

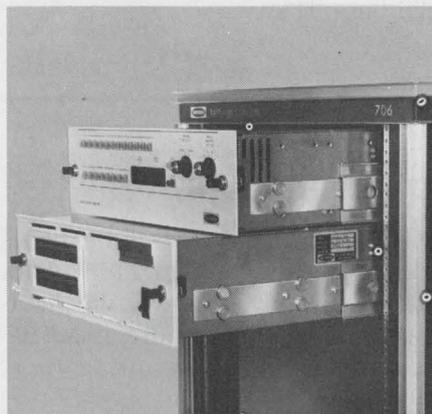
putting the results in a container would prove of high interest. Thus does history begin.

Bacchus, who established the first really popular excursion trips with his Dionysian Tours to Egypt, India, etc., forthwith then set another record as the world's original wine bottler.

His own person found this endlessly pleasurable and grew to accommodate more of the same. In fact, the Bacchus chassis soon became unstable, unable, even fixed. Or, if you like, utterly stoned, thus making necessary an evolutionary step in package movement so admirably exemplified today by products made for modern markets by the well known firm of Jonathan.

One of the results of Jonathan's great humanitarian interests is movement by the

Jonathan Type 110 Ultra Thin Steel Series Precision Full Ball-bearing Slide. In fact, they decided that the bulky balking that was Bacchus' bag is still a problem for electronic chassis slides. Modern packaging concepts demand high capacity, compact design and ruggedness. And solutions for quick disconnect and tilt problems still must be solved. The people at Jonathan have the perfect solution—the Type 110.



The Type 110 is a full ball-bearing steel slide with a heavy duty pivoting mechanism that will easily handle any rated load requirement. It is readily available and inexpensive.

Jonathan's Type 110 is so improved that its smooth action would make the Saturnalia Santa smile with delight.

Others, too, such as Raytheon, who utilize this versatile slide in its 706 Computer, (see photo) an expandable, low-cost processor with large computer capability and compatibility. This newest addition to the Raytheon computer family uses a packaging concept designed for reliability and maintenance ease. Sm-o-o-o-th Jonathan Slides help make it possible. What's your requirement? Detail us your needs, today!



JONATHAN MANUFACTURING COMPANY N.J.
1101 S. ACACIA AVE., FULLERTON, CALIF. 92631 • 1258 TEANECK RD., TEANECK, N.J. 07666 NATIONAL LEAD

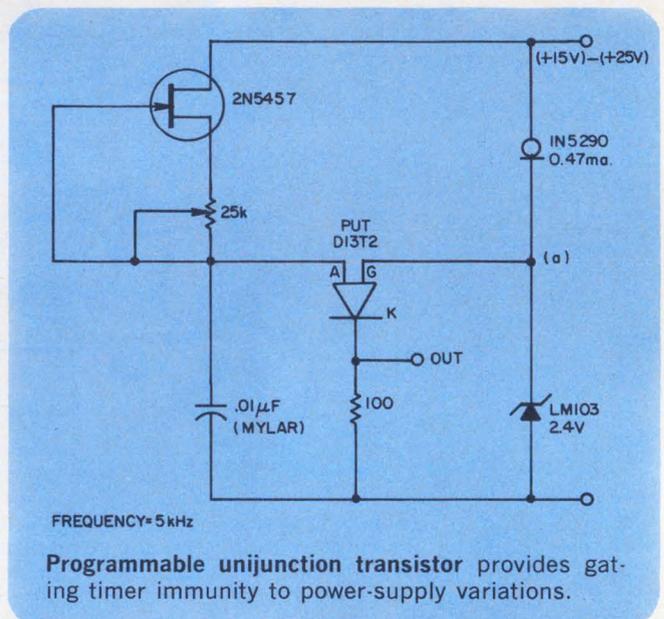
INFORMATION RETRIEVAL NUMBER 56

Programmable design gives gating timer line immunity

Many times in the design of digital systems, a stable and accurate timer is needed for gating functions or counter applications. Often the power supply used has a high ripple content along with poor dc line regulation; therefore, the timer should be immune to output voltage changes from the regulator.

The particular application described here requires a reliable timer for gating information from storage buffers. A D13T2 programmable unijunction transistor (PUT) is used. Along with the PUT, a constant-current diode, feeding an LM103 low-voltage reference diode, and a low goss FET for linearly charging the timing capacitor are selected.

The current diode and LM103 provide the necessary voltage division needed for the PUT. This combination gives the required immunity against line voltage changes. A 20-V line change, for example, will result in less than a 1-mV variation at point (a) of the voltage divider. The FET current source has an output conductance of 10 μ mhos (typical). This corresponds to a current stability of 10 μ A per volt. For this particular circuit, a 20-V line change produced less than



0.001% deviation in the nominal 5 kHz output frequency.

Carl Brogado, Engineering Technician, TEC/Technetics Inc., Boulder, Colo.

VOTE FOR 311

New starting circuit requires little power

Are you looking for a series-regulator starting circuit that does not degrade regulation, has inexpensive parts and draws very little power? You may find your answer here.

Part of a typical series regulator is shown in Fig. 1 with the required starting resistor R_s . Current flows through this resistor into node A, starting and sustaining series regulator operation. The disadvantages are that this arrange-

ment degrades regulation. Since any change in the input voltage is reflected as a change of current into node A. Also, the value of R_s becomes quite small if V_{in} is only 1 or 2 volts above V_{out} , resulting in a large power waste when V_{in} increases.

The starting resistor may be replaced with a constant current source as shown in Fig. 2. This type of circuit requires several volts from the

There isn't another like it. A 1/4-inch, single-pole, six position, 28-vdc. Helipot switch for PC boards.

Beckman® INSTRUMENTS, INC.

HELIPOT DIVISION

Fullerton, California 92634

INTERNATIONAL SUBSIDIARIES: AMSTERDAM; CAPE TOWN;
GENEVA; GLENROTHES, SCOTLAND; LONDON; MEXICO CITY;
MUNICH; PARIS; STOCKHOLM; TOKYO; VIENNA



Model 374H \$3.00 (1-9 pieces)

Model 374 \$2.75 (1-9 pieces)

positive line to node A for proper operation, so V_{in} must always be about 4.5 V greater than V_{out} or the regulator will cease operation.

A new type of starting circuit is shown in Fig. 3. The voltage divider R_1 and R_2 drives current into node B to start the regulator. As soon as the regulator starts, the voltage at node B rises above the voltage at node C, causing D_1 to be back-biased. Q_1 has been changed from an npn transistor to a pnp transistor so that the current now flows out of the base. Consequently, no external current is required to sustain operation of the regulator. This regulator will continue operation even with $V_{in} = V_{out} + 1.5$ V.

The criteria for choosing R_1 and R_2 are as follows:

- Starting: The divider must be capable of supplying a minimum I_s , where

$$I_s = I_{L\max} / [(H_{fe\ Q1})(H_{fe\ Q2})(H_{fe\ Q3})]$$

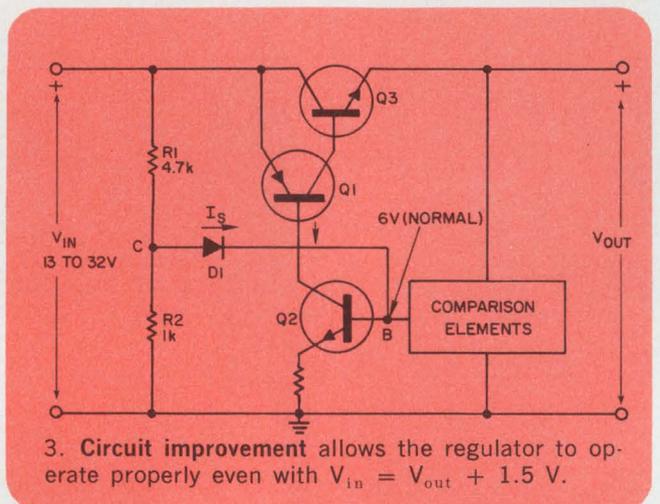
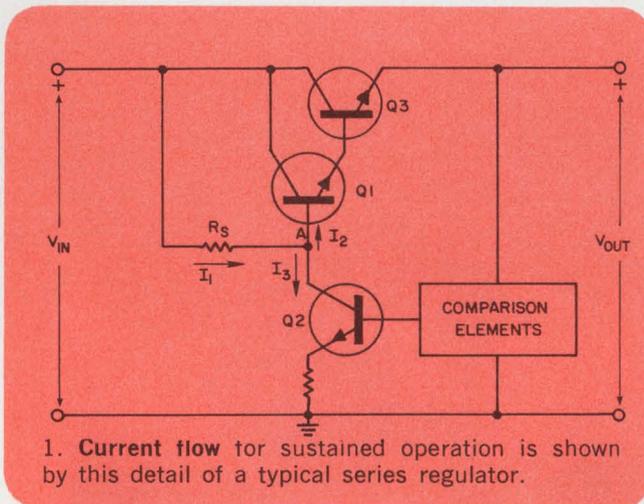
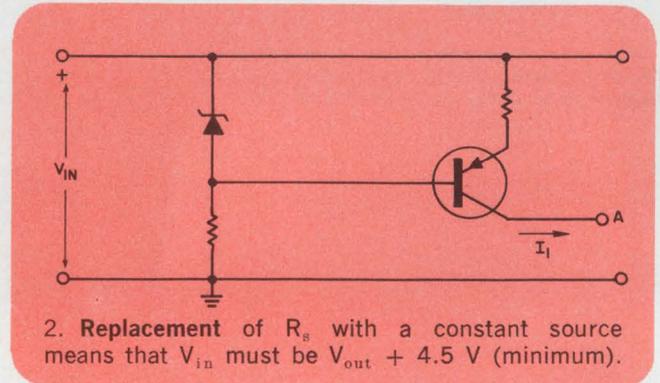
when the input voltage is at a minimum and the voltage at C is 1.5 V.

- D_1 kept back-biased: The divider voltage at

C must never rise above the normal voltage at B with maximum V_{in} .

Q_2 must have a collector-to-emitter breakdown greater than the maximum V_{in} for proper operation.

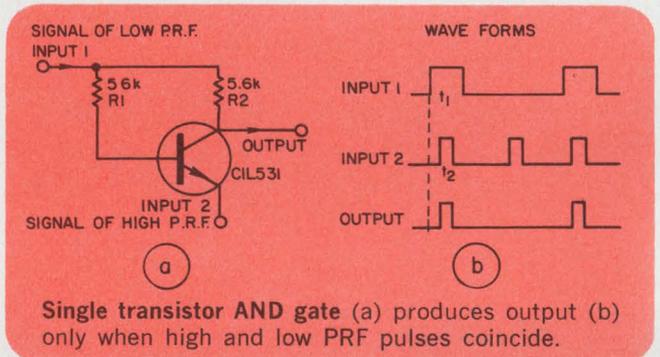
Bernard Doden, Design Engineer, The Magnavox Co., Fort Wayne, Ind. VOTE FOR 312



Single transistor AND gate needs no power supply

Digital systems often require that a high pulse repetition frequency (PRF) signal should appear simultaneously with a low PRF signal. This need is most often satisfied by the use of an AND gate. However, the circuit shown here, needing no power supply and having few components, can serve the same purpose.

The low PRF signal is applied to both the base and the collector terminals of a transistor through resistors R_1 and R_2 , respectively. The high PRF signal is applied at the emitter terminal. When the signal at the base and collector is



ADVANCED TESTING

1...2...3...

THE WORLD'S *MOST ADVANCED*
ALL-SOLID-STATE VOM

"601"

It's the first of its kind. Triplet's creative engineering has gone and done it. It has designed and engineered an entirely new concept in All-Solid-State VOM's for fast in-circuit testing of electronic and electrical applications. It has built the new portable Model 601 with Field Effect Transistorized circuitry, push-button and battery operation and with 11 Megohm Input Resistance on all AC-DC voltage ranges. It's ideal for testing IC's, making audio measurements, and usable with Frequencies to 50 KHz.

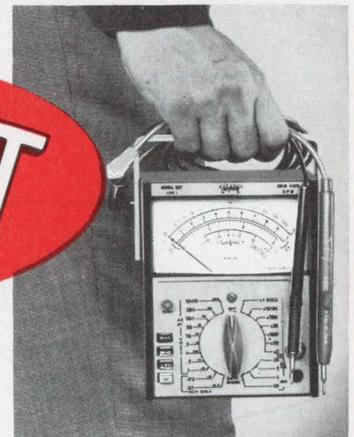
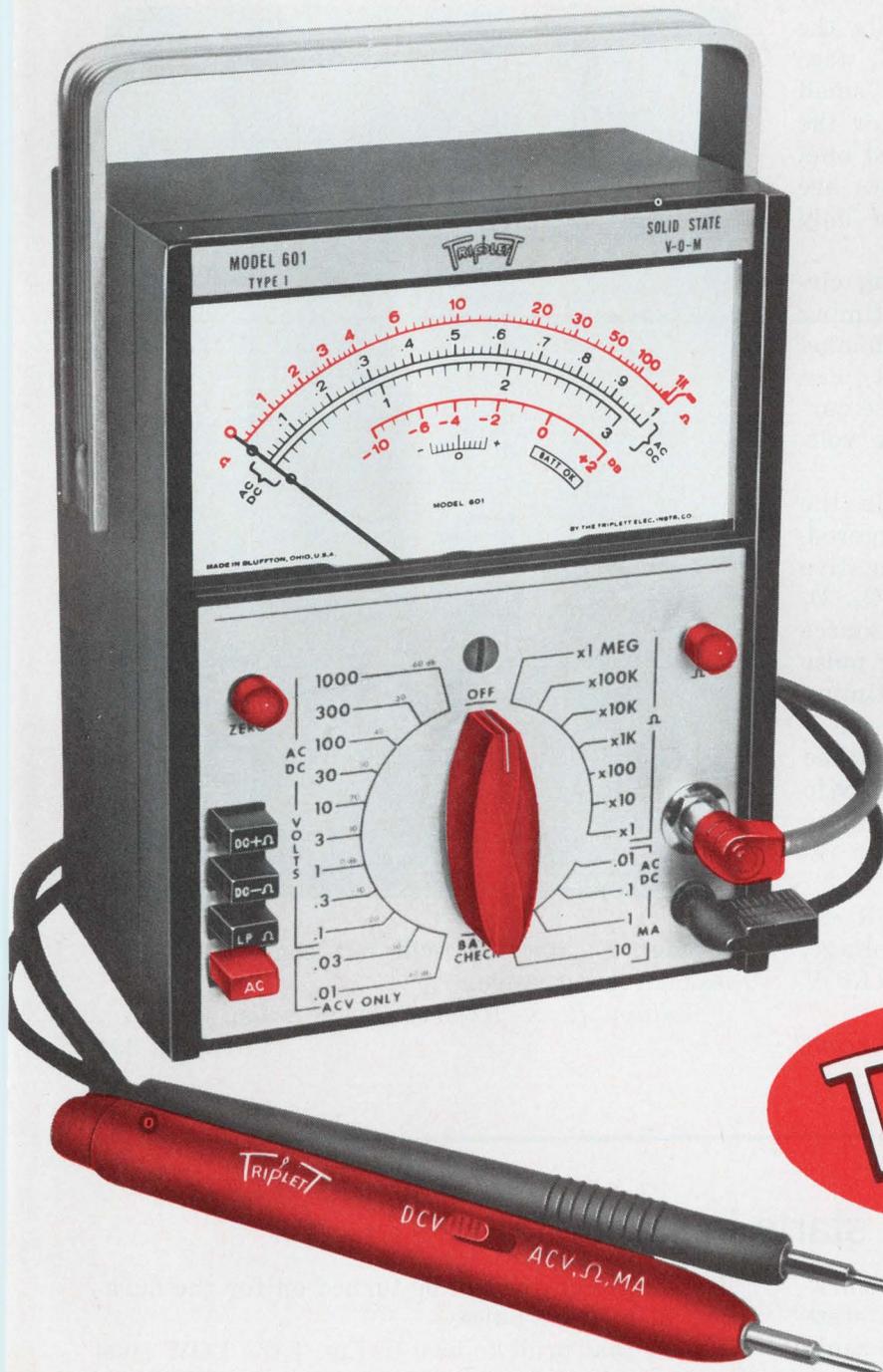
- ① 14 Ohmmeter ranges with 7 Low-Power ranges at 75 mV DC for transistorized and Integrated Circuits.
- ② Voltage ranges from 10 mV AC and 100 mV DC full scale; plus AC and DC Current ranges from 10 uA full scale.
- ③ Modern, easy-to-use push-button selection of DC Polarity, AC and Low-Power Ohms functions.

See this new, All-Solid-State (F-E-T) VOM at your local Triplet distributor and you'll be Testing 1 . . . 2 . . . 3

Model 601 (F-E-T) VOM

\$158

Suggested U. S. A. User Net



THE TRIPLET ELECTRICAL INSTRUMENT COMPANY

BLUFFTON, OHIO 45817

INFORMATION RETRIEVAL NUMBER 58

at the ONE level, the emitter signal will appear (with about 100-mV offset) at the circuit output. The transistor will be in saturation. In other words, the high PRF emitter signal appears at the circuit output in the presence of a low PRF signal at the base and the collector.

The component values shown have been used successfully.

D. Visweswara Raju, Electronics Engineer, Space Science & Technology Centre, Trivandrum-1, India

VOTE FOR 313

Modified one-shot provides long delay time

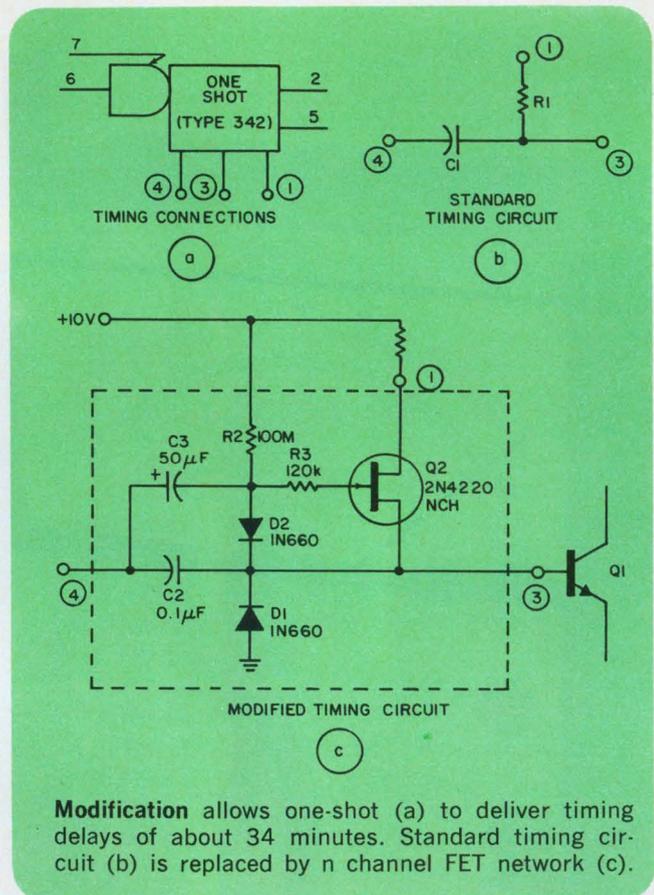
The limiting factor in obtaining a long delay time with conventional one-shots is usually the base current into the ON transistor, Q_1 , (see figure). The timing resistor must be small enough to allow sufficient base current for the transistor to be saturated. In this modified one-shot (Amelco 342), 30 to 40-minute delays are obtained. Maximum delay time is limited only by the timing capacitor leakage current.

Essential features of the external timing circuit shown are that the conventional timing resistor, R_1 , has been replaced by an n channel FET, and that the new timing resistor, R_2 , can be made large since it no longer passes base current but determines the FET gate source voltage.

The modified timing circuit operates in the following manner. When one-shot is triggered, the voltage at pin 4 goes negative. This negative pulse is coupled through C_2 and cuts off Q_1 . D_1 clamps the voltage at the base of Q_1 and source of Q_2 to about -0.5 V. The negative-going pulse is also applied to the gate of Q_2 through timing capacitor C_3 . Since the source of Q_2 is at -0.5 V and the gate pulse is about 9 V, Q_2 is pinched off and remains so until C_3 charges sufficiently to bring it on. When this occurs, C_2 will begin to charge until Q_1 turns on and the one-shot reverts to its stable state.

The purpose of D_2 is to keep the $C_3/R_2/Q_2$ gate junction from rising to the supply voltage, and it holds this point at approximately $+1.0$ V in the stable state.

The delay time is limited by leakage current



Modification allows one-shot (a) to deliver timing delays of about 34 minutes. Standard timing circuit (b) is replaced by n channel FET network (c).

through C , since Q_2 will not come on if this leakage is excessive.

William R. S. Hepler, Great Falls, Va.

VOTE FOR 314

Astable multivibrator always starts in same state

The main features of this astable multivibrator are that it always starts in the same state and its first transition always occurs at the same time after the leading edge of the turn-on pulse.

The multivibrator can be turned on for the duration of a single pulse.

Note that prior to $t=0$ in Fig. 1 the LOW level at V_1 will produce a HIGH level at V_{1a} and a



40 times faster than drum!
A modular semiconductor memory
for mini-computers, I/O storage,
general buffering applications,
low cost main memory extension,
general purpose data storage
...priced at drum memory costs

Applies to virtually any system. Word length, transfer rate, logic levels, capacity—one of our SSU/m's will fit your exact need.

Interfacing is no problem. SSU/m's have only 4 control lines plus address and data lines. SSU/m's won't overrun. With 130 microsecond access time they'll handle I/O requests ten times faster than drum and double the number of terminal transactions.

SSU/m's are a modular design, made from only five

card types. No warm-up, no moving parts, and 100% usable storage space with no record gaps.

SSU/m is a high speed auxiliary storage module that can be relay rack mounted and provide low cost storage in a small size. It's like giving your mini-computer an extra set of brains.

Send for the facts. Now. The AMS Solid State Memory can give you a competitive edge. Now.

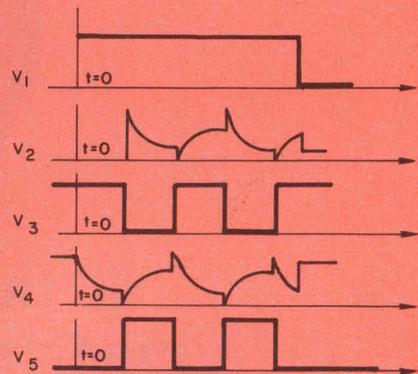
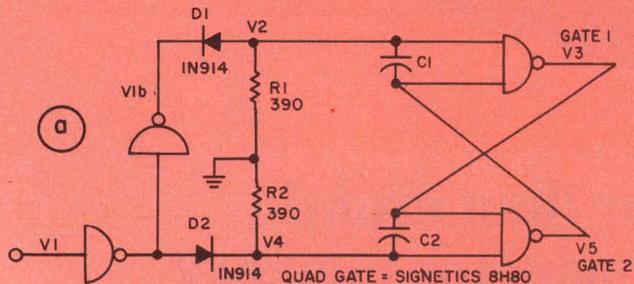
Performance Specifications, SSU/m			
Access Time (μ sec)	Min.	Av.	Max.
Random	1	131	525
Sequential	1	1	4
Capacity	Readout	Data Rate	
(No. of Bits)	(Bits)	(Megabits/sec.)	
2,097,152	64	64	
1,048,576	32	32	
524,288	16	16	
262,144	8	8	
Interface (TTL Compatible)			
Address, Data, Control (Read, Write, Data Ready, Busy)			
Size (19" Rack Mount)	Readout	Depth	Height*
	64	9"	31½"
	32	9"	17½"
	16	9"	12½"
	8	9"	12½"

* Height includes power supply.

ADVANCED MEMORY SYSTEMS, INC., 1276 HAMMERWOOD AVENUE
SUNNYVALE, CALIFORNIA 94086 • TELEPHONE (408) 734-4330



INFORMATION RETRIEVAL NUMBER 59



1. The oscillation characteristics of this astable multivibrator are fully predictable.

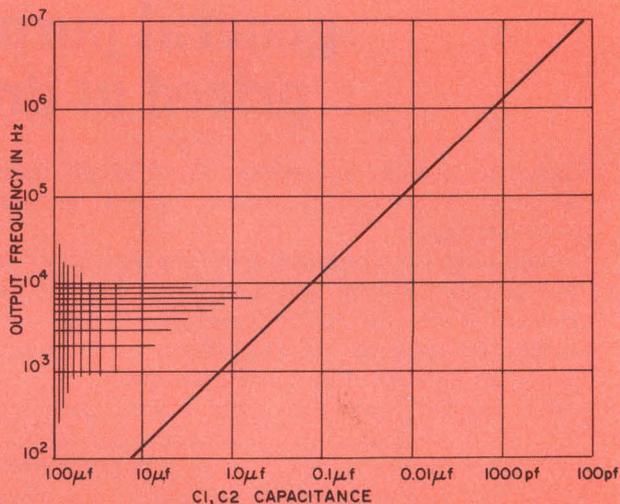
LOW level at V_{1b} . These levels will clamp V_2 and V_4 , respectively, negative (LOW) and positive (HIGH). The LOW level at V_2 will cause V_3 to be HIGH. Because of the NAND gate function, this HIGH level combined with the clamped HIGH level at V_4 will cause V_5 to be LOW. Note that under these conditions, no charge is stored in either C_1 or C_2 .

A positive pulse or level at V_1 will turn the multivibrator on. When V_1 is driven positive, points V_{1a} and V_{1b} change states. This cuts off diodes D_1 and D_2 , thereby removing the clamping voltages from the inputs of the gates (V_2 and V_4). C_2 now begins to charge through R_2 , causing the potential at V_4 to decrease exponentially toward ground.

As soon as the V_4 potential has decreased to the switching level of gate 2, the gate 2 output (V_5) goes positive. This causes both inputs of gate 1 to become instantly positive. As a result, V_3 goes LOW. C_1 now charges through R_1 , causing the positive voltage at V_2 to decrease exponentially toward ground. As soon as voltage V_2 reaches the switching level of gate 1, the output of this gate (V_3) goes positive, thereby repeating the cycle.

The value of R_1 and R_2 is set at 390 ohms to ensure that capacitors C_1 and C_2 can charge to a potential below the 0.8-V worst-case switching level for the gate used. The Signetics 8H80 quad-gate was selected for this circuit because of its fast rise and fall times and its low output impedance.

The circuit has been tested with various values for C_1 and C_2 , and the resulting frequency vs capacitance curve is shown in Fig. 2. The maximum



2. Linear relationship exists between capacitance and frequency for a wide range of capacitor values.

operating frequency was 10 MHz. An attempt to determine the minimum frequency was made, but the multivibrator continued to operate properly even at 0.5 Hz. This indicates that the frequency of oscillation may be lowered below 0.5 Hz by using capacitors larger than 1000 μF . It should be noted that the fixed 390-ohm resistors can be replaced with a dual potentiometer to provide some frequency adjustment.

George S. Krause, Assistant Project Engineer, Bendix, Communications Div., Baltimore, Md.

VOTE FOR 315

FAREWELL

One more time:

Fairchild built a reputation on new products, new technology and new applications. Last month we ran the editorial below. It announced another new step for Fairchild. A commitment to do business wherever there's business. First source. Or second. It was a major policy decision for us. So major, in fact, we're repeating the editorial this month.

EDITORIAL

If We Can't Sell You Ours, We'll Sell You Theirs.

For a long time, Fairchild built only linears designed by Fairchild engineers. We didn't think anything else was worth the effort. People said we had an NIH (Not Invented Here) complex. And, they were right.

However, it's been brought forcefully to our attention that a couple other guys in this business know what they're doing. The competition is coming out with some pretty worthwhile linears. Our customers have noticed too, because they're talking to other manufacturers about linears we don't make. They're even talking to sole sourcers!

To keep things even, we've decided to give our wandering customers something they're going to need if they start dealing with a sole source linear maker: A second source. Us. (Just in case the original supplier's factory blows up or they lose the formula or whatever it is that happens when you can't get delivery.)

Starting now, Fairchild is introducing a new line of linears. We call them IT circuits (Invented There). The first two are available today: The LM101 and the MC1495. Soon we'll add the LM101A, MC1496 and the SN7524. Of course, we've given them Fairchild part numbers. Here's a conversion chart:

μ A795	Analog Multiplier	MC1495
μ A796	Modulator	MC1496
μ A748	Operational Amplifier	LM101
μ A777	Operational Amplifier	LM101A
μ A761	Sense Amplifier	SN7524

There will be other additions to the IT line soon. So be sure you contact your local Fairchild Sales Engineer before you drop a design for lack of a reliable alternate source. Just give him the part number you want and ask him to check the IT line. Farewell NIH.

Application Digest

Fairchild Cuts Prices of Ten Popular Linears

If you'd like any of the following application literature just write: Fairchild Linear Applications, Box 880A, Mountain View, Calif. 94040. Ask for it by publication number.

Say goodbye to modules. New prices on Fairchild's most popular Linear ICs now make modules expensive as well as bulky.

Publication Number	Title
138	μ A725 Instrumentation Applications
134	The Frequency Division Multiplex Channel Amp with the μ A748
131	An Arithmetic Analog Computer using μ A735
129	Logarithmic Amplifier
125	Low-Pass Active Filter for Electronic Imaging using the μ A715
125	Applications of the μ A749 Dual Operational Amplifier
141	μ A742 (TRIGAC) AC Power Control Handbook
164	Applications of the μ A722 10-Bit Current Source
136	Low-Drift, Low-Noise Monolithic Operational Amp for Low Level Signal Processing - μ A725
133	More Voltage Regulator Applications using the μ A723
128	A High Speed Sample and Hold using the μ A715
126	The μ A749 Dual Operational Amplifier
123	A Micropower Monolithic Op Amp - μ A735
99	μ A733 Oscillators
140	μ A731 High Speed Dual Channel Sense Amplifier
130	μ A725 AGC Amplifier
127	A Trapezoidal Deflection Circuit for use with the 3250 Numeric Character Generator using the μ A715
111	A High Speed, Zero Input Current Chopper Amp - μ A715
119	A High Speed Differential Preamp for Thin Film Memories - μ A751
124	The μ A746E Color TV Chroma Demodulator IC
183	A Low-Noise Preamplifier - μ A741
175	The μ A739 - A Low-Noise Dual Operational Amplifier
122	A Monolithic Radiation-Resistant Operational Amp - μ A744
171	Applications of the μ A739 and μ A749 Dual Preamplifier Integrated Circuits in Home Entertainment Equipment

The Price Story:

DEVICE TYPE	ORDERING CODE	TEMPERATURE RANGE	OLD PRICE 100-999	NEW PRICE* 100-999
μ A715	U5F7715312	-55°C to +125°C	\$48.00	\$30.00
μ A715C	U5F7715393	0°C to +70°C	15.00	7.95
μ A722	U3M7722333	-20°C to +85°C	65.00	37.50
μ A722B	U3M7722334	0°C to +55°C	50.00	22.50
μ A725	U5B7725312	-55°C to +125°C	48.00	37.50
μ A725B	U5B7725333	-20°C to +85°C	37.50	25.00
μ A725C	U5B7725393	0°C to +70°C	-	15.00
μ A735	U5B7735312	-55°C to +125°C	48.00	37.50
μ A735B	U5B7735333	-20°C to +85°C	37.50	25.00
μ A735C	U5B7735393	0°C to +70°C	-	15.00

*Call your local Fairchild distributor or Field Sales office for even lower volume prices.

The Performance Story:

μ A715 - High Speed Op Amp
 100V/ μ S Unity Gain Slew Rate
 300nS Settling Time
 65MHz Bandwidth
 70nA Offset Current
 Reader Service Number 213

μ A722 - 10 Bit D/A Converter
 Current Source
 $\pm 8\frac{1}{2}$ Bit Accuracy
 10 Bit Resolution
 600nS Switching Speed
 Internal Precision Reference
 Reader Service Number 214

μ A725 - Instrumentation Op Amp
 0.5 μ V/ $^{\circ}$ C Voltage Drift
 128dB Voltage Gain
 120dB Common Mode Rejection
 0.6pA $\sqrt{\text{Hz}}$ Input Noise Current
 Reader Service Number 215

μ A735 - Micropower Op Amp
 100 μ W Power Consumption
 0.5nA Offset Current
 10M Ω Input Resistance
 Wide Supply Voltage Range
 Reader Service Number 216

Win \$100

We hope you're getting your entries ready for the contest we announced last month.

Just in case you missed the announcement, here's what you have to do to enter:

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!

FAIRCHILD
SEMICONDUCTOR

Introducing the World's First Monolithic J-FET Input Op Amp

Punch-through op amps are obsolete.

Fairchild's new μ A740 now offers 150pA (max.) current into either input. While some manufacturers are talking about super beta or punch-through transistors with current gains of 1000, Fairchild technology now makes possible J-FET devices with equivalent betas of over 15,000. And, they're completely compatible with standard monolithic processing.

The μ A740 is a simple two-stage design similar to the μ A741, but employs J-FET input transistors to obtain extremely low input currents.

μ A740 Electrical Performance

Input Current 150pA max.
(either input)
Unity Gain Slew Rate 6V/ μ S
Input Resistance 10^{12} Ohms
Voltage Gain 120dB
Input Offset Current 30pA

The new linear has all the convenience of the μ A741: internal frequency compensation for unity gain, input over-voltage protection to either supply, output short circuit protection to ground or either supply, and the absence of "latch-up."

Balanced offset null is easily obtained with a 10K Ω potentiometer and does not affect other parameters.

Other μ A740 features include a wide common mode range of ± 12 volts, high differential voltage range of ± 30 volts, and wide operating supply range of ± 5 V to ± 22 V.

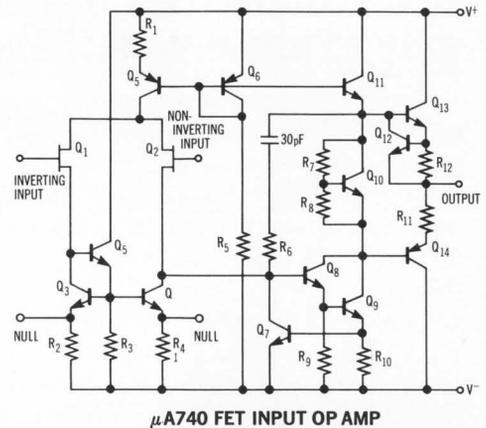
The μ A740 is directly interchangeable with the μ A741, μ A748 or μ A709.

The new Fairchild device provides circuit designers with superior performance in such

applications as active filters, voltage followers, integrators, summing amplifiers, sample and holds, transducer amplifiers and other general-purpose feedback applications.

The μ A740 is now available in TO-99 packages (both military and industrial temperature ranges) from any Fairchild Distributor.

Reader Service Number 211



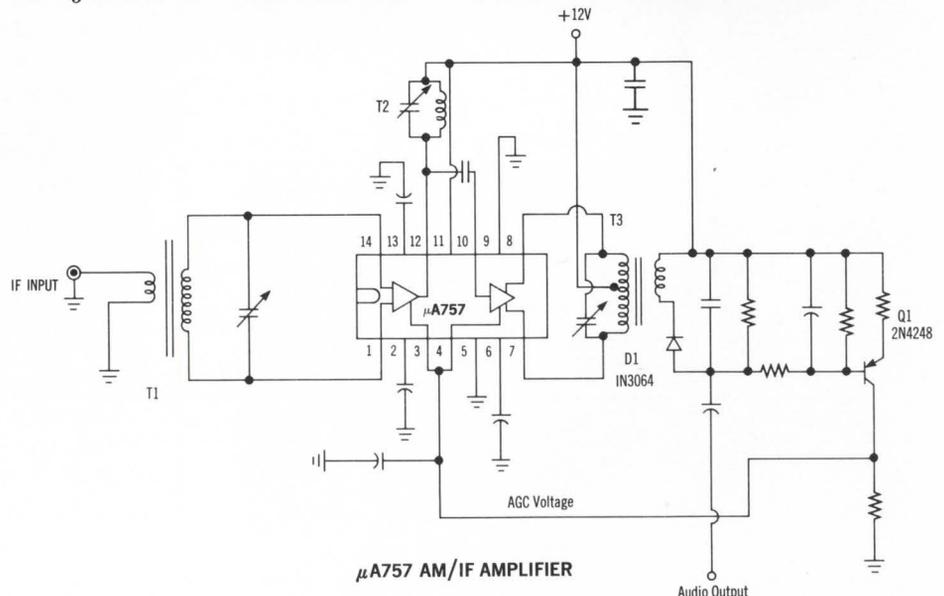
μ A757 Ideal Choice for an AGC-Able AM/IF Amplifier

Fairchild's μ A757 can be used very effectively as a high gain, wide AGC range IF amplifier. In this application, the input signal from the generator is matched to the input of the microcircuit with transformer T₁. The output of the 1st section is taken from Pin 12 across a tank circuit which acts as a load impedance. The signal is coupled through a capacitor to the input of the 2nd section, Pin 10. The output of the 2nd section is taken in a push-pull manner with transformer T₃. The secondary of T₃ drives the diode detector

from which audio is recovered. Q₁ acts as an AGC signal amplifier to provide gain for the AGC signal from the diode detector.

Voltage gain of the circuit from the input of T₁ to the input of T₃ is typically 80 dB, while the AGC range is typically 70 dB. Input signal handling capability of the microcircuit is typically 300 mV_{RMS} at the input terminals of the microcircuit at full AGC. Stable gain is obtained over a wide temperature range, regardless of AGC setting.

Reader Service Number 212



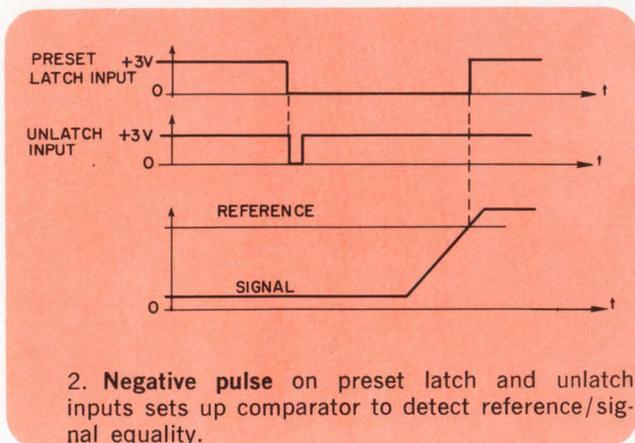
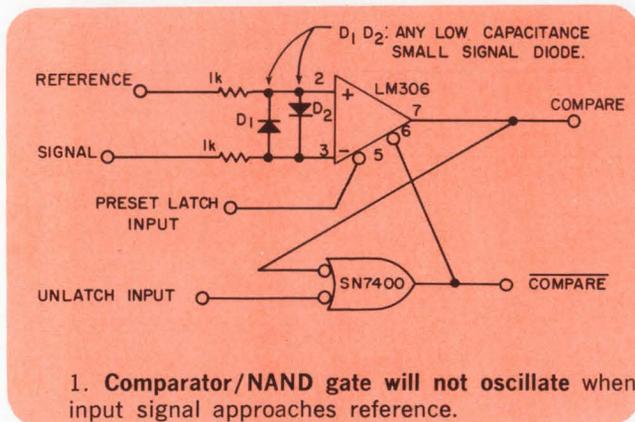
Comparator uses NAND gate to prevent oscillation

Comparators suffer from a common problem of oscillation of the output signal as the input voltage comes to equal the reference input. A method to overcome this oscillation, and to provide logical storage of the comparison, is to form a data latch using the comparator and a NAND gate.

The circuit can be placed in an initial *compared* state by a negative-going pulse on the preset latch input. At the proper time the comparator can be released to function normally by a negative going pulse on the unlatch input. When the signal voltage equals the reference voltage the *compare* output will once again go high and remain in this state until an unlatch pulse is given.

Leonard Halio, Design Engineer, Digital Equipment Corp., Maynard, Mass.

VOTE FOR 316



VOTE! Go through all Idea-for-Design entries, select the best, and circle the appropriate number on the Reader-Service-Card.

SEND US YOUR IDEAS FOR DESIGN. You may win a grand total of \$1050 (cash)! Here's how. Submit your IFD describing a new or important circuit or design technique, the clever use of a new component or test equipment, packaging tips, cost-saving ideas to our Ideas-for-Design editor. You will receive \$20 for each accepted idea, \$30 more if it is voted best-of-issue by our readers. The best-of-issue winners become eligible for the Idea Of the Year award of \$1000.

IFD Winner for December 6, 1969

Kingsley P. Roby, Test Engineer, Data-Control Systems, Inc., Danbury, Conn. His Idea "Flip-Flop Measures Frequency Difference Between Two Signals" has been voted the Most Valuable of Issue Award.

Vote for the Best Idea in this Issue.

IFD Winner for December 20, 1969

Peter Lefferson, Senior Engineer, Electronic Communications, Inc., St. Petersburg, Fla. His Idea "Multivoltage Monitor Circuit Uses Only A Single Transistor" has been voted the Most Valuable of Issue Award.

Vote for the Best Idea in this Issue.

IFD Winner for January 4, 1970

Howard Raphael, Design Engineer, Singer Corp., Friden Division, San Leandro, Calif. His Idea "Neon-Bulb Circuit Doubles As Pilot Light and Trouble Light" has been voted the Most Valuable of Issue Award.

Vote for the Best Idea in this Issue.

IFD Winner for January 18, 1970

Saul Ritterman, Assistant Professor, Bronx Community College, N.Y. His Idea "Single Transformer Provides Positive and Negative Voltages" has been voted the Most Valuable of Issue Award.

Vote for the Best Idea in this Issue.

New Products

Optical encoder with remote reflective disc controls speed digitally without adding mass

Trump-Ross Industrial Controls, Inc., 265 Boston Rd., Billerica, Mass. Phone: (617) 663-3451. P&A: \$35 to \$45 in quantity; 4 to 8 wks.

Dubbed a reflective-surface incremental encoder, a new rotary pulse generator provides a digital means of sensing velocity without the conventional shaft coupling, extra bearings and rotating masses associated with previous devices. Essentially, it reduces the amount of moving mass that is required to generate an incremental pulse train without sacrificing acceleration time.

The device consists of two separate parts: a thin (4.5 mils nominal) reflective plastic count track disc, and a small electro-optical pickup head. The user simply cements the disc on the rotating surface to be monitored.

Conventional rotary encoders require the shaft and code disc to be coupled to the rotating member.

This results in both mass and torque contributions because of the bearings needed.

On the other hand, the new reflective encoder simply views a pattern on the rotating surface. The mass of this pattern depends on the application—it can be as little as an etched pattern on a reflective surface, or as much as a thin metal disc cemented to the surface.

A standard rotary incremental code pattern is developed over the reflective surface. This pattern is then affixed concentric and perpendicular to the axis of rotation.

The pickup head, which contains a focused light source, projects a mating pattern on the rotary surface pattern. The head is mounted opposite the count track gratings at a distance from the disc that results in a strong reliable signal.

A solid-state opto-electronic element inside the pickup responds to the light-chopping effect produced

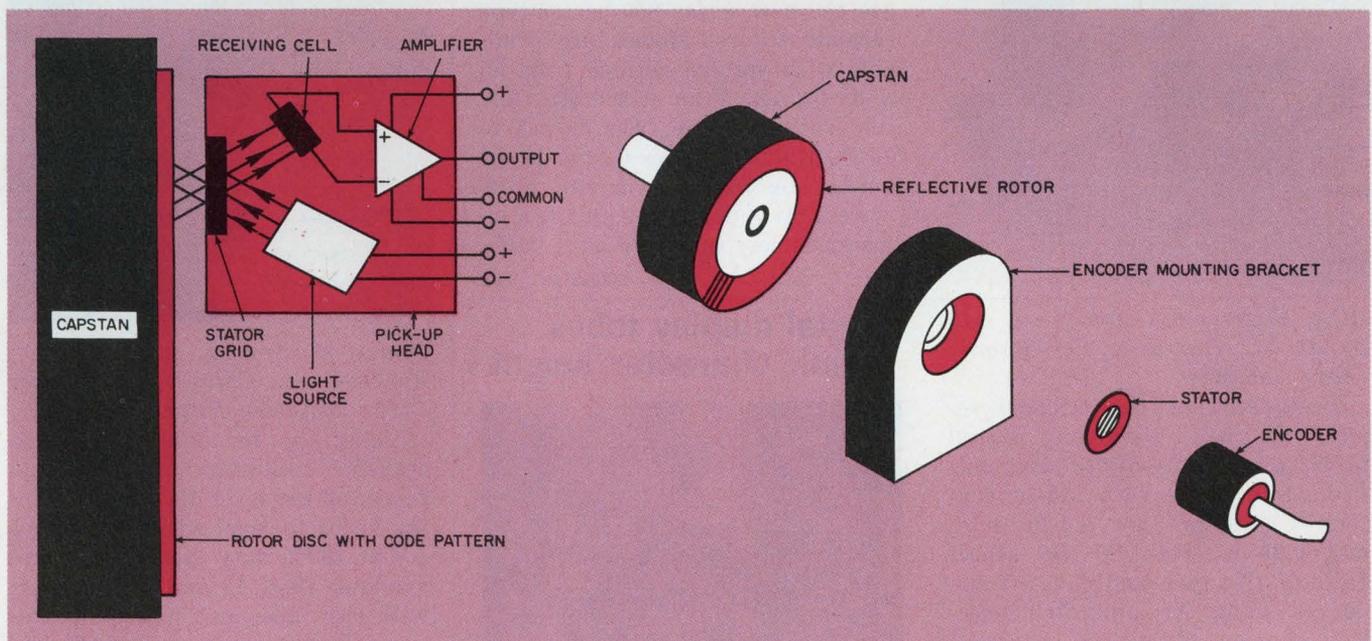
by the rotary pattern as it passes beneath the head. For many applications, the resultant sinusoidal output signal does not require external amplification.

When the disc has a diameter of 1.5 in., it can generate up to 500 pulses per revolution. Supply voltages of 5 to 15 V dc yield a single-channel sine-wave output that measures 0.4 V peak-to-peak from dc to 50 kHz.

Dimensions for the pickup head are a 5/8-in. diameter and a 3/4-in. length. A slightly longer housing for the pickup allows the addition of an amplifier shaper with a DTL/TTL-compatible output.

A prime application for the new reflective encoder is in computer tape transports, where the capstan used to drive the tape cannot assume additional mass. Here, the disc is simply cemented directly to the capstan with no sacrifice in acceleration rate.

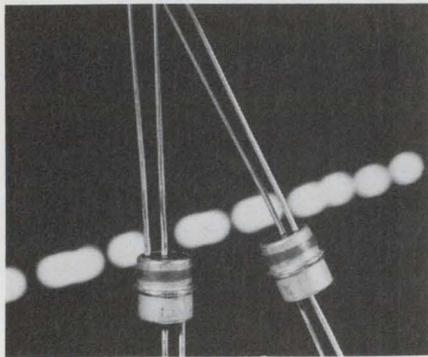
CIRCLE NO. 285



Reflective-surface rotary encoder permits digital speed control without increasing mass or sacrificing acceleration time. Code pattern on reflective plastic disc is

sensed and amplified by remote pickup head. Typical application (right) is monitoring computer tape speeds by cementing the disc to the drive capstan.

High-speed isolators withstand ± 1 kV

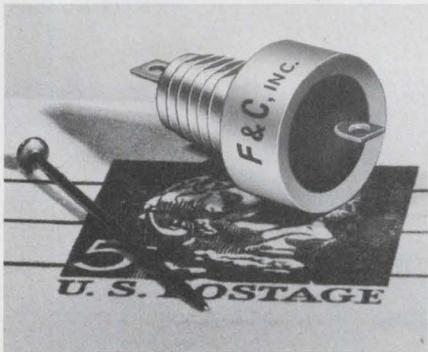


Joseph Pollak Corp., 195 Freeport St., Boston, Mass. Phone: (617) 282-9550.

Available in 192 combinations is a new toggle switch that's smaller than equivalent switches with a current rating of 6 A. It features a one-piece die-cast mounting stem and frame and a high-impact plastic case. Ratings are 6 A at 120 V ac or 3 A at 240 V ac. It is available in spst, spdt, dpst and dpdt configurations. Matching ON/OFF indicator plates are optional.

CIRCLE NO. 287

Button-type filters are the size of a pin



RCA Electronic Components, 415 S. 5th St., Harrison, N.J. Phone: (201) 485-3900.

Designated as the DR2100 series, the new Numitron digital tubes provide 16-digit capability in an 8-in. space with 1/2-in. centers. Characters are 0.4-in. high and 0.23-in. wide for an aspect ratio of 1.74 to 1, and have a four-degree slant. An unlimited selection of color filters can be placed in front of the digit to produce the most desirable display.

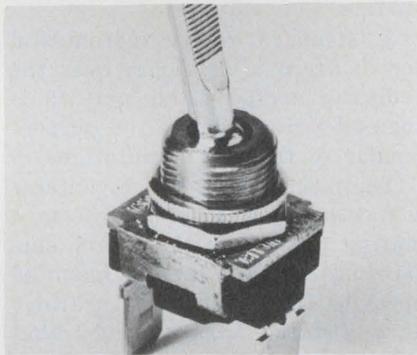
CIRCLE NO. 289

Texas Instruments Inc., Components Group, 13500 N. Central Expressway, Dallas, Tex. Phone: (214) 238-2011. P&A: \$6, \$10; stock to 2 wks.

Two new solid-state optically-coupled isolators with high-speed switching feature high voltage isolation of ± 1 kV. The TIL107 and TIL108 consist each of a gallium arsenide diode light source which is optically coupled to a silicon phototransistor. Both are compatible with TTL/DTL levels.

CIRCLE NO. 286

Small toggle switch carries 6 amperes

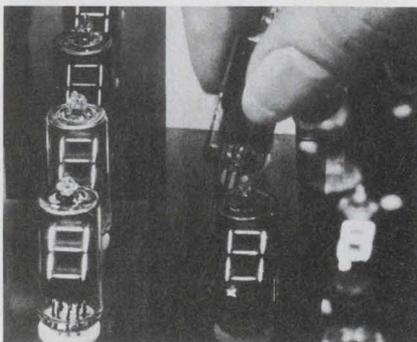


Filters & Capacitors, Inc., 425 N. Fox St., P.O. Box 1272, San Fernando, Calif. Phone: (213) 365-3228. P&A: \$12; stock.

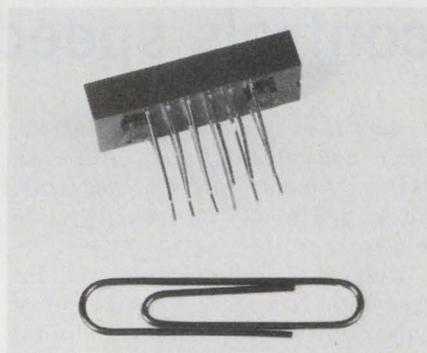
No longer than a straight pin are the new series 800 button-type ceramic filters. Models are available with voltage ratings from 50 V dc to 120 V ac at 400 Hz. Current ratings range from 40 mA to 15 A. Units measure 0.4 in. in diameter by 0.17 in. in length. A typical 50-V dc 40-mA unit has an insertion loss of 80 dB at 1 MHz.

CIRCLE NO. 288

Digital display tubes shrink character height



Ten-tap DIP delay line features 100-ns delay

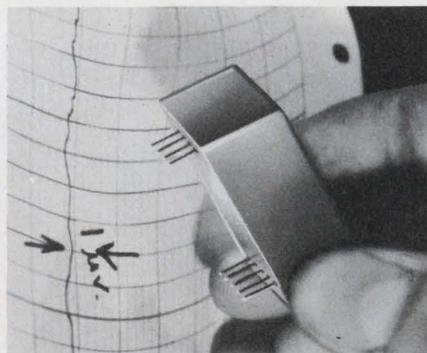


Kappa Networks, Inc., 165 Roosevelt Ave., Carteret, N.J. Phone: (201) 541-4226. P&A: under \$10 per 100; stock.

Incorporating ten taps in a dual-in-line package, a new low-cost delay line features an overall delay of 100 ns $\pm 5\%$. Its maximum rise time is 18 ns, impedance is 200 Ω and attenuation is under 0.3 dB. Temperature coefficient is less than 100 ppm/ $^{\circ}$ C and operating temperature range is -55 to $+125^{\circ}$ C. The unit is encapsulated in a 1x0.4x0.22 in. epoxy shell.

CIRCLE NO. 290

Low-thermal-drift relay keeps offset to 2.5 μ V



James Electronics Inc., 4050 N. Rockwell St., Chicago, Ill. Phone: (312) 463-6500. Price: from \$2.

Using a heat-stabilizing and transfer technique, the Milliscan relay for low-level dry-reed switching keeps thermal offsets under 2.5 μ V at 100% duty cycles. Units are available in 6, 12 and 24-V models with spst, dpst and 3pst configurations. Mounting is on printed circuit boards with 1-in. mounting centers and overall height is 0.5 in.

CIRCLE NO. 291

Glass-film-overlay chips up resistor protection

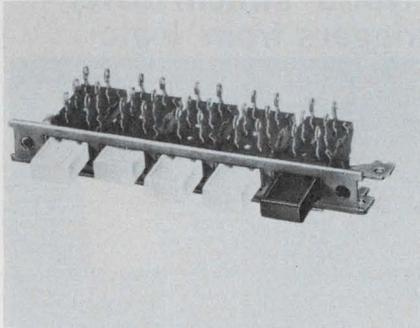


Airco Speer Electronic Components, Niagara Falls, N.Y.

Using a deposited glass film overlay for extra protection are new stable micro-miniature leadless metal-film resistor chips. They feature thick wrap-around gold terminations suitable for eutectic bonding or wire bonding to thin or thick-film conductors. Resistances range from 100 Ω to 50 k Ω . Temperature coefficient of resistance is 25 ppm/ $^{\circ}$ C and size is 75-mils square.

CIRCLE NO. 292

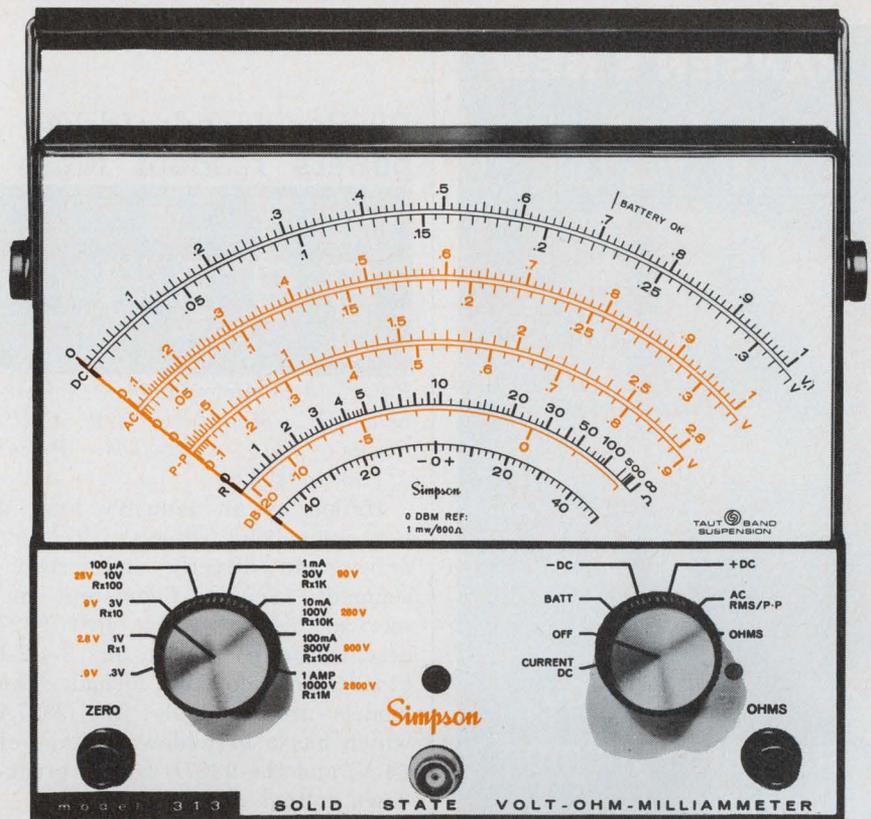
Push-to-lock switches release with one stroke



Switchcraft, 5555 N. Elston Ave., Chicago, Ill. Phone: (312) 774-1515.

Offering single switch versions up to 4pdt, the 65000 DW multi-switch assembly has push-lock and push-release features for each pushbutton, plus a common release for all the pushbuttons. The common release function makes the switch ideal for programming applications where it is desirable to release all operated switches simultaneously. This saves an operator valuable time by not having to release each switch individually.

CIRCLE NO. 293



Simpson's NEW solid-state VOM with FET-Input

- **HIGH INPUT IMPEDANCE...**
11 Meg Ω DC 10 Meg Ω AC
- **PORTABLE..... battery operated**
- **7-INCH METER..... overload protected**

Simpson's new 313 gives you high input impedance for accurate testing of latest circuit designs . . . free of line cord connections. Over 300 hours operation on inexpensive batteries. And the new 313 is *stable*, which means positive, simplified zero and ohms adjustments. Protected FET-input handles large overloads. DC current ranges to 1000 mA. Sensitive Taut Band movement and 7-inch meter scale provide superior resolution down to 5 millivolts. Write today for complete specifications.

Complete with batteries, 3-way AC-DC-Ohms probe, and operator's manual **\$125.00**

GET "OFF-THE-SHELF" DELIVERY FROM YOUR LOCAL ELECTRONIC DISTRIBUTOR

Simpson

ELECTRIC COMPANY



5200 W. Kinzie Street, Chicago, Illinois 60644 • Phone (312) 379-1121

EXPORT DEPT.: 400 W. Madison Street, Chicago, Illinois 60606. Cable Simelco
IN CANADA: Bach-Simpson Ltd., London, Ontario • IN INDIA: Ruttonsha-Simpson Private Ltd., International House, Bombay-Agra Road, Vikhroli, Bombay

INFORMATION RETRIEVAL NUMBER 61

HANSEN'S NEW 900 SERIES



gives you
standard Synchron[®]
reliability with up
to 98 oz.-in. torque

Now, without sacrificing compact size, you can get high torque even at higher speeds—from 1 to 900 RPM. Synchron[®] 900 Series has thick, wide gears, specially designed to give the added gear strength that makes full use of its power increase. Highest quality instrument gear train for all speeds below 900 RPM.

The new self-starting hysteresis motor has positive direction of rotation—right or left hand. Plus extra heavy phenolic first gear for low noise level. It can be stalled continuously without electrical or mechanical damage.

Added strength in both the rotor and gear train enables 900 Series to handle your toughest timing and control jobs. Because of its compact dimensions, it is often interchangeable with motors of lower torque. To find out what 900 SERIES can do for you, write or phone today to have a representative contact you.

VISIT BOOTH NO. 320
DESIGN ENGINEERING SHOW



HANSEN MFG. CO., INC.
Princeton, Indiana 47570

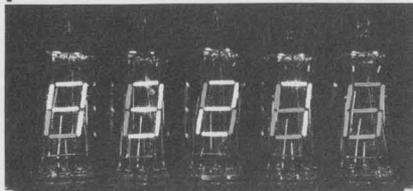
HANSEN REPRESENTATIVES: CAREY & ASSOCIATES, Houston and Dallas, Texas; R. S. HOPKINS CO., Sherman Oaks, Calif.; MELCHIOR ASSOCIATES, INC., San Carlos, Calif.; THE FROMM CO., Elmwood Park, Ill.; JOHN ORR ASSOCIATES, Grand Rapids, Mich.; H. C. JOHNSON AGENCY, INC., Rochester, N.Y.; WINSLOW ELECTRIC CO., Essex, Conn.; Villanova, Pa., and New York, N.Y.

EXPORT DEPARTMENT: 2200 Shames Drive, Westbury, N.Y. 11590

INFORMATION RETRIEVAL NUMBER 62

ICs & SEMICONDUCTORS

Bipolar decoder/driver powers readout tubes



Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. Phone: (415) 962-3563. Price: \$11.95 to \$15.50.

Hailed as an industry first, a new monolithic bipolar decoder/driver can directly drive seven-segment vacuum fluorescent numerical displays. The MSI 9327 accepts four inputs in 8-4-2-1 binary-coded-decimal format. Two models are available: the 9327A which has a breakdown voltage of 64 V, and the 9327B with a breakdown voltage of 30 V.

CIRCLE NO. 294

Transient suppressors sustain 1500-W surges

General Semiconductor Industries, Inc., 230 W. Fifth St., Tempe, Ariz. Phone: (602) 966-7263. P&A: \$3.25; stock.

Capable of dissipating 1500 W of peak power for 1 ms, TransZorb transient voltage suppressors come in voltages from 6.8 to 200 V (JEDEC types 1N5629 through 1N5665A). They can dissipate 10 kW for 10 μ s.

CIRCLE NO. 295

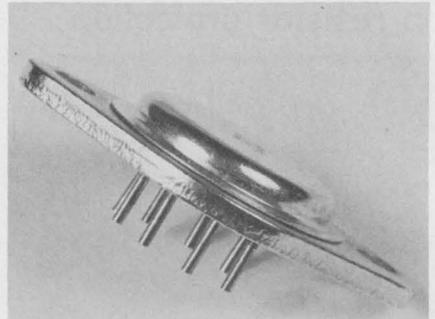
Amplifier chip varies its gain

Silicon General Inc., 7382 Bolsa Ave., Westminster, Calif. Phone: (714) 839-6200. P&A: \$4.95; stock.

Featuring variable gain and provision for gating and agc, the SG1402 linear IC amplifier boasts a frequency response beyond 50 MHz. At 10 V, typical gain is 25 dB and power consumption is just 50 mW. It operates from -55 to $+125^{\circ}\text{C}$.

CIRCLE NO. 296

Dc voltage regulators handle 50 V at 3 A

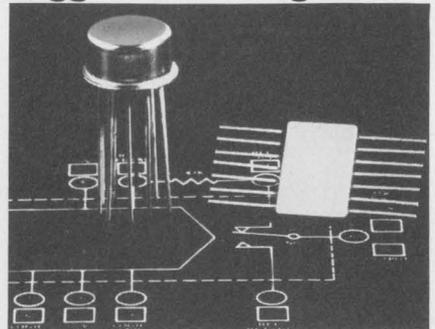


Solitron Devices, Inc., Semiconductor Div., 1177 Blue Heron Blvd., Riviera Beach, Fla. Phone: (305) 848-4311. Availability: stock.

Offering a voltage range of 8 to 50 V with maximum output current of 3 A, a new line of high-power dc voltage regulators features a regulation of 0.5% maximum and 0.05% typical, from no load to a 1-A load. These units are available for positive and negative applications: positive circuits are HCCA 100, 103, 105; negative circuits are HCCA 102, 104 and 106.

CIRCLE NO. 297

Hybrid switch/driver triggers from logic

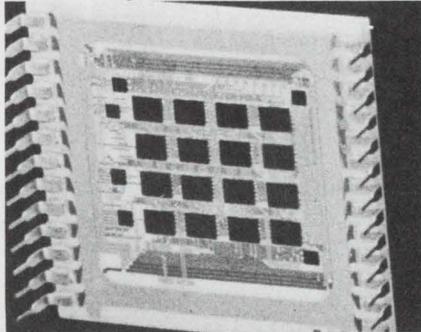


Crystalonics, a Teledyne Co., 147 Sherman St., Cambridge, Mass. Phone: (617) 491-1670. \$50 or \$60; stock.

The CDA18 hybrid IC is a spdt switch and driver circuit that operates directly from positive logic with a maximum turn-on time of 20 ns. The unit is supplied in a 10-lead TO-100 package or in a 14-lead TO-87 flatpack. Maximum on-resistance is 50 Ω . The new hybrid is intended for use in digital-to-analog converters.

CIRCLE NO. 298

MOS/bipolar memories store up to 4096 bits



Computer Microtechnology Inc.,
610 Pastoria, Sunnyvale, Calif.
Phone: (408) 736-0300. P&A:
\$1200; stock.

Combining the best of two worlds, MOS and bipolar technologies, a new line of hybrid read/write random-access memories can store up to 4096 bits, and offers a typical read access time of 150 ns. Ultra-mem series CM2400 multi-chip memory modules also feature a unique package—they use an aluminum beam-lead interconnection system on a dual-level metal-ceramic substrate. This type of construction provides high packing density, low costs, and good reliability.

The MOS/bipolar multi-chip approach simplifies the design of interface circuitry needed to work efficiently with different types of logic families. It also means that level shifting is done internally, yielding additional cost savings and performance optimization.

Since the modular package is DIP compatible, it can be assembled with the same techniques used for putting together integrated circuit packages. The housing measures 1.43x1.35 in. and has a seated height of 0.2 in.

Series CM2400 memories consist of up to 16 MOS storage chips and up to six bipolar chips for driving, sensing and output functions. The units are designed for use as buffers, scratchpads and main-frame memories.

Memory configurations can range from 4096 words with one-bit lengths to 1024 words with four-bit lengths. Maximum read cycle time is 600 ns; maximum write cycle time is 600 ns. Input and output signals are TTL.

CIRCLE NO. 299

SENSITIVE MERCURY WETTED CONTACT RELAYS

Ultra-reliable, highest quality Sensitive Relays with mercury wetted contacts are ideal for critical applications, such as digital and analog computers, telecommunication systems, multiplex, industrial control equipment and power control devices. New type MWK (center off—SPST) is ideal for multiple channel switching.

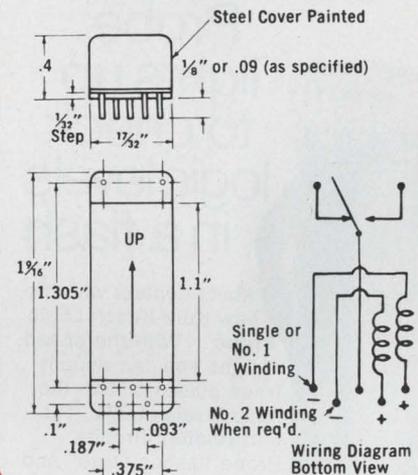
ELECTRICAL (Type AWCM):

Contact Arrangements:
Form C and D
Insulation Resistance:
1000 Megohms minimum
Current Rating:
Up to 2 amps or 500 VDC
Contact Resistance:
50 milliohms maximum
Life:
1 billion operations
Contact Bounce:
NONE
Contact Rise Time:
10 nano seconds or less
Operating Speed:
To 200 operations/second

PACKAGING (Type AWCM):

Environmental Protection: Hermetically sealed contacts, potted metal case
Shielding: Internal shielding available
Shock and Vibration: Withstands all normal handling/transportation effects
Mounting: Printed Circuit

Advanced manufacturing methods and stringent quality control procedures assure highest quality. Many types available directly from stock. Engineering and applications assistance available. Surprisingly short delivery schedules.



MERCURY DISPLACEMENT RELAYS

Time delay and load relays meet the toughest, most demanding switching applications. Non-adjustable time delay relays offer contact forms A and B with delays up to 1/2 hour, current ratings to 15 amps. Load relays switch from 30 to 100 amps with contact forms A and B.

DRY REED RELAYS

Miniature, intermediate, and standard sizes offer A and B contact forms with from 1 to 4 poles of switching. Typical life is 20×10^6 operations (rated load) or 500×10^6 operations (dry circuit).

USE READER-SERVICE NUMBER FOR COMPLETE INFORMATION



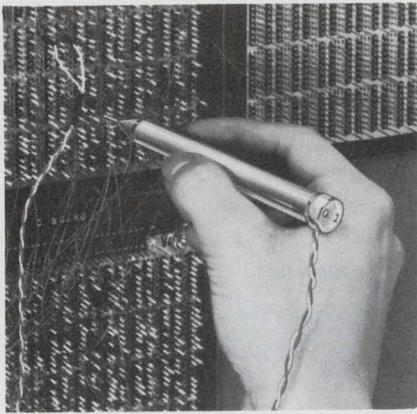
THE ADAMS & WESTLAKE COMPANY

Elkhart, Indiana 46514 • (219) 264-1141 • TWX (219) 522-3102 • TELEX 25-8458 • Cable ADLAKE



SUBSIDIARY OF
ALLIED PRODUCTS CORPORATION

INFORMATION RETRIEVAL NUMBER 63



Probe lights up to check logic levels in a flash

Make contact with the new Kurz-Kasch Logic Probe ... With the speed of light, you can visually trace pulses or test the logic levels of DTL, TTL and related circuits. Probe flashes "true" and "zero" logic readings by illuminating signal lamps in the end of the instrument. Like having a lab of test equipment at your fingertips. Indicates "infinity" too, identifying improper logic or a disconnection. Displays symmetrical wave forms by illuminating both lamps.

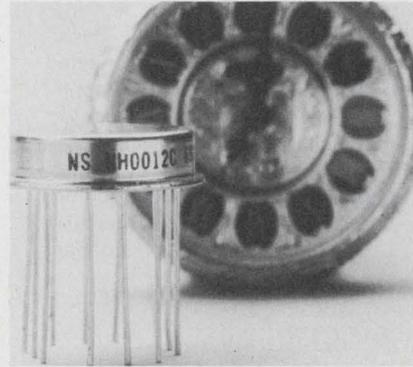
You'll light up at the low user price of \$39.90. The probe is used for testing, inspection, troubleshooting and circuit design. Fits in a shirt pocket; leads attach to unit being tested for power. Responds to systems from 3.75 to 6.5 vdc. Input impedance: 150 k Ω (logic "true"). Logic Probe is available through your local electronic distributor for immediate delivery, or for demonstration upon request. For additional information write Kurz-Kasch, Inc., Logic Instrument Division, 1421 S. Broadway, Dayton, Ohio 45401. (513) 223-8161.



INFORMATION RETRIEVAL NUMBER 64

ICs & SEMICONDUCTORS

Hybrid level shifter clocks up to 10 MHz

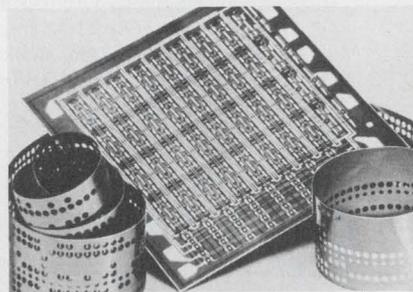


National Semiconductor Corp., 2975 San Ysidro Way, Santa Clara, Calif. Phone: (408) 245-4320. P&A: \$27 or \$37.50; stock

With its output swing of 12 to 30 V for driving either low or high-level MOS devices, a new bipolar-to-MOS level shifter can drive MOS shift-register clocks at rates to 10 MHz. Model NH0012 is a hybrid IC designed to be driven by a TTL or DTL line driver or a high-current buffer. Its output is a fixed-width clock pulse with maximum output of 1 A.

CIRCLE NO. 340

MOS memory chip accesses in 400 ns



Motorola Semiconductor Products Inc., P.O. Box 20924, Phoenix, Ariz. Phone: (602) 273-6900. P&A: \$13.70; stock.

Featuring a typical access time of 400 ns, a 64-bit MOS random-access memory is said to offer twice the speed of previous larger MOS memories. Organized as 16 words of four bits each, the MC1170L uses four-input binary addressing with full decoding performed on the chip. An enable input is also provided for easy address expansion.

CIRCLE NO. 341

LSI logic arrays are custom devices

Texas Instruments Inc. Components Group, P.O. Box 5012, Dallas, Tex. Phone: (214) 238-2011. P&A: \$43.50 or \$50.70, plus tooling; 90 days.

Combining MOS and bipolar technologies, two LSI circuits are custom-programmed random logic arrays at catalog-device prices. Because their final gate oxide removal mask is custom-programmed during the manufacturing process, the TMX-2000JC and the TMX-2200JC bring small-quantity prices down to \$43.50 or \$50.70 (less tooling). Both devices provide complexities of 130 equivalent gates, and are fully compatible with TTL and DTL systems.

CIRCLE NO. 342

Power Si rectifiers take 500 A at 2.4 kV

International Rectifier Semiconductor Div., 233 Kansas St., El Segundo, Calif. Phone: (213) 678-6281. P&A: \$66 or \$102; stock.

Available in both forward and reverse polarities, series 501V silicon rectifiers can carry up to 500 A at repetitive peak reverse voltages as high as 2400 V. Peak surge capability can be either 8000 or 10,000 A, depending on the model. In quantities of 1 to 9, types 501V60B and 501VR60B cost \$66 each, while types 501V120 and 501VR120 are \$102 each.

CIRCLE NO. 343

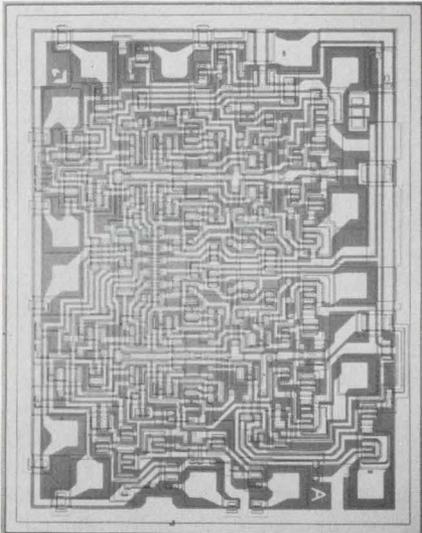
Agc i-f amplifier prevents detuning

Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. Phone: (415) 962-3563. Price: \$7.30.

Designed for use in AM and FM communications receivers, a new automatic-gain-control i-f amplifier provides high-gain amplification without detuning the external filter circuits. The μ A757C is a two-section device.

CIRCLE NO. 344

**Commercial-price ICs
are 100% MIL-tested**



Advanced Micro Devices Inc., 901
Thomson Pl., Sunnyvale, Calif.
Phone: (408) 732-2400. P&A:
\$5.30 to \$16; stock.

Seven new MSI devices that are
pin-for-pin replacements of the
Fairchild 9300 series are 100%
tested to MIL Standard 883 Level
B, yet cost the same as conven-
tional commercial units.

This means that the user can
benefit from added component re-
liability due to 100% temperature
cycling, baking, hermetic-seal test-
ing and centrifuging, at no extra
cost.

Units are also available for oper-
ating in the military temperature
range of -55 to $+125^{\circ}\text{C}$ at only
50% more in cost.

The devices are the 9300 shift
register, the 9301 decoder, the 9304
adder, the 9309 multiplexer, the
9310 decade counter, the 9312
digital multiplexer and the 9316
binary counter.

Circuits in this series of units
meet Military Specification 883
Level B, regardless of whether or
not they are commercial or mili-
tary versions.

Discount prices for any 100-unit
lot are the same, as long as the lot
contains a combination of ten units
or more of any particular device.

Prices for military and commer-
cial types, respectively, are \$9.75
and \$6.05 (9300); \$9.35 and \$6.25
(9310); \$10.25 and \$7.50 (9304);
\$7.95 and \$5.30 (9309 and 9312);
\$16 and \$11.75 (9310 and 9316).

CIRCLE NO. 345

KEITHLEY'S NEW DIGITAL ELECTROMETER is a way out MULTIMETER

- MEASURES WITH DIGITAL ACCURACY:

100 μv to 100 v
0.2 A to 10^{-15} A
 10^4 to 10^{14} Ohms
 10^{-5} to 10^{-11} Coulomb

- OPTIONAL BCD 1-2-4-8 OUTPUT WITH FULL COMPUTER COMPATIBILITY
 - DISPLAY RATE VARIABLE FROM 24 READINGS/SEC. TO 2 READINGS/MIN.
 - AUTOMATIC POLARITY AND OVERLOAD INDICATION
 - 10^{14} OHMS INPUT RESISTANCE: 1 MILLIVOLT PER 24 HOURS STABILITY
 - FLOATS TO 100 VOLTS OFF GROUND
 - \$1295 WITH BCD OUTPUT; \$1195 WITHOUT*
- *U.S.A. Prices

SEND FOR FULL DETAILS

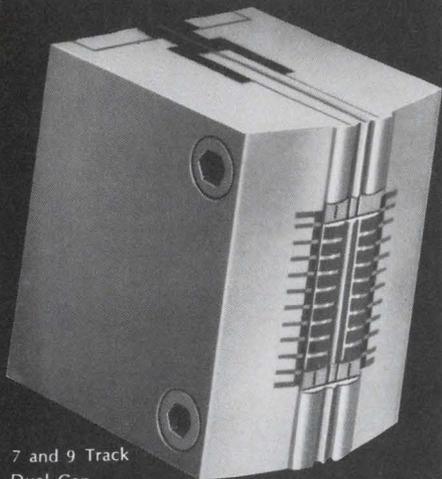
**KEITHLEY
INSTRUMENTS**
U.S.A.: 28775 AURORA ROAD, CLEVELAND, OHIO 44139
EUROPE: 14, AVENUE VILLARDIN, 1009 PULLY, SUISSE



INFORMATION RETRIEVAL NUMBER 65

YES!
NORTRONICS
 will show these
 and other
IBM-compatible

**DIGITAL
 HEADS***



7 and 9 Track
 Dual Gap
 READ AFTER WRITE



7 and 9 Track
 Single Gap
 READ/WRITE

**AT
 SJCC**

BOOTH 50010

See them there or write for specs!

*Card Reader and Mini-Digital Heads too...
 From The World's Leader In Magnetic Recording
 Heads.



8101 Tenth Avenue North
 Minneapolis, Minnesota 55427
 (612) 545-0401

INFORMATION RETRIEVAL NUMBER 66

DATA PROCESSING

**Display generator
 views two functions**



MacNeal-Schwendler Corp., 7442
 N. Figueroa St., Los Angeles,
 Calif. Price: \$350 to \$495.

When used with analog or hybrid computers and an oscilloscope, a new two-variable display generator enables looking at the functions actually stored in the analog function generators, or in the digital computers. These displayed functions may be either a function of two variables or many functions of one variable. The final display can be magnified or stretched.

CIRCLE NO. 346

**Matched data modules
 transmit and receive**

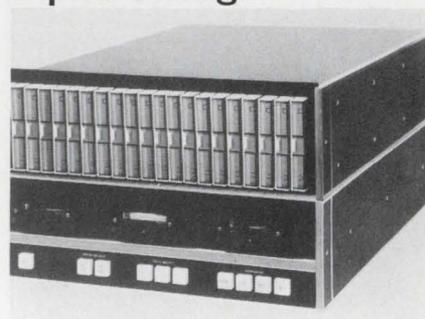


Plessey Co., Ltd., Components
 Group, Professional Components
 Div., Titchfield, Hampshire, Eng-
 land.

Called data modules, matched pairs of transmitters and receivers enable users to construct and completely tailor frequency division multiplexing systems. The transmitters contain an oscillator and filter to give the required output signal. The receivers have an appropriate bandpass filter, together with a discriminator and amplifier; they can drive either relays or logic.

CIRCLE NO. 347

**Cassette drive
 triples storage**



Xebec Systems, Inc., Mountain
 View, Calif.

Intended to increase the capability of minicomputers, the ICU on-line magnetic tape drive system incorporates a compact triple-drive tape cassette unit: one cassette carries the standard software system; a second cassette handles the user's source information; and a third cassette carries the object program. This combined hardware/software system provides the user with increased flexibility and simplified operation.

CIRCLE NO. 348

**Microfiche reader
 is portable unit**



Dasa Corp., Information Systems
 Div., Andover, Mass. Phone: (617)
 475-4940. Availability: summer,
 1970.

Weighing only 7-1/2 lb and measuring just 13x13x7-1/2 in., the PRM/50 portable microfiche reader features an 8-1/2x11-in. viewing screen and accepts 4x6-in. microfiche with interchangeable grid formats for scanning control. Focusing is constant once set by a fingertip dial. High or low screen illumination is accomplished by a single ON/OFF button. The unit plugs into a standard electrical outlet.

CIRCLE NO. 349

Magnetic tape recorder verifies data entries

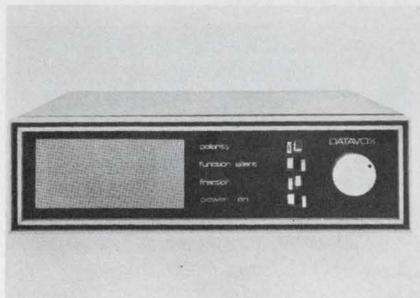


Singer Co., Friden Div., San Leandro, Calif. Phone: (415) 357-6800. Price: \$7000 or \$8000.

The 4301 magnetic data recorder is a stand-alone unit that performs all the functions of a key-punch and of a verifier, but with expanded capabilities. It can be cable-connected to a central pooler or act as one itself when equipped with a pooling adapter. The recorder produces computer-compatible tape with densities of 200, 556 or 800 bits per inch and with either seven or nine tracks.

Booth No. 35002 Circle No. 350

Voice converter calls out data

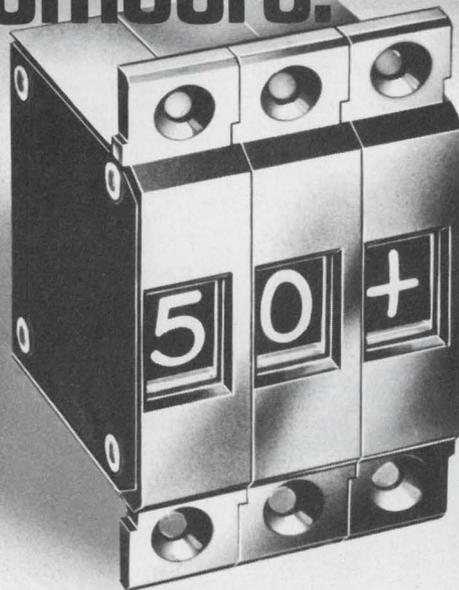


Instrumentation Systems Inc., 1111 San Mateo N. E., Albuquerque, N.M. Phone: (505) 265-9536. P&A: \$795; 30 days.

Datavox I is a digital-to-voice converter that speaks in a clear natural voice to read numbers, and announce the polarity and function (like volts, ohms and frequency) of numerous measurements. The unit can read numbers as English words from 0.00001 to 999.99, and as digits from 0.00001 to 9999.9. A private earphone can be used.

CIRCLE NO. 351

Magneline[®] whatever the light it doesn't keep you in the dark... because it shows, tells, and remembers.



Magneline[®], the digital and data display with inherent memory, can easily be read in normal light, brilliant ambient light, or in the dark. And what a memory! When the characters of the message—numbers, colors, or symbols—are magnetically pulsed into display position, they hold that position by magnetic force after the coils are de-energized, and remain on display without any external power. Other key advantages are Extremely high reliability Wide mounting variety Low power requirement Multiplex Indication. Remember . . . Magneline is now numbered among Veeder-Root's product groups. We invite new—and renewed—interest in the Magneline capability. Now at new low prices. Write:

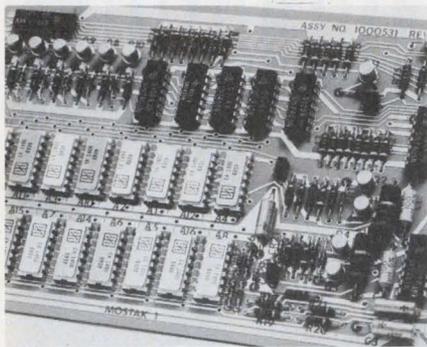
VEEDER-ROOT

INSTRUMENT & ELECTRONIC DIVISION
HARTFORD, CONNECTICUT 06102-(203) 527-7201



INFORMATION RETRIEVAL NUMBER 67

MOS memory card cycles in only 1 μ s

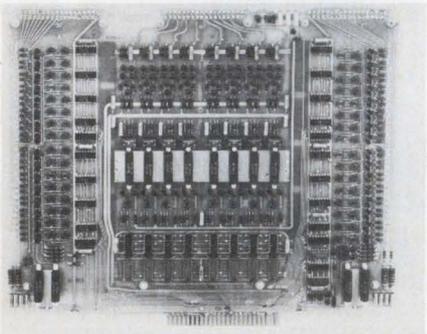


United Telecontrol Electronics, Inc., 3500 Sunset Ave., Asbury Park, N.J. Phone: (201) 988-0400. Price: \$500 or \$1500.

Two new Mesa 200 core memories offer full-cycle times of 2 μ s. The model 5034-1B, which costs \$500, is a 1kx8 unit and has an operating temperature range of 0 to 50°C. The model 5036, which costs \$1500, is a 4kx18 system with an address register and party-line data registers.

Booth No. 6112 Circle No. 353

Memory cards access in 600 ns



Codex Corp., 150 Coolidge Ave., Watertown, Mass. Phone: (617) 926-3000. P&A: \$4000; 30 days.

A new time-division multiplexer can simultaneously service up to eight terminals of intermixed data speeds from 1200 to 4800 bits per second. Model TM-8 is totally transparent so that EIA-RS232B modem control signals can be passed through it without changes in system operating concepts. In addition, the unit can interface to switched-network modems.

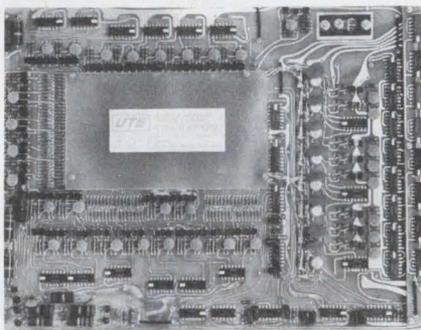
Booth No. 15000 Circle No. 258

Electronic Arrays, Inc., Systems Div., 9060 Winnetka Ave., Northridge, Calif. Phone: (213) 882-9610. Price: \$400.

Employing MOS semiconductors for data storage and address decoding functions, Mostak I read/write memory system features a 1- μ s full-cycle time. The unit is a 512-word, four-bit-per-word random-access system with a 0.8- μ s read access time. The entire memory is housed on a single board measuring 6-3/4x4-1/4 in.

Booth No. 3008 Circle No. 352

Core memories cycle in 2 μ s



Standard Memories Inc., 15130 Ventura Blvd., Sherman Oaks, Calif. Phone: (213) 788-3010. P&A: \$1105 typical; 30 days.

Besides a full-cycle or split-cycle time of 2 μ s, Ecom series D memories feature a data access time of 600 ns. The units are available with capacities of 1024, 2048 or 4096 words with 8-bit lengths. In addition, the memories have a single I/O connector and interface directly to DTL circuits. Total power consumption is 52 W.

Booth No. 50016 Circle No. 252

High-speed multiplexer can mix data rates



Tape cleaner/certifier evaluates all errors



Data Devices Inc., sub. of Data Products Corp., 18360 Topham St., Tarzana, Calif. P&A: \$8750; 60 days.

Providing two functions in the same package, the model 7900 tape cleaner/certifier determines whether a reel of tape is computer acceptable, marginal or unacceptable with its dual-error permanent-error and marginal-error counters. Permanent-error level is factory preset, and marginal-error level is selected by the operator.

Booth No. 1000 Circle No. 354

Tape reader rewinds too

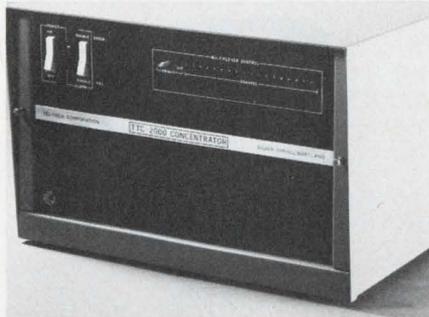


Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 326-7000. P&A: \$3000; 60 days.

Besides reading punched tape at speeds up to 500 characters per second, the model 2758A tape reader/rewinder also rewinds the tape so that it's ready to use again immediately. After removing the tape from its clear plastic storage canister, the operator just inserts the tape into the reader, snaps the canister into place, and pushes a button. The tape is read and automatically rerolled into the canister.

CIRCLE NO. 355

Data multiplexers blend 38 channels

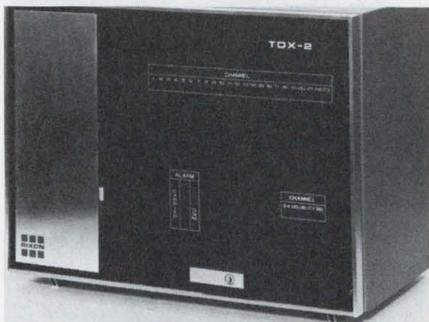


Tel-Tech Corp., 9170 Brookville Rd., Silver Spring, Md. Phone: (301) 589-6035.

Designed to transmit multiple low-speed data streams, two new time-division multiplexers can handle up to 38 full-duplex channels of data over a single 3-kHz type 3002 voice-grade circuit. The channels may operate at speeds of 110, 135, 150 or 300 bits per second. Model TTC-3000 is for multi-point networks and permits full contention for channels from remote stations.

Booth No. 4607 Circle No. 255

Data multiplexer mixes 88 channels



Rixon Electronics, Inc., sub. of United Utilities, Inc., 2120 Industrial Parkway, Silver Spring, Md. Phone: (301) 622-2121.

Able to handle as many as 88 channels, a new time-division multiplexer can intermix up to four data rates: 300, 150, 134.49 and 110 bits per second. Model TDX-2 is absolutely data transparent and will transmit all combinations of 7 and 8-bit data characters. Status and data quality indicators provide rigorous diagnostic capability.

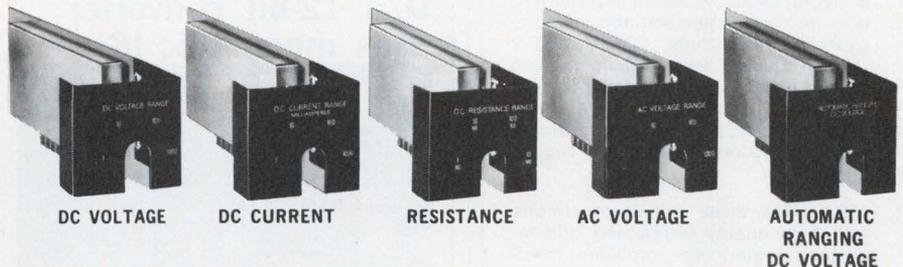
Booth No. 2103 Circle No. 263



Simpson's new 2700.

Versatile Digital System:

- New, fast warm-up*
- 4½ digits
- 0.05% accuracy
- 5 plug-in function modules



- Automatic Polarity Selection
- Built-in Self Calibration
- 100 Microvolt Resolution
- Optional BCD output
- IC Modular Design for reliability

2700 DIGITAL SYSTEM \$615⁰⁰
complete with DC voltage range module, test leads, and operator's manual

AVAILABLE "OFF-THE-SHELF" AT ELECTRONIC DISTRIBUTORS STOCKING SIMPSON INSTRUMENTATION PRODUCTS.

Simpson ELECTRIC COMPANY



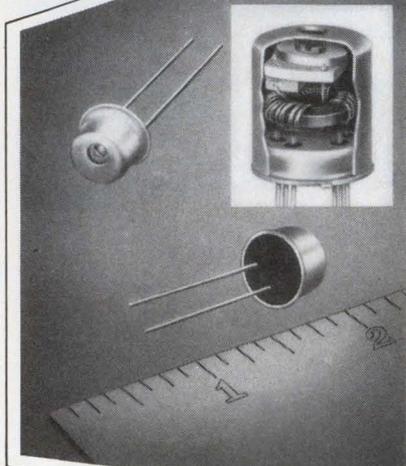
DIVISION

5200 W. Kinzie Street, Chicago, Illinois 60644 • Phone (312) 379-1121
Export Dept: 400 W. Madison Street, Chicago, Illinois 60606. Cable Simelco
IN CANADA: Bach-Simpson Ltd., London, Ontario • IN INDIA: Ruttonsha-Simpson Private Ltd., International House, Bombay-Agra Road, Vikhroli, Bombay

INFORMATION RETRIEVAL NUMBER 68

JFD

MTLC SERIES



MICRO-MINIATURE TUNED-CIRCUIT PACKAGE

JFD MTLC TUNERS enable circuit designers to shrink various LC circuits into TO-5 configurations completely compatible with today's miniaturized or hybrid circuitry. The tuning element is a microminiature variable ceramic capacitor measuring: .208 x .280 x .120 in. thick. These variable ceramic capacitors offer high capacitance plus a choice of wide ΔC s in extra small, ultra stable units. New improved construction makes MTLC more rugged than ever.

JFD builds these miniature circuits with high quality ferrite and iron inductor toroidal cores, providing maximum Q for any given frequency. Where necessary, special JFD Uniceram fixed capacitors are used with Modutrim microminiature ceramic variable capacitors to yield lower center frequencies or to satisfy special circuit requirements.

Standard tunable LC networks are available for a wide range of applications such as: RF tank, FM discriminator, impedance matching, frequency multiplier, IF amplifier and many others.

Write for catalog.

JFD

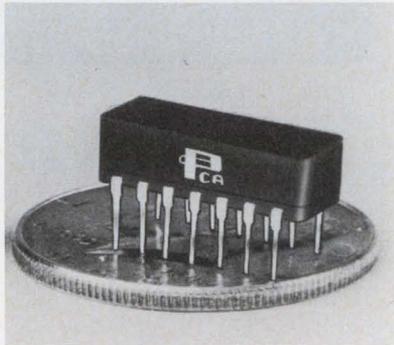
JFD ELECTRONICS CORP. / COMPONENTS DIVISION

15th Avenue at 62nd Street
Brooklyn, New York 11219
Phone 212-331-1000

SUBSIDIARY OF RIKER-MAXSON CORPORATION

MODULES & SUBASSEMBLIES

Hybrid function modules are multi-circuit DIPs

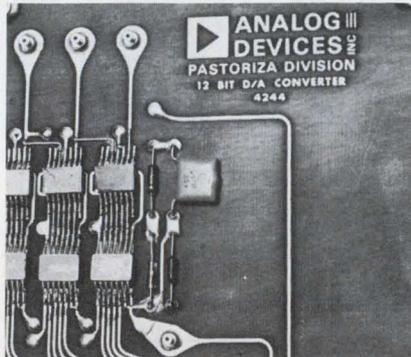


PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif. Phone: (213) 781-3034. Availability: 2 to 15 wks.

Designed for use in many circuits with various functions are hybrid modules that contain delay lines, pulse transformers, transistors, diodes, resistors and capacitors. They are available in a variety of combinations in 14-pin dual-in-line packages. Modules are 0.78-in. long and 0.27-in. wide with heights varying from 0.18 to 0.3 in.

CIRCLE NO. 356

D/a 12-bit converter uses monolithic ICs



Analog Devices, Inc., Pastoriga Div., 221 5th St., Cambridge, Mass. Phone: (617) 492-6000. P&A: \$191 to \$330 for 12 bits.

The new μ Dac family of thin film monolithic quad switches (AD550) and resistor networks (AD580) and AD582) serve as building blocks for a 12-bit d/a converter with an accuracy of 0.01% $\pm 1/2$ the least significant bit. These units can be supplied individually or on PC boards whose layout could be determined by the user at a nominal cost.

CIRCLE NO. 357

Voltage-source converter doubles output polarity



Delta-X Corp., Box 26733, Houston, Tex.

The Bi-Volter is a new device that accepts a single-polarity voltage and develops voltages of opposite polarity with a stable reference point at any fraction of the input voltage. Load currents of the two output voltages are unimportant as long as the imbalance limitations of the device are met. Maximum input voltage and current imbalance vary by model. Models are available for many input currents and voltages.

CIRCLE NO. 358

Two-quadrant multiplier reaches 0.1% accuracy



Hybrid Systems Corp., 95 Terrace Hall Ave., Burlington, Mass. Phone: (617) 272-1522. P&A: \$120; stock to 2 wks.

Using the pulse modulation principle, the model 108 two-quadrant multiplier achieves an accuracy of 10 mV out of 10 V. It computes the function $XY/10$ with an accuracy of 0.1%. Gain versus temperature is 0.005%/°C and offset versus temperature is 50 μ V/°C. Bandwidth at -3-dB points is 100 Hz. The unit measures 3.5x2.5x0.825 in.

CIRCLE NO. 359

Legend readout displays digits too



Inter-Market, Inc., 312 Waukegan Rd., Glenview, Ill. Phone: (312) 729-3550. Price: \$20 for legend display only.

Displaying up to 12 legends in a window 2-5/8-in. wide and 1-in. high, the M4X legend readout combines with several digital readouts on the same panel. Legends can be engraved in many positions and be coordinated for various messages. The display uses flanged-base T-1-3/4 lamps with 6, 12, 24 or 28-V ratings.

CIRCLE NO. 360

Flatpack power supply powers up to 100 ICs

Elasco-Eastern, Inc., 5 Northwood Rd., Bloomfield, Conn. Phone: (203) 242-0708. P&A: \$185; stock to 2 wks.

The IC 5-5A is a flatpack power supply that delivers 5 V dc at 5 A to power up to 100 ICs. It requires less space than conventional units since it measures only 4-5/8 × 3-1/8 × 1-3/8 in. Load and line regulation is held to ±5 mV maximum.

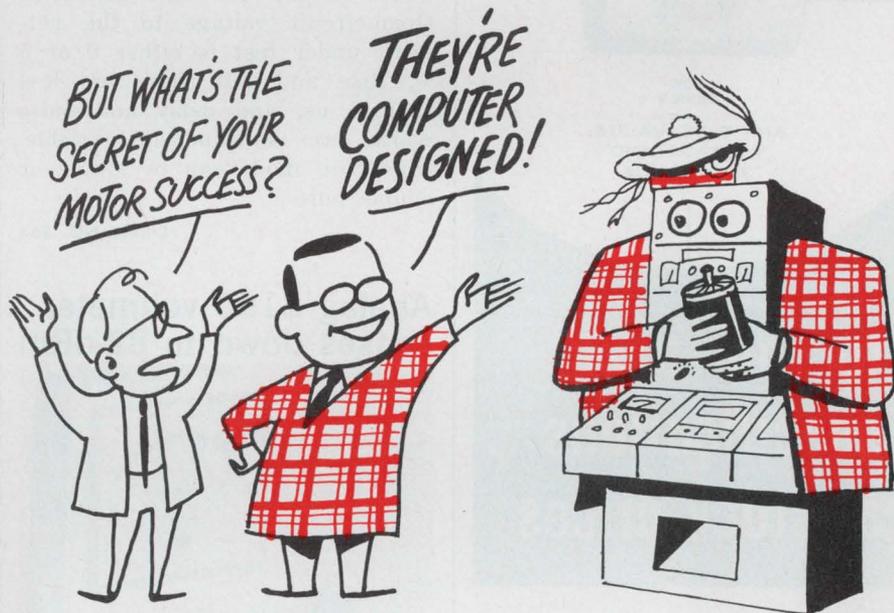
CIRCLE NO. 362

Variable active filters give 3 outputs at once

Varadyne, Inc., 2330 Michigan Ave., Santa Monica, Calif. Phone: (213) 394-0271. P&A: \$24.50, \$29.35; stock.

The VAF-100 (hybrid) and VAF-200 (PC card) active filters are two series of state-variable units with simultaneous bandpass, low-pass and high-pass outputs. They feature independent frequency, bandwidth and gain adjustments.

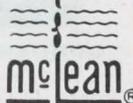
CIRCLE NO. 361



Thousands of complex calculations are required to mate a motor to your system's needs. Ordinary motor manufacturers never quite reach the objective but McLean's unique, computerized system quickly matches performance to the problems. Our high speed digital computer plots curves relating motor RPM to shaft torque, power factor, percent efficiency, etc., etc. Result — precision instrument motors, without equal anywhere.



Write Today-

McLEAN 
ENGINEERING LABORATORIES

Princeton Junction, New Jersey 08550 • Phone: 609-799-0100 • Telex: 84-3422

INFORMATION RETRIEVAL NUMBER 70

METALIZED POLYESTER CAPACITORS

ACTUAL SIZE



M2W
SERIES

ANY SIZE, VALUE,
VOLTAGE AND
TOLERANCE

to your exact specifications... at stock prices

Unique, self-healing units that remain in circuit during voltage surges with little or no loss of electrical properties. Use the M2W's where size and weight are limiting factors and long life and dependability are required. The units utilize metalized Polyester Dielectric with film wrap and custom formulated epoxy resin end fill. Available in round and flat styles.

Samples available on
your letterhead request



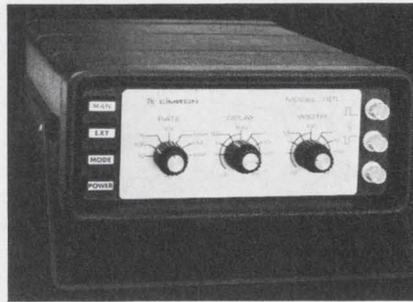
CONDENSER CORPORATION

Dept. ED-4 1065 W. Addison St.,
Chicago, Ill. 60613 • 312-327-5440

INFORMATION RETRIEVAL NUMBER 71

INSTRUMENTATION

Pulse generator drives logic directly



Lear Siegler, Inc., Cimron Div.,
1152 Morena Blvd., San Diego,
Calif. Phone: (714) 276-3200.

The model 3101 pulse generator provides simultaneous logical complement outputs to eliminate the need for an external inverter when driving IC logic networks. Open-circuit voltage to the network under test is either 0 or 5 V. Rise and fall times are less than 8 ns, and delay and pulse width are continuously variable. Operation mode can be single or double pulse.

CIRCLE NO. 363

Analog \$160 voltmeter senses down to 82-dBm



Abphot Corp., Instrument Div.,
105 W. 27th St., New York, N.Y.
Phone: (212) 242-1307. P&A:
\$160; 1 to 4 wks.

Providing a sensitivity of -82 dBm for only \$160, a new analog-readout voltmeter can measure ac signals with amplitudes of $30 \mu\text{V}$ to 100 V over the frequency range of 10 Hz to 1 MHz. Model 1001 is a solid-state battery-operated instrument with a typical internal noise level of -108 dBm on its $300\text{-}\mu\text{V}$ scale. Input impedance is 1 M Ω .

CIRCLE NO. 364

Bias supply for \$25 eases TV alignment



Sencore, 426 Westgate, Addison,
Ill. Phone: (312) 543-7740. Price:
\$24.95.

Developed primarily for color TV alignment, a new seven-in-one bias supply can be used with any sweep and marker generator, and with either solid-state or tube-type systems. Model BE156, which sells for \$24.95, provides three separate 25-V supplies that can be switched positively or negatively. Two of its outputs can be varied from -25 to $+25$ V, while a third goes from -75 to $+25$ V.

CIRCLE NO. 365

Digital event counter can be panel-mounted



Digilin Inc., 6533 San Fernando
Rd., Glendale, Calif. Phone: (213)
246-8161. Price: \$149.

Complete with an internal power supply, a solid-state panel-mounted digital-display event counter makes possible local as well as remote readout of counted or accumulated data. Model 320 is a 3-1/2-digit panel meter that can be located at the sensor or transducer site in high-electrical-noise environments. It can operate at rates as high as 1 MHz.

CIRCLE NO. 366

Ka-band MIC source incorporates afc loop

Texas Instruments Inc., Components Group, P.O. Box 5012, Dallas, Tex. Phone: (214) 238-2011. \$2400; 60 days.

Designed for use as a signal source or local oscillator from 32 to 33 GHz, a new MIC Ka-band solid-state source includes an automatic-frequency-control loop. Model MIC100 is a microwave thin-film hybrid rf source that meets the environmental requirements of MIL-E-5400 for Class II equipment. This compact unit operates from a 20-V 300-mA power supply.

CIRCLE NO. 367

Microwave mixers use replaceable diodes

Control Data Corp., Boston Space and Defense Systems Div., 400 Border St., East Boston, Mass. Phone: (617) 569-2110. P&A: \$1360; 30 to 60 days.

Intended for use in the millimeter-wavelength region, a new family of Schottky-barrier diode mixers features wafer-mounted field-replaceable diodes. Series 965 units are available in each waveguide band from 26.5 to 110 GHz; with rf bandwidths up to 7 GHz at the upper end of the frequency spectrum.

CIRCLE NO. 368

Metalized substrates do microwave work

HRB-Singer, Inc., Science Park, P. O. Box 60, State College, Pa. Phone: (814) 238-4311.

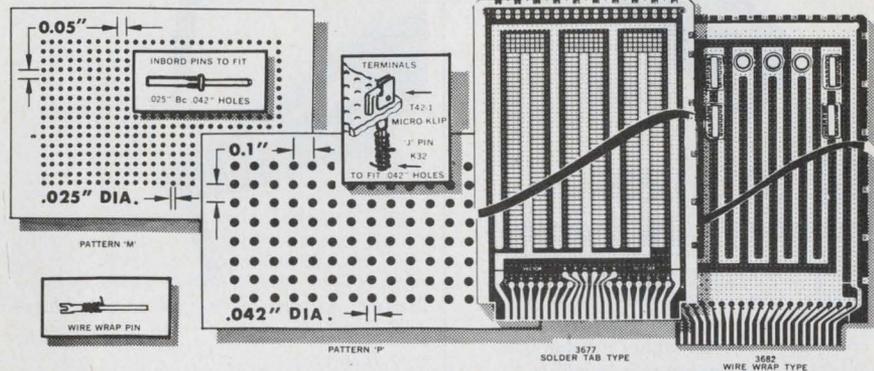
Ceramic metalized substrates for microwave applications are now available in standard sizes and thicknesses. Semiconductor-type cleanliness and procedures allow production of metal films with good adhesion and low insertion loss. Custom metalization and etching of dielectrics, ferrites, and garnets are also possible.

CIRCLE NO. 369

New

MICRO-VECTORBORD® AND D.I.P. PLUGBORDS ARE HERE!

Save time — Save work — Save money



WIDE SELECTION OF SIZES AND MATERIALS

MICRO-VECTORBORD "P" .042" holes match D.I.P. leads. Epoxy glass or paper, cop. cld. also 1/64" to 1/16" thk.

MICRO-VECTORBORD "M" .025" holes match Flat-Paks, 1/32" Epoxy glass, cop. cld. also or .007" Mylar.

NEW SOLDER-PAD D.I.P. PLUGBORDS — 3677 Series Epoxy glass, "P" pat., 1/16" thick with 44 etched plug contacts (2 side total) power, ground

busses, pads for up to 24 D.I.P.'s (14's). Also 21 units 16-leads D.I.P.'s, T-O's and discretes.

NEW WIRE WRAP D.I.P. PLUGBORDS — 3682 Series Similar to above but closely spaced bus lines for higher density. Up to 48 D.I.P. 14 lead wire wrap sockets mountable or T-O's and discretes.

TERMINALS — Micro-Klips, Mini-Wire-Wraps, Rd. Pins, Patch Cords, etc., available.

Vector

Send for complete literature

ELECTRONIC CO., INC.

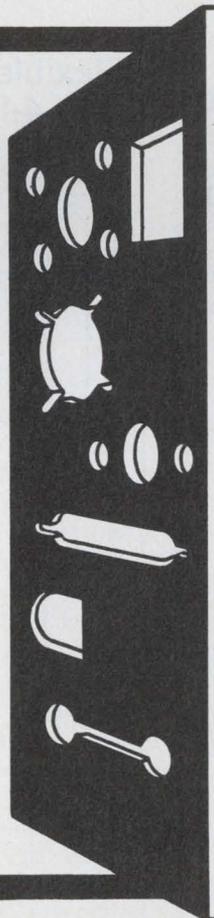
12460 Gladstone Ave., Sylmar, California 91342

Phone (213) 365-9661 • TWX (910) 496-1539



INFORMATION RETRIEVAL NUMBER 88

Roper Whitney wants you to be strong



... but it isn't necessary

Roper Whitney tools are a pleasure to use. Operation is easy and without strain—you don't have to be strong to exert great power. You can design with freedom: prototypes, breadboards, custom chassis, or produce low volume cabinets and panels. With Roper Whitney tools you can swiftly and powerfully punch any shape hole, shear, notch, rip, rivet and bend sheet metal or light plate and angle iron for custom framing. Manual punching power from 2 to 30 tons can be yours.

NEW 56-page Roper Whitney Catalog 70A illustrates and describes hundreds of hand tools from scratch awls to clip punches and hand seamers. Twenty pages of punches and dies are included along with prices for all items. We're holding your **FREE** copy for you . . . We'll send you 70B on power equipment too.



ROPER WHITNEY, INC.
Formerly Whitney Metal Tool Co.
2833 Huffman Blvd., Rockford, Ill. 61101

INFORMATION RETRIEVAL NUMBER 89



Mite-size miniature 7/16" indicator

These tiny indicators are compact, rugged, versatile and easy to read. They feature a microminiature moving coil core magnet mechanism. A1-21 Indicators operate in -55°C to $+85^{\circ}\text{C}$ environments and are sealed against dirt and dust. Choice of pointer or flag display in a wide variety of electrical sensitivities and functions. Size: 7/16" in diameter, 31/32" in length. Weight: 11.5 grams. Write today for complete information.

AMMON

AMMON INSTRUMENTS, INC.
345 Kelley St., Manchester, N.H. 03105

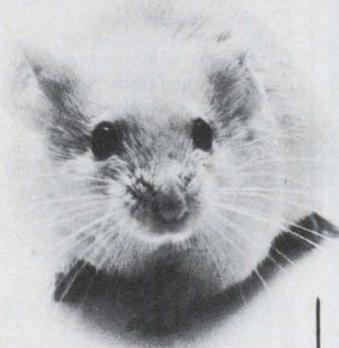
INFORMATION RETRIEVAL NUMBER 73

THIS SPACE CONTRIBUTED BY THE PUBLISHER

**A mouse has
already been saved
from leukemia.**

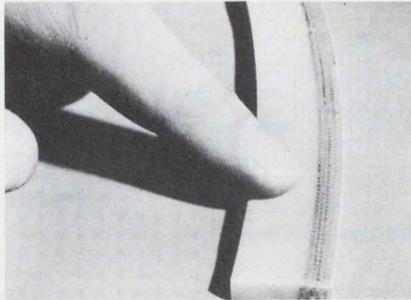
Help us save a man.

For years, you've been giving people with leukemia your sympathy. But sympathy can't cure leukemia. Money can. Give us enough of that, and maybe we'll be able to do for a man what has already been done for a mouse.



American Cancer Society 

Emi gasketing imbeds wires

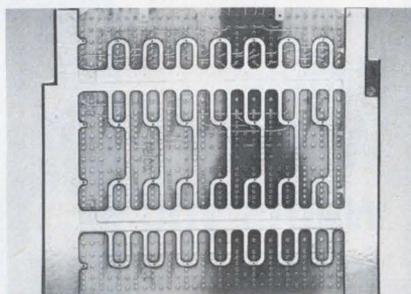


Metex Corp., 970 New Durham Rd., Edison, N.J. Phone: (201) 287-0800.

Developed for emi shielding and pressure-tight sealing of wide flange areas in electronic gear, Combo Polastrip gasketing consists of wire mesh embedded in an elastomeric material. Since the wires are perpendicular to the surface being gasketed, they provide direct current paths for high emi-shielding capabilities. Since the shielding portion is not bonded to, but molded into the pressure seal, the chance of gasket component separation is virtually eliminated.

CIRCLE NO. 370

Flexible circuits give 4-layer boards



Rogers Corp., Rogers, Conn. Phone: (203) 744-9605.

Offering ground and power lines on separate layers, Multi/Bus flexible circuits can become an integral part of a printed circuit board by lamination, transforming a two-layer PC board into a three or four-layer one. The change is reportedly accomplished at a fraction of the fabrication cost of a three or four-layer board. Also the proximity of Multi/Bus to the board and board components results in effective shielding of radiated electrical noise.

CIRCLE NO. 371

Breadboard system stacks together

Heath Co., Benton Harbor, Mich. Phone: (616) 983-3961. Price: \$37.50.

Consisting of a small desktop chassis, a power patch card and a component patch card, Stack-n-Patch EU-53A breadboarding system eliminates soldering with on-card connectors that make a tight electrical connection by simple wire insertion. Patching up a design is fast and simple—pick your power supply and connect it to the power patch card, stack the component and power patch cards in the chassis, and then patch components or hook-up wire into the component card.

CIRCLE NO. 372

Semiconductor glass replaces oxide layer

Innotech Corp., 181 Main St., Norwalk, Conn. Phone: (203) 846-2041. P&A: \$25 to \$55/lb; stock.

IP 650 is a glass that is applied directly to a semiconductor junction rather than on top of an oxide. Substituting a stabilizing glass for the oxide prior to dicing cleans the surface of impurities and prevents migration. Devices are not only gettered but hermetically sealed as well.

CIRCLE NO. 373

Rf connectors telescope together

Sealectro Corp., RF Components Div., 225 Hoyt St., Mamaroneck, N.Y. Phone: (914) 698-5600.

Nanohex microminiature rf connectors feature a telescoping interface to ensure proper mating by first aligning metal bodies, then insulators and then contacts. This permits electrical performance to be maintained over thermal extremes. The units have a typical VSWR of 1.25 from dc to 12.4 GHz when used with 0.056 or 0.07-in.-diameter semi-rigid cable.

CIRCLE NO. 374

Desoldering kit frees DIP ICs



Eldon Industries, Inc., Ungar Div., Compton, Calif. Phone: (213) 774-5950.

Ideally suited for small printed circuit boards, the Princess 6939 five-piece desoldering kit contains a three-wire grounded handle, an 18-W heat capsule and three specially designed tips. One tip is a slotted bar for releasing up to 16-pin DIP ICs in one operation. Another tip is for use on 0.375-in. TO packages and transistors. The third tip melts and straightens bent tabs and leads.

CIRCLE NO. 375

Benchtop solder meter reads out in just 1 s

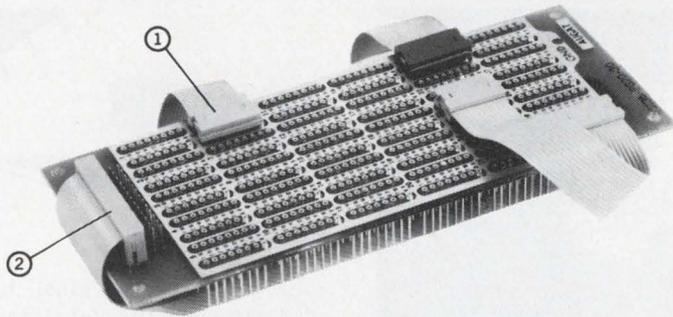


Zeva Electric Corp., 3 Great Meadow Lane, Hanover, N.J. Price: \$98.50.

Designed especially for soft soldering applications, a soldering temperature meter gives on-the-spot temperature readings in just one second. Model LT 50 has a wide temperature range of 32 to 932°F, making it useful for measuring soldering irons, pots and baths. The scale is graduated for both Fahrenheit and Centigrade readings. A leather carrying case is optional.

CIRCLE NO. 376

FLAT CABLE PLUG ACCESSORIES



Greater flexibility in Prototyping and Packaging. Plugs come un-assembled, unique contact design eliminates cutting, stripping, soldering or crimping. Permits installation of plugs at ends of cable or any desired bussing location with a fast and simple press operation. Assembly tool available.

1. 14 & 16 Pin Plug – Used for interfacing, input-output connections and testing. May also be used for cable termination into P.C. board. Pins are on .100" centers and .300" between rows.

2. 26 Pin Plug – Designed for input-output connections on standard Augat panels. May also be used for interfacing and testing. Pins are on .100" centers and .100" between rows. Header Assembly also available, mates with plug.

Request I.C. folder

AUGAT INC.

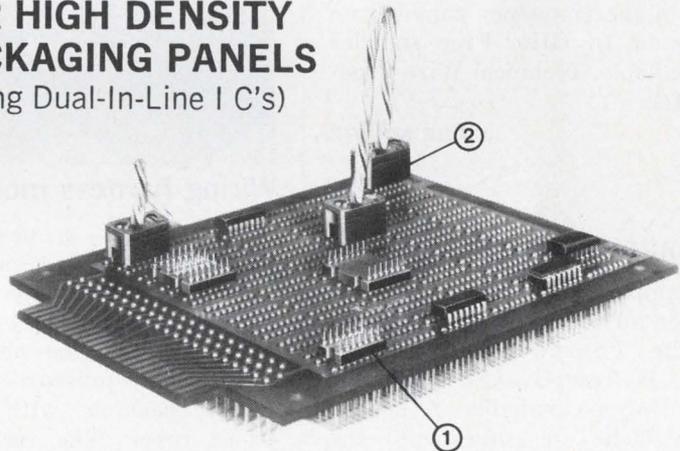
TEL: 617/222-2202
31 PERRY AVE., ATTLEBORO, MASS. 02703

INFORMATION RETRIEVAL NUMBER 74

PLUG ACCESSORIES

FOR HIGH DENSITY PACKAGING PANELS

(Using Dual-In-Line IC's)



Provide greater flexibility in prototyping and packaging. Facilitate interposing of discrete components. Plugs have 14 and 16 leads with pins on .100" centers and .300" between rows.

1. Adaptor Plugs – in single and double pattern combinations. Also permit modular construction with P. C boards and sub-strates.
2. Interfacing Plug – permits combining patterns on a single board or interconnection of patterns between boards. Also used as test plug.

Contact patterns on Augat panels permit insertion of I C, adaptor plug or interfacing plug.

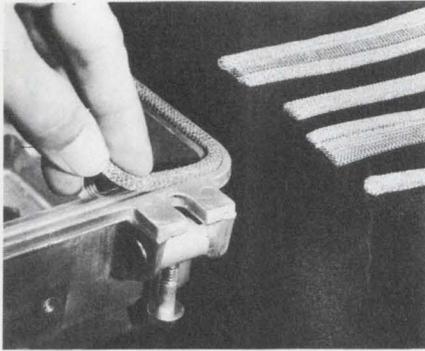
Request I. C. folder

AUGAT INC.

TEL: 617/222-2202
31 PERRY AVE., ATTLEBORO, MASS. 02703

INFORMATION RETRIEVAL NUMBER 75

Evaluation Samples



Rfi/emi gaskets

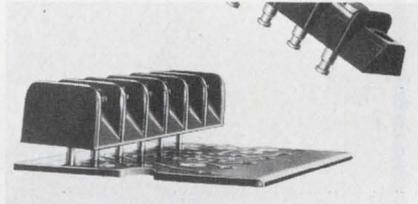
Tecknit strips are resilient, conductive, knitted wire mesh strips used to effectively shield seams and joints in electronic enclosures against emi/rfi. The standard fine wires used to produce this gasketing material are tin-coated copper-clad steel, monel, aluminum and silver-plated brass. The gaskets are generally used on shielding joints that are simple in shape and have a periphery greater than 4-in. Gaskets are available in five different shapes: round, square, rectangular, round with single fin and double core. Total shielding effectiveness up to 120 dB is provided in the frequency range from 1 kHz to 10 GHz. Free samples are available. Technical Wire Products, Inc.

CIRCLE NO. 377

Computerized tag

A sample of a computerized all-weather steel tag designed with a specially compounded coating which is receptive to computer imprinting is available. A special ribbon etches messages into the coating, making the copy as permanent as the steel tag. The tag is then wire-tied to any item. It also can be supplied with a pressure-sensitive backing. The new tags have been subjected to accelerated aging tests duplicating severe outdoor exposure with a predicted life span of at least two years. They can be color-coded for product identification purposes. Impact Label Corp.

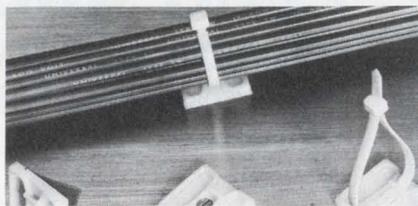
CIRCLE NO. 378



Terminal blocks

Single-screw terminal blocks with attached tin-plated brass lugs and pins are now being offered as free samples. These devices feed through the center of the block allowing the block itself to protect the connection. The pins are made for soldering to a printed circuit board while the lugs have specially shaped ends to which individual wires can be soldered. Lugs and pins are available mounted on either a 15-A 3000-V rms or a 20-A 3400-V rms single-screw block. Blocks are formed from sturdy lightweight phenolic. ETC Inc.

CIRCLE NO. 379



Wiring harness mount

Samples of a new adhesive-backed mount for securing wiring harnesses to virtually any smooth surface for light-duty applications are available. The new ABMS-A mount has a pressure-sensitive adhesive backing with a peel-off paper cover. The inclusion of a countersunk hole permits the mount to be used with a #6 flat-head screw or a 1/8-in. flat-head rivet. The result is a one-hole mount which will not rotate. The adhesive-backed mount is used in conjunction with any miniature, intermediate or standard cable tie to provide a neat, secure harness. It can be mounted to virtually any clean, dry, and smooth surface. Panduit Corp.

CIRCLE NO. 380



Artwork patterns

New connector contact patterns, which come in time-saving continuous strips of up to 880 contacts each, are available as free samples. The strips eliminate the old time-consuming method of laying down multiple small segments, allowing the draftsman to count and cut exactly what he needs in a single piece. The connector contacts include a plating bar pattern effecting further time savings by eliminating need for conventional taping. All patterns conform to MIL-STD-275. Bishop Graphics, Inc.

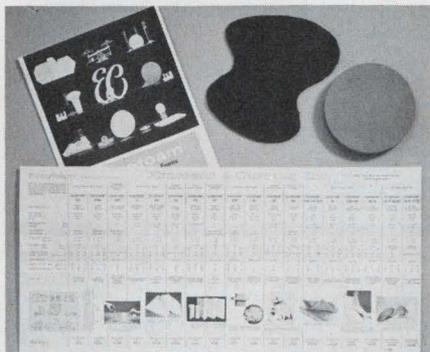
CIRCLE NO. 381

Cable bushings

Two new nylon open/closed bushings for 1/2-in. and 7/8-in. holes feature a split body which allows the bushing to be placed over electric wires and cables, tubing or hose, after installation through panels or housings. When inserted into the proper size hole, a perfect circle and complete insulation barrier is formed. The bushing permits protection of pre-assembled harnesses, control tubes and capillary tubes. A snap-lock feature locks the open/closed bushing to the panel with fingertip pressure and withstands a push-back test of 35 lb. Cost ranges from 95¢ to \$2.80 per 100. Free test samples are available. Heyman Manufacturing Co.

CIRCLE NO. 382

Design Aids



Foams chart

Standard plastic and ceramic foams are described and illustrated in a new color chart. Basic materials include polyurethanes, epoxies, phenolics, silicone rubbers, glasses, silica, and other ceramics. Bulk densities range from 2 to 45 lb/ft³ for the plastic foams and 25 to 68 lb/ft³ for the inorganic foams. Cell structures available are closed, open, partly closed, and syntactic. Other properties for each foam, listed in a handy table, are color, comprehensive strength, thermal conductivity, water absorption, dielectric constant and loss tangent. Many applications are listed and illustrated including electronic packaging, heat and vibration insulation, lightweight machined parts, and lightweight lenses and antennas for microwaves. Emerson & Cuming, Inc.

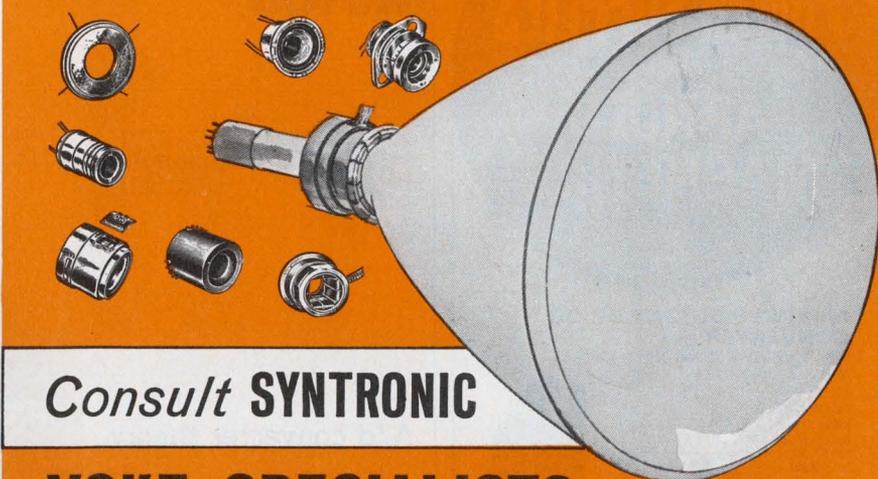
CIRCLE NO. 383

Cable size nomogram

To simplify the selection of cable sizes which must consider voltage drop, current, resistance, length of cable and voltage, two nomograms are available. One is for 115/230-V single-phase systems; the other is for 220/440-V three-phase systems. By using the nomograms, selection can be made quickly and easily by merely coordinating two straight lines across the scales. Prosser Industries, div. of Purex Corp., Ltd.

CIRCLE NO. 384

WHICH DEFLECTION YOKE FOR YOUR DISPLAY ?



Consult **SYNTRONIC**

YOKE SPECIALISTS

Syntronic's team of experts knows more about yoke design, engineering and quality control than anyone else. A solid 10-year record of leadership—acknowledged throughout the industry. Benefit from it.

syntronic

INSTRUMENTS, INC.
100 Industrial Road, Addison, Illinois
Phone: Kingswood 3-6444

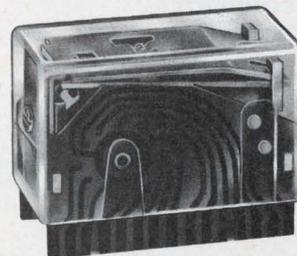
INFORMATION RETRIEVAL NUMBER 76

the **NEW** mighty-mini

Schrack's **NEW MINIATURE STEPPING SWITCH**, Type RTM, is the smallest stepping switch available on the market today. Only 1/4 the size of comparable steppers, it combines high performance with economy of space and cost.

The RTM is equipped with 2 x 10 or 2 x 12 gold-plated contacts and mates with our socket which meets standard printed circuit spacings. Unique hold-down spring enables mounting in any position.

Write for free catalog today. Schrack also manufactures all types of relays, stepping switches and accessories. Catalogs upon request.



1 41/64" L x 13/16" W x 15/16" H

SCHRACK ELECTRICAL SALES CORP.

1140 Broadway, New York, New York 10001
tel: (212) 683-0790

INFORMATION RETRIEVAL NUMBER 77

NEWEST
POWER SUPPLIES
FROM
**ARNOLD
MAGNETICS**

**MULTIPLE OUTPUT DC-DC
CONVERTER**

FOR TTL, OP AMP, MOS, AND DISPLAY POWER

Size: 1 1/2 x 3 1/2 x 3 3/4
Input: 26-30 VDC
Regulation: 2%
Ripple: 2%
Operating Temp: -55 to +85°C

Model	Outputs (Volts DC)	Price (1 pc)
SHU 200/05-5/2	5 @ 2 Amps	\$250.00
	200 @ .05 Amp	
SHU 30CT/5-5/2	5 @ 2 Amps	275.00
	+15 @ .5 Amp	
	-15 @ .5 Amp	

Delivery: Stock — 4 weeks ARU

**CIRCLE
231**

**MULTIPLE OUTPUT AC-DC
CONVERTER**

FOR TTL, OP AMP, MOS, AND DISPLAY POWER

Size: 1 1/2 x 3 1/2 x 3 3/4
Input: 108-130 VRMS 50-500 Hz
Regulation: 2%
Ripple: 2%
Operating Temp: -55 to +85°C

Model	Outputs (Volts DC)	Price (1 pc)
PHU 200/05-5/2	5 @ 2 Amps	\$322.00
	200 @ .05 Amp	
PHU 30CT/5-5/2	5 @ 2 Amps	365.00
	+15 @ .5 Amp	
	-15 @ .5 Amp	

Delivery: Stock to 4 weeks ARU

**CIRCLE
232**

**100 WATT DC-SINE WAVE
INVERTER**

Size: 5 x 4 x 2 1/2

Weight: 56 oz

Input: 24-30 VDC

Output: 100 Watts @ 8 PF

Closely Regulated at 400 Hz, 4%

Total Harmonic Distortion (other frequencies available to 10 KHz)

Operating Temp: -55 to +71°C

Model	Output (VRMS @ 400 Hz)	Price (1 pc)
SKD-28-28-400-100	28	\$479.00
SKD-28-115-400-100	115	479.00

Delivery: Stock — 4 weeks ARU

Other inverters available from 12 Watts to 700 Watts

**CIRCLE
233**

**400 WATT AC-DC
CONVERTER**

Size: 8 x 8 x 3 (192 in³)

Weight: 14 Pounds

Input: 115 VAC 47 to 500 Hz

Regulation:

Load: 2%

Line: 2%

Short Circuit/Overload Protection

Operating Temperature: -20 to +71°C

Model	Output	Price (1 pc)
MAP-20/20	20 VDC @ 20 AMPS	\$995

Other outputs available 3.5 VDC @ 60 Amps to 50 VDC @ 8 Amps

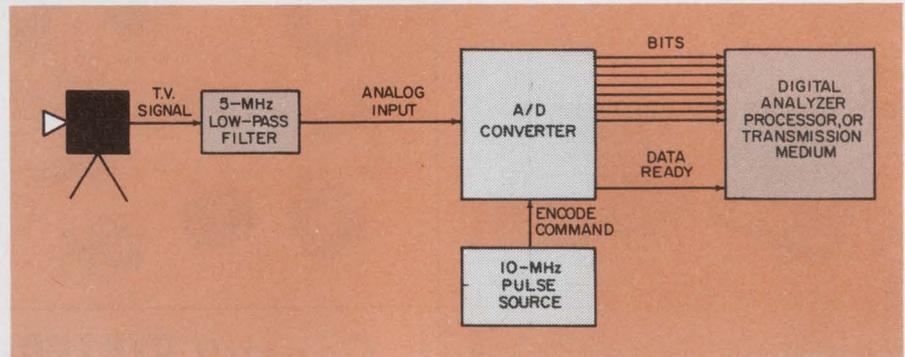
Delivery: 3 to 5 weeks

**CIRCLE
234**

11264 Playa Court, Culver City, Calif. 90230
(213) 870-7014 TWX 910-343-6468



Application Notes



A/d converter theory

Digitizing color television is just one of the unique applications to be found in a new 22-page booklet entitled "An Introduction to Analog-to-Digital Converters." The technique illustrated above can be implemented with seven-bit binary numbers for full-color high-resolution pictures, or with four bits or less resulting in some loss of

color resolution but retention of picture integrity. Other applications presented include pulse contour measurements, and time compression and expansion. In addition, a theoretical discussion covers the basics of a/d converters, their operation, the common codes used, and the various errors in the conversion process. Computer Labs.

CIRCLE NO. 385

High-temperature metal

How to make molybdenum high-temperature resistant is the subject of a four-page brochure. It describes a coating material that protects molybdenum from catastrophic oxidation in the air. A reprint of a recent technical article shows how a silicided diffused coating is produced. A chart lists test results showing how siliciding improves the performance of molybdenum. General Electric Co., Lamp Metals and Components Dept.

CIRCLE NO. 386

Noise measurements

The second edition of the Primer of Plant-Noise Measurement is now available. This revised 24-page booklet features how-to-do-it discussions on making noise measurements consistent with the latest provisions set forth in the Safety and Health Standards of the Walsh-Healey Public Contracts Act. A special section on the measurement of impact noise has been added. General Radio Co.

CIRCLE NO. 387

Stepping-motor glossary

Users of stepping motors who are caught in the middle of a conflict of nomenclatures used by the makers of high-speed steppers and those who make high-torque, low-speed devices can now resolve the problem with a six-page glossary of terms associated with stepping motors. Starting with definitions of three basic types of steppers, based on their method of construction, the glossary classifies the motors by type of application. A series of terms with definitions are presented. These are arranged sequentially, rather than alphabetically, with each definition building on those preceding it. Among these are such terms as torque, work, total load torque, static torque, dynamic torque, stepping angle, torque angular displacement, detent torque, maximum pulse length, and many others. Although many of the terms also refer to other dynamic systems, the definitions provided in the glossary are specifically related to stepping motors. Heine-mann Electric Co.

CIRCLE NO. 388

New Literature



Computer handbook

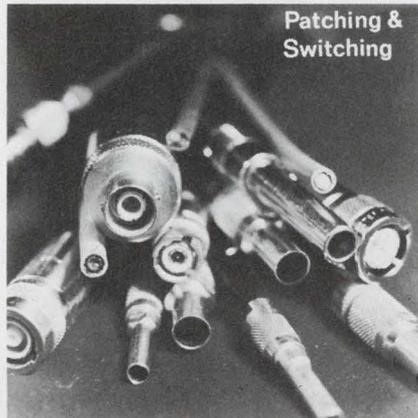
The 520/i, a versatile mini-computer priced at \$7500, is the subject of a 408-page manual. It provides, in a single document, a complete description of the computer for such categories as hardware, interfaces and software. This information is a useful reference for systems designers, programmers and ultimate users. The various sections are cross-referenced to aid the reader in finding exactly what he needs. Varian Data Machines.

CIRCLE NO. 389

Bridge rectifiers

Characteristic charts for an entire line of silicon bridge rectifier assemblies are contained in a 12-page publication. The line covers diffused-junction silicon rectifiers with over 150 devices. These range in ratings from 1-mA 200-V units for consumer and low-voltage industrial applications to high-voltage rectifier assemblies. Featured is a double-page chart which serves as a designer's guide for rectifier circuits. It includes a sample calculation which enables an engineer to determine voltage ratings for high-voltage assemblies in circuit configurations. RCA Electronic Components.

CIRCLE NO. 390



Patching & Switching

Patching and switching

Information detailing high and low-frequency switches and matrices is in a 44-page 1970 full-color catalog. It illustrates a complete line of coax, twinax, triax and quadrax connectors, plus patch panels, plugs, jacks, patch cords and accessories. These are employed in TV broadcasting, CATV, CCTV, telemetry, telephone, nuclear instrumentation and information retrieval. Included is a technical discussion on noise in cable systems which will assist materially in the design of instrumentation, communication and data systems. Trompeter Electronics Inc.

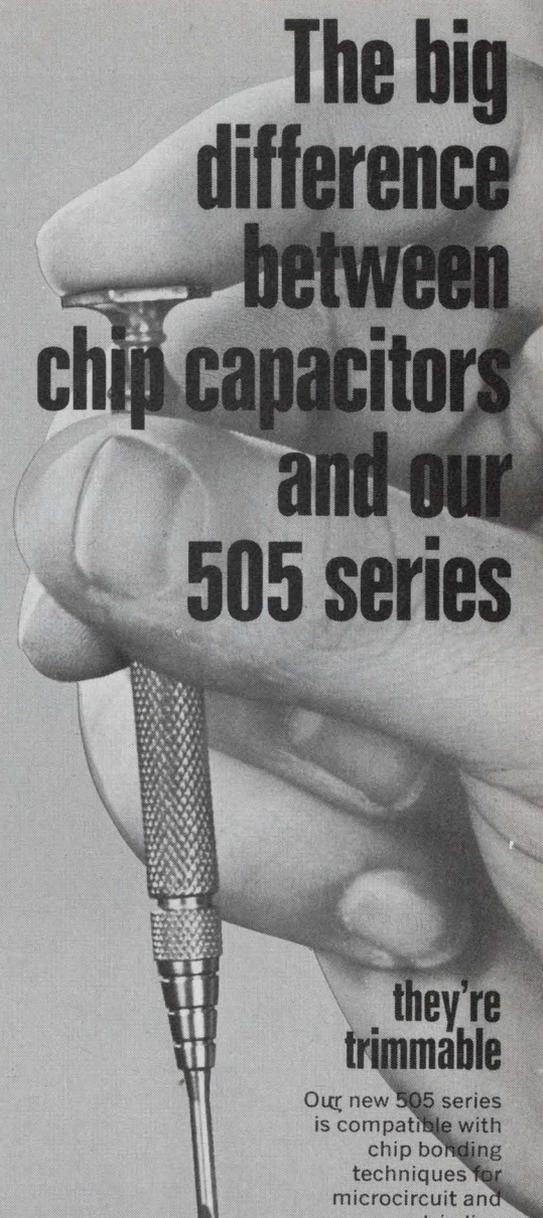
CIRCLE NO. 391

Readout tubes

Of interest to many users of display devices is a readout-tube quick-reference catalog. Design and development engineers will be particularly interested in it. It lists a complete line of readout tubes with condensed technical information. Complete technical data for readout tubes with display character size ranging from 0.31 to 2-in. is given, including data on a new economical side-view series. Improved driving circuits are also discussed. Critical ratings and characteristics, as well as photographs and outline drawings of all types are shown. National Electronics, Inc.

CIRCLE NO. 392

The big difference between chip capacitors and our 505 series



they're trimmable

Our new 505 series is compatible with chip bonding techniques for microcircuit and strip line applications . . . and they're trimmable in ranges from .1 to 100 pF!

But trimmability is only one of the plus advantages of this new series, they feature high Q (self-resonant into X band), ΔC 's of 1 to 15 pF, and low temperature coefficients (0 ± 20 PPM/ $^{\circ}$ C).

When your application calls for high Q chips, be sure to check the 505 series, they do everything a chip does — plus. Send today for full details.

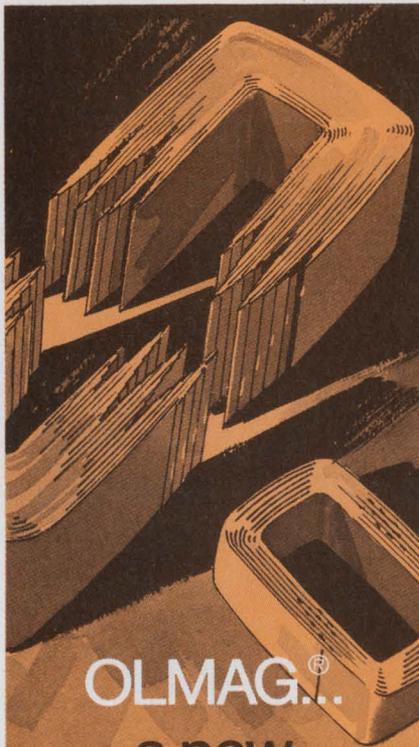


Johanson

MANUFACTURING CORPORATION

400 Rockaway Valley Road, Boonton, N.J. 07005
(201) 334-2676 TELEEX: 13-6432

Electronic Accuracy Through Mechanical Precision



OLMAG[®]

a new and superior design in magnetic cores

An Olmag core requires less than half as much exciting current as a regular C core of comparable size. Watt losses are lower. Operation is quieter.

Unique sawtooth joint design eliminates the usual concentrated gap. Bonding along the edges of the laminations only, instead of between them, minimizes degradation of magnetic properties. Halves cannot be mismatched.

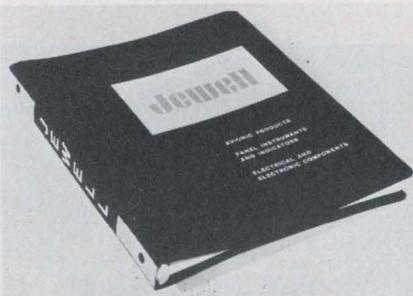
Olmag cores—for applications in the 25-60 Hertz range—are available in standard and custom sizes from 0.1 pound to 10.0 pounds. We also make larger sizes and cores for 400 Hertz applications. Write or call for literature, prices, delivery information and technical assistance.



Olsen Magnetic Inc.

Box 942 • Mt. Vernon, Ill. 62864
Phone 618/244-2670

NEW LITERATURE



Panel meters

A new 50-page catalog describes and illustrates various designs of several panel meter lines. It contains engineering specifications and dimensions on each meter line, which includes elapsed time indicators, taut-band panel meters and null indicators. Meters are available in round, square, rectangular, wing and edgewise styles to fit various equipment designs. Sizes range from 1-1/2-in. through 5-1/2-in. Some meters offer a choice of front or behind-panel mounting. Also included in this catalog is pricing information and a listing of sales representatives and distributors. Jewell Electrical Instruments, Inc.

CIRCLE NO. 393

CRT display software

The broad range of software packages available for the IDIOM interactive graphics display system is described in a concise eight-page brochure. The booklet outlines the function and use of such packages as a FORTRAN package, an MOS master operating system, IDAS and DAS programming systems, an AID debugging package, a TED text-editing subroutine, a TRAK light-pen tracking program and a variety of graphics routines. This extensive library of software combines with the programming convenience and display capabilities afforded by the unique design concept of IDIOM hardware to provide a practicable and economical means of utilizing the display as a direct man-computer interface. Information Displays, Inc.

CIRCLE NO. 394

Information retrieval

A three-page application abstract describes a computer program that enables time-sharing users stationed at desk-side remote terminal devices to perform data-management and information-retrieval functions. Called Aksess, the program can be used effectively by personnel, who have neither computer expertise nor programming ability, to maintain and retrieve files stored on disk units situated at the central computer site. Detailed are Aksess's capabilities, typical applications, and procedure for its use. Three examples show how commands are issued, information is selected, and various calculations are performed. Remote Computing Corp.

CIRCLE NO. 395

Miniature terminals

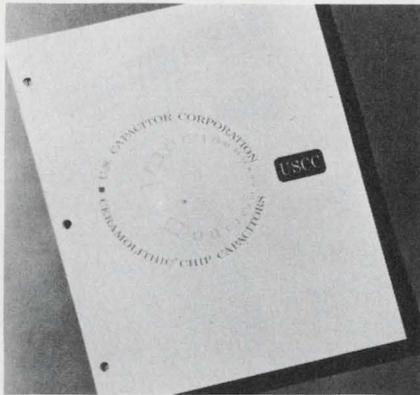
A six-page brochure describes a high-reliability disconnect terminal for electronic pilot or production assembly, cable and harness terminations. Other applications include customized back planes, test panels, programming boards, breadboards, and standard-wire terminations to wire-wrap pins. Also described are hand and machine crimping tools to facilitate crimping the terminals to leads, as well as standard molded housings for multiple, simultaneous terminations. Berg Electronics, Inc.

CIRCLE NO. 396

IC video amplifiers

A new series of video amplifiers useable from dc to 200 MHz is described in a new technical bulletin. In addition to complete characterization, this six-page bulletin contains two pages of applications notes. Specifications are also listed. Silicon General Inc.

CIRCLE NO. 420



Chip capacitors

A broad spectrum of chip capacitors is covered in a 16-page two-color catalog. It gives complete specifications, physical drawings, part numbers and ordering information. A multitude of sizes and capacitance values with the closest tolerances currently obtainable are covered. These provide solutions for most hybrid or integrated circuit problems requiring ceramic chip capacitors. Also included are typical curves for W and NPO dielectric characteristics and detailed test procedures during manufacture and subsequent high reliability testing. Among the charts supplied are capacitance vs temperature, capacitance vs ac voltage, capacitance vs dc voltage and dissipation factor vs temperature. U. S. Capacitor Corp.

CIRCLE NO. 397

Cathode-ray tubes

Selection of cathode-ray tubes is now available in an eight-page technical catalog. In three separate tables, it lists 41 registered screen phosphors and 165 magnetic-deflection and electrostatic-deflection CRTs, according to physical dimensions and operational characteristics. Listed types are categorized as general-purpose, military, industrial or special-purpose. Footnotes are utilized to denote special characteristics such as flat, gray, spherical face-plate and magnetic focus. General Electric Co., Tube Dept.

CIRCLE NO. 398

Rf connectors

Catalog 1069 is an rf connector booklet whose 161 pages cover all major rf connector classifications and sub-types. Included are comprehensive part number cross-reference tables for military to manufacturer and vice versa, and cable data and assembly instructions. Also included are a full line of adapters between series, terminations, and diagrams of mounting holes and mounting plates. Illustrations, dimensions and engineering data for each connector type within a series are shown. Bendix, Microwave Devices Div.

CIRCLE NO. 399

TTL ICs

Series 54H/74H high-speed TTL integrated circuits are the contents of a comprehensive 88-page handbook. It is divided into three sections. One section provides general design characteristics information. A second section on electrical characteristics gives specific test limit and test condition information for device evaluation in integrated circuits. A third section has parameter measurement information with dc and ac measurement methods and procedures. Sprague Electric Co.

CIRCLE NO. 400

Active filters

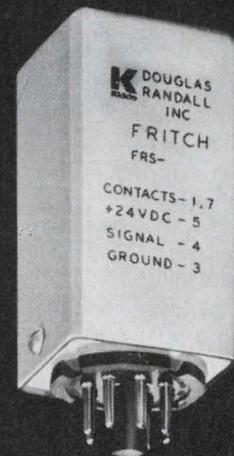
An active filter data package consisting of data sheets, application notes, design notes and general information on the design and selection of active filters is available. The package is of significant use to engineers involved in filter design, communications, data processing and related fields. Three application notes detail the basic analysis of the state-variable filter, estimating filter complexity and tables of normalized section tuning for lowpass and highpass filters. Varadyne, Inc.

CIRCLE NO. 401

INFORMATION RETRIEVAL NUMBER 81 ▶

SWITCH TO FRITCH

FREQUENCY RESPONSIVE SWITCHES



HERE'S WHY:

- Broad Frequency Range ... 20 HZ to 100 KHZ
- Low Signal Power ... as low as 0.3 milliwatts
- Fast Response Time ... up to 150 operations per second
- Solid State Reliability
- Shock and Vibration Resistant
- SPST to DPDT Outputs

Especially Recommended For:
 "TOUCH-TONE"* Decoding •
 Telemetry • Over and Under
 Frequency Control •
 Multi-Zone Alarm Detection
 Over One Telephone Line.

Price in units of 100 ... \$14.40
 (Oscillators also available)

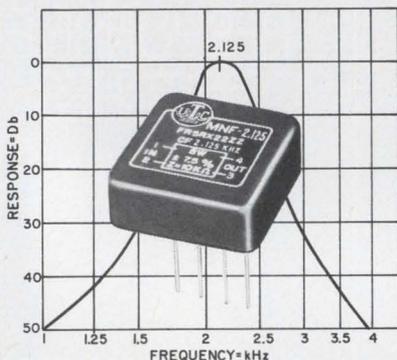
*Registered Service Mark of AT&T.

DOUGLAS RANDALL, INC.

A Division of
 Walter Kidde & Company, Inc.



New miniature filter for MODEM applications.



Designing for modem applications? You'll find this MNF 2.125 band-pass filter precisely what you need. It has a center frequency of 2125 Hz and a pass band from 2025 to 2225 Hz within 1 db. Impedances are 10K ohms source and load.

This tiny filter weighs only 1 oz; measures 1-3/16" square, and 1/2" high. Hermetically sealed. Metal cased. Epoxy terminal board with pin terminals.

UTC has become the leader in filter technology for modems. The filter shown is one of a series of band pass and low pass filters UTC makes for modem applications. Most are available now—in stock.

Contact United Transformer Company, Division of TRW, INC., 150 Varick Street, New York, New York 10013. Tel: 212-255-3500. Ext. 556.



INFORMATION RETRIEVAL NUMBER 82

NEW LITERATURE



Engineering artwork

Durable heat-resistant transfer letters, numerals and symbols are the subject of a new catalog. They are especially designed to meet the needs of the engineer and industrial art director and feature a wide variety of type faces, including the widely used Leroy engineering standard and the new Microfont that is specifically designed for microfilming. Uniform matte density in both black and white insures excellent photographic resolution. Also shown are projection letters, numbers and symbols for use on overhead transparencies, and a wide selection of pressure-sensitive tapes for recurring symbols and patterns. Keuffel & Esser Co.

CIRCLE NO. 402

Instruments & components

A new eight-page sales bulletin lists many electronic components and instruments for sale. Listed are such components as capacitors, resistors, diodes, knobs, waveguides, coaxial switches, attenuators and couplers. Instruments include voltmeters, oscilloscopes, generators, power supplies and bridges. Baynton Electronics Corp.

CIRCLE NO. 403

Computer software

A 12-page brochure outlines new technical services and computer software available. Included in these services are engineering, design automation, computer simulation, project control, computer software and process control. Also included are such services as real-time and communications systems, technical applications, and consultation and contract programming. NCS Computing Corp.

CIRCLE NO. 404



A/d converters

A series of 14 analog-to-digital converters is shown in a new four-page bulletin. Units featured are plug-in printed circuit boards with 8, 10 and 12-bit binary and 12-bit BCD conversion. Included are complete electrical and mechanical specifications plus information on companion mounting cases. All necessary ordering information is included. Computer Products.

CIRCLE NO. 405

Thumbwheel switches

A complete line of thumbwheel switches, including four new series is contained in a six-page, two-color condensed catalog. Emphasized are both the convenience of operation of the switches and the enormous number of standard configurations or standard design variations that are available. Interswitch.

CIRCLE NO. 406

Microwave devices

Catalog 70A is a 12-page brochure that lists a wide variety of receiver components as well as a large selection of wideband FM receivers and transmitters. It includes FM microwave relay equipment, mixer preamplifiers and linear and logarithmic i-f amplifiers. Other items described are discriminators, pulse and rf amplifiers, filters and multipliers. Specifications, descriptions and illustrations are included. RHG Electronics Laboratory, Inc.

CIRCLE NO. 421

Capacitors

Polyester film, metalized polyester film, polystyrene and polycarbonate capacitors are listed in a 16-page catalog. Case types listed include ceramic, phenolic and tape-wrap in cylindrical and flat configurations. Photos, dimensional drawings and performance charts supplement the listings. Included are tolerances, temperature range ratings and lead specifications where applicable. Information on RC networks and special capacitors is also presented. Standard Condenser Corp.

CIRCLE NO. 407

Thyristors

A thyristor product line with over 150 different types of devices is described in a 24-page publication. Included are silicon-controlled rectifiers, diacs and triacs. Detailed matrices show principal characteristics of all the devices. There is a compilation of thyristor type numbers and ratings arranged by family classification. A group of charts present applications information in certain specialized categories. Introductory material includes a brief explanatory note on triac firing modes. RCA Electronic Components.

CIRCLE NO. 408

Programming costs

How to cut programming costs by 40% is the subject of a four-page brochure titled "Applying Computer Science to the Problems of Management." It describes contract services for computers which save costs in implementing programming design, coding, testing and documentation without sacrificing quality. Also described are the software systems design, consulting, and EDP education capabilities of the company which operates in the United States and overseas. International Data Applications, Inc.

CIRCLE NO. 409

CRT displays

Cathode-ray tube display products are described in a new brochure. It includes detailed descriptions of precision CRT displays, as well as display modules such as deflection amplifiers and tube and coil mounts. Also included are linearity and focus-correction circuits, high and low-voltage power supplies and phosphor-protection circuits. Beta Instrument Corp.

CIRCLE NO. 410

IC comparators

Four technical bulletins describe two new voltage comparators. One is a differential voltage comparator and the other is a dual-input voltage comparator. Each of these devices is available in four grades for military and commercial applications. Shown are specifications several typical characteristics curves, maximum ratings and schematic programs. Silicon General Inc.

CIRCLE NO. 411

Semiconductors

Ratings on a wide range of semiconductor devices are given in a 12-page catalog. It includes silicon and selenium bridges, high-voltage rectifiers, and custom assemblies. Custom circuits, package drawings and photographs are also included. A brief description of the relative merits of silicon and germanium materials is presented. General Instrument Corp.

CIRCLE NO. 412

Power supplies

Fourteen different lines of power supplies are indexed by output voltage in a short-form catalog. The 12-page booklet gives full specifications and prices for low and high-voltage dc power supplies, ac line-voltage regulators, and special-purpose power supplies. Raytheon Co., Sorensen Operation.

CIRCLE NO. 413

THE NEW ONE



There's something about AMF's Modular Preamplifiers you won't hear...

It's the noise generated by most preamplifiers. Working in conjunction with selected bipolar or FET semiconductor front end, self-generated noise is reduced to a minimum (less than 400 rms nanovolts). Features include a frequency range from less than 1 Hz to more than 5 MHz, and gain to 60 db. For more information on standard or special Quiet Ones from AMF, contact: Ed Rosenthal, AMF Alexandria Div., 1025 N. Royal St., Alexandria, Va. 22314

AMF
ALEXANDRIA

You can reduce costs by Improving Reliability

**AEROTRONIC ASSOCIATES
CAN HELP YOU KEEP
THE COMPETITIVE EDGE**

with Burn-In and Life-Test Systems custom designed to your own specifications. If you are a large user of semiconductor or IC devices, preconditioning can significantly

reduce sub-assembly or system failures. Eliminate costly rework by

preconditioning semiconductor and IC components.

Reduce SUB-ASSEMBLY FAILURES as much as 80 percent

Reduce SYSTEM failures by 40 to 50 percent

For more information about Aerotronic Associates

Life Test and Burn-In Systems

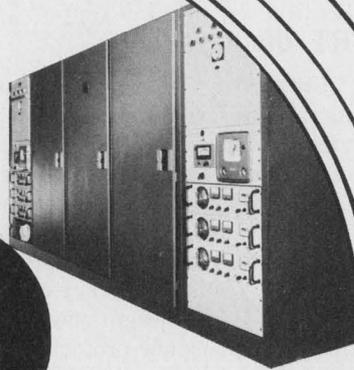
contact

AEROTRONIC ASSOCIATES, INC.

CONTOOCOOK, NEW HAMPSHIRE 03229

TELEPHONE (603) 746 - 3141

INFORMATION RETRIEVAL NUMBER 84



NEW LITERATURE



Rfi filters

A complete line of new low-cost rfi filters for equipment are described in a new design engineering catalog. Complete descriptions and details for 25 standard models are given with drawings and mechanical details. Electrically-detailed are 1, 2, 3, 5 and 10 A versions. Graphical illustrations are complete with attenuation characteristics. Components Corp.

CIRCLE NO. 414



THICK FILM MATERIALS

NEW

Thick Printing Fine Line Gold

ESL #8831 T CERAMIC GOLD CONDUCTIVE CERMET PASTE

- Thick Prints
- Sharp Line and Edge Definition
- Ultrasonic Wire Bondable
- Direct Eutectic Silicon Chip Bondable
- Smooth Glossy Surface
- High Density Film
- High Conductivity

- Conductive Pastes
 - Resistive Pastes
 - Dielectric Pastes
- Literature is available

ESL is a major producer of conductive, resistive and dielectric pastes for thick film and hybrid integrated circuit manufacturers throughout the world.

ESL pastes are formulated to both simplify and speed production with full assurance of the highest quality results. Try ESL products . . . you'll see the difference!

Electro-Science Laboratories, Inc.

1133 Arch Street, Phila., Pa. 19107 • 215/563-1360

215/563-2215 • Cable: ELECTROLAB

INFORMATION RETRIEVAL NUMBER 85

Hybrid semiconductors

Hybrid semiconductor circuits are featured in a 36-page catalog. Listed are hybrid devices with their schematic diagrams and physical and electrical characteristics. The catalog gives characteristic curves, specification tables, dimensional case drawings, applications schematics and test circuits. Circuits include drivers, switches, amplifiers and regulators. Amelco Semiconductor.

CIRCLE NO. 415

Photo-thyristors

The applications of a photo-thyristor are discussed in an eight-page technical brochure. It starts off with an introductory discussion of the device's principles of operation, then proceeds to give applications examples. Seven different examples are thoroughly discussed. Each example application is shown in a circuit schematic configuration. Telefunken Sales Corp.

CIRCLE NO. 416

Temperature sensors

A newly-published 21-page two-color temperature-sensing catalog and reference manual provides data in text and tables, for both thermocouples and thermistors. Capabilities, relative speeds of response and temperature ranges are compared. Included is a line of standard and special mineral-insulated and metal-sheathed thermocouple cables. Specialized high-temperature designs and heavy-duty thermowell assemblies are also shown. The catalog can be used for specifying complete probe assemblies in almost unlimited combinations. Conax Corp. sub. of Easterline Corp.

CIRCLE NO. 417

Filter transformers

Descriptions of lowpass and bandpass coaxial filters and high-power low-loss impedance transformers are contained in a 12-page technical bulletin. By utilizing graphs contained, the design engineer can determine the size, weight, insertion loss and attenuation of an infinite variety of bandpass and lowpass filters. The coaxial filters shown cover a frequency range from 10 MHz to 6 GHz, with bandwidths varying from 1/2 to 100%. Included in the bulletin are standard specifications and prices. Lark Engineering Co.

CIRCLE NO. 418

Allied Radio supplement

A supplement to the 1970 Allied Electronics Industrial catalog number 700 is available. It introduces a wide range of new products for industrial use. This 56-page supplement includes an up-to-date revised semiconductor and integrated circuit directory. It also includes the latest digital display equipment, oscilloscopes, power supplies and other industrial products. Allied Electronics Corp.

CIRCLE NO. 419

The industry leader in fiberglass and ABS thermoplastic cases...

Skydyne offers the industry's most complete line of standard, off-the-shelf fiberglass and thermoplastic transit and operating cases. We also provide custom designs on fiberglass and ABS cases. Our cases are designed to protect against every environmental hazard. We also offer fast delivery of custom designed fiberglass, ABS, and sandwich panel cases to meet all MIL specs. Call or write for our standard price list and catalogs.

Skydyne builds a case for you.

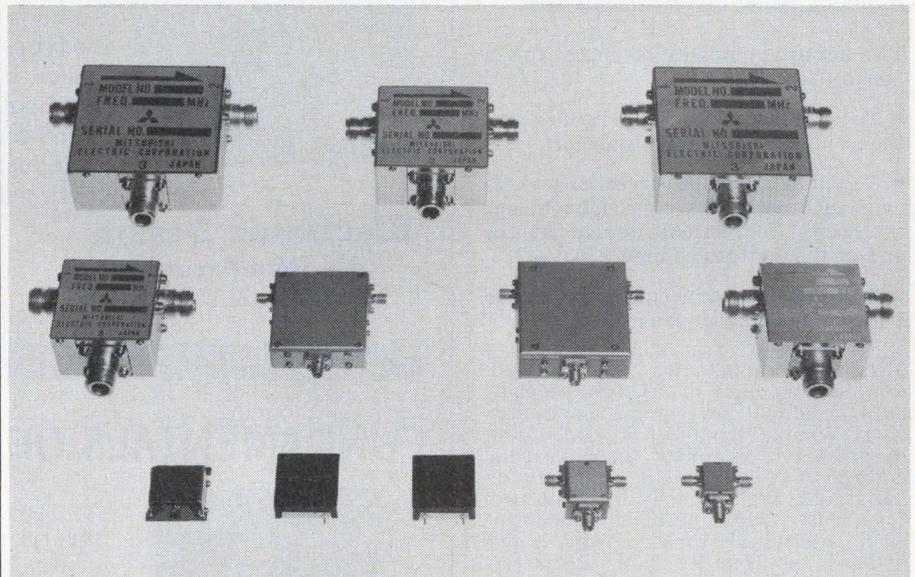


Skydyne[®], Inc.

River Road, Port Jervis, N. Y. 12771 • (914) 856-6655

Subsidiary of **b+p** Brooks & Perkins, Inc.

INFORMATION RETRIEVAL NUMBER 86



Thanks for Visiting the Mitsubishi Booth

We extend our sincere appreciation to all those IEEE Show visitors who took the time to stop by the Mitsubishi Electric booth. The enthusiastic interest shown in the displays was especially encouraging. We are glad to be able to report that our monolithic ICs and mini circulators—VHF, UHF, and SHF, as well as the 700 MHz type—were all favorably received.

Now that the show is over, we welcome any further inquiries from you about the new research developments and techniques.

ADVANCED AND EVER ADVANCING
MITSUBISHI ELECTRIC
Tokyo, Japan

INFORMATION RETRIEVAL NUMBER 87

Electronic Design

ELECTRONIC DESIGN's function is:

- To aid progress in the electronics manufacturing industry by promoting good design.
- To give the electronic design engineer concepts and ideas that make his job easier and more productive.
- To provide a central source of timely electronics information.
- To promote two-way communication between manufacturer and engineer.

Want a subscription? ELECTRONIC DESIGN is sent free to qualified engineers and engineering managers doing design work, supervising design or setting standards in the United States and Western Europe. For a free subscription, use the postfree application form inside the back cover. If none is included, write to us direct for an application form.

If you do not qualify, you may take out a paid subscription for \$25 a year in the U.S.A., \$35 a year elsewhere. Single copies are \$1.50 each.

If you change your address, send us an old mailing label and your new address; there is generally a prepaid postcard for this inside the back cover. You will have to requalify to continue receiving ELECTRONIC DESIGN free.

The accuracy policy of ELECTRONIC DESIGN is:

- To make reasonable efforts to ensure the accuracy of editorial matter.
- To publish prompt corrections whenever inaccuracies are brought to our attention. Corrections appear at the end of the Letters column.
- To refuse any advertisement deemed to be misleading or fraudulent.

Microfilm copies are available of complete volumes of ELECTRONIC DESIGN at \$19.00 per volume, beginning with Volume 9, 1961. Work is now in process to complete the microfilm edition of Volumes 1-8. Reprints of individual articles may be obtained for \$2.00 each, prepaid (\$.50 for each additional copy of the same article) no matter how long the article. For further details and to place orders, contact the Customer Services Department, University Microfilms, 300 North Zeeb Road, Ann Arbor, Michigan 48106; telephone (313) 761-4700.

Want to contact us? If you have any comments or wish to submit a manuscript or article outline, address your correspondence to:

ELECTRONIC DESIGN,
850 Third Avenue,
New York, N.Y. 10022.

Design Data from

Computer-Compatible New Mini-Analyzer



The new 200-line UA-10, the lil' Ubiq™, is compared to the 500-line UA-6A Ubiquitous® Spectrum Analyzer, highlighting savings possible for less demanding production and field applications. On-line frequency domain measurements of vibration, noise, underwater signals, and machine signatures are described. UA-10 is 100 times faster than traditional sweeping systems and has greatly increased resolution over 1/3-octave. The UA-10 is specially designed for accurate testing by inexperienced operators. Advantages of the big precision UA-6A for R&D requiring higher resolution and wider dynamic range are included.

Federal Scientific Corporation
a subsidiary of Elgin National Industries, Inc.
615 West 131st Street, New York, N. Y. 10027

171

How To Write Technical Articles

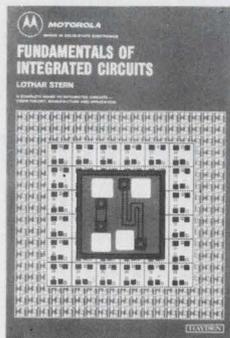


A guide for the engineer-author, "How to Write Articles for Electronic Design" shows how easy it is to write for publication—once the engineer knows what to write and how to write it. The Author's Guide includes a complete run-down of the types of articles published by Electronic Design—plus detailed instructions on how to prepare technical articles and short special features. A MUST for every "would-be-writer" in the electronics industry. Send for your complimentary copy by circling the number to the right.

Electronic Design
850 Third Avenue
New York, N.Y. 10022

172

FUNDAMENTALS OF INTEGRATED CIRCUITS



A practical guide to integrated circuits, their theory, manufacture, and applications. This new guide by Lothar Stern offers complete, highly readable coverage of the various techniques of circuit fabrication, and their effect on circuit design and performance. As to marketing considerations, it compares the characteristics of the numerous IC structures devised to date in terms of economics and logistics. A volume in the Motorola Series in Solid-State Electronics. 198 pages, 7 x 10, illustrated. \$8.95, clothbound. Circle the reader-service number below for 15-day examination copies.

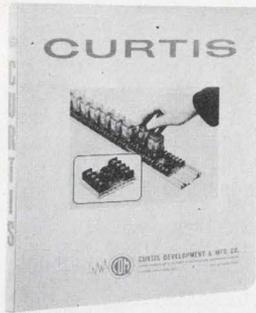
Hayden Book Company, Inc.
116 West 14th Street
New York, N.Y. 10011

173

Manufacturers

Advertisements of booklets, brochures, catalogs and data sheets. To order use Reader-ServiceCard (Advertisement)

NEW RELAY SOCKET ASSEMBLIES CATALOG



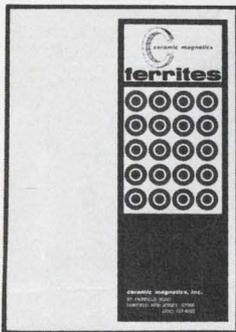
The new Curtis line of printed circuit snap-in track-mounted relay socket assemblies is completely illustrated in this new 2-color, 6 page catalog. Variations include RS8 octal relay sockets, as well as RS11 and RS15 with eleven and fifteen pin relay sockets. Complete dimensional drawings and list prices are included. All units snap in or pop out vertically from prepunched vinyl track and feature Curtis barrier terminal blocks. CSA approved. Send today for your free copy.

See us at booth 321, Design Engineering Show

Curtis Development & Mfg. Co.
3236 North 33rd Street
Milwaukee, Wisconsin 53216

174

Ferrites For Electronics



This new catalog provides detailed engineering information pertaining to ferrite materials, their inherent magnetic characteristics and recommended applications for their optimum usage.

Offered are specific materials designed for:

- Low and Medium Frequency Small Signal Devices.
- Medium to High Frequency Devices.
- High and V.H.F. Devices.
- U.H.F. Microwave and Millimeter Wave Devices.
- Magnetostrictive and Electromechanical Transducers, Couplers and Filters.

Ceramic Magnetics, Inc.
87 Fairfield Road
Fairfield, New Jersey 07006
(201) 227-4222

175

ELECTRONIC KITS CATALOG



Build all **professional** Eico Kits and **save 50%**. The more you know about electronics, the more you appreciate Eico for 25 years uncompromising engineering at lowest cost.

- SOUND N' COLOR® high fidelity color light-works: color organs, strobes, translators.
- SERIES-5® solid state test instruments guaranteed for 5 years.
- CORTINA® solid state stereo receivers, amplifiers, tuners.
- EICOCRAFT® solid state jiffy project electronic kits.

Send for FREE 32-page catalog.

EICO Electronic Instrument Co., Inc.
283 Malta Street, Brooklyn, N. Y. 11207

176

Electronic Design

Advertising Sales Staff

Keith Aldrich
Sales Manager

New York 10022

Robert W. Gascoigne
Thomas P. Barth
Samuel M. Deitch
850 Third Avenue
(212) Plaza 1-5530
TWX: 867-7866

Philadelphia 19066

William C. Repetto
P. O. Box 206
Merion Station, Pa.
(215) MA-3-5888

Boston 01945

Joseph F. Palmer
14 Peter Hobart Drive
Hingham, Mass.
(617) 742-0252

Chicago 60611

Thomas P. Kavooras
Berry Conner, Jr.
200 East Ontario
(312) 337-0588

Cleveland

Thomas P. Kavooras
(Chicago)
(312) 337-0588
(call collect)

Los Angeles 90303

Stanley I. Ehrenclou
W. James Bischof
2930 Imperial Highway
Inglewood, Calif.
(213) 757-0183

San Francisco 94022

Arthur R. Shields, Jr.
175 San Antonio Rd., S 243
Los Altos, Calif.
(415) 941-3084

London W. 1

For United Kingdom and Holland
Brayton C. Nichols
44 Conduit Street
Tel: REGent 4714

Verviers, Belgium

For Continental Europe
Andre Jamar
1, Rue Mallar, 1
(087) 253.83 Telex 41563

Tokyo

Haruki Hirayama
Electronic Media Service
Rm. 601, Daini Miyauchi Bldg.
6-8-14, Roppongi,
Minato-ku
Phone: 402-4556
Cable: Electronicmedia, Tokyo



How would you like to have to get 268 OK's on every decision you make?

If the U.S. Post Office wants to get approval for a new Post Office facility, it has to get a majority of the 535 members of Congress to vote "yes."

That's 268 separate "yeses."

And it has to get them several times between concept and completion. On the average, it takes seven years. Seven years.

Why? Largely because Post Office appropriations have to compete for money with all sorts of requests that are politically more attractive.

So it's no wonder the Post Office tries to make do with inadequate facilities. With crowded buildings, antiquated equipment, almost unbelievable working conditions.

If you had to get 268 OK's in your business, maybe you'd give up. And maybe, like the Chicago Post Office in 1966, you'd break down, too. (Hardly a piece of mail moved for three whole weeks.)

You're in business, and you need the Post Office. You can help put it on a businesslike, efficient basis.

Write or phone your congressman today. Tell him you want to see HR 11750 passed soon. HR 11750. The total Postal Reform bill. The only true Postal Reform bill. The bill to establish a government authority and take the Post Office out of politics.

Write or phone today. Put the Post Office on a businesslike basis. Either you do, or nobody does.

Citizens Committee for Postal Reform

1725 Eye Street N.W. Washington, D.C. 20006
Lawrence F. O'Brien/Thruston B. Morton
National Co Chairmen

Space contributed by
Hayden Publishing Co. Inc.

Advertisers' Index

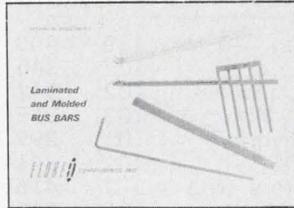
Advertiser	Page	Advertiser	Page
ACDC Electronics, Inc.	C50 A-H	General Automation, Inc.	C61
AMF, Alexandria	121	General Dynamics	78, 79
AMP, Incorporated	C38, C39	General Electric Company	C52, C53, 55
Abbott Transistor Laboratories Incorporated	13	General Radio Company	40
Acopian Corp.	23	Grant Pulley & Hardware Corporation	C50
Adams & Westlake Company, The	101	Grayhill, Inc.	64
Adar Associates, Inc.	35		
Advanced Memory Systems, Inc.	95	HEI, Inc.	52
Aerotronics Associates, Inc.	122	Hansen Manufacturing Co., Inc.	100
Ammon Instruments, Inc.	112	Hayden Book Company, Inc.	54, C56, 124
Amperex Electronic Corporation	C4	Hewlett-Packard	1, 6, C33, 44, 45, 62
Amphenol, The Bunker-Ramo Corporation	14, 15	Hoffman Engineering Company	64
Arnold Magnetics Corp.	116	Honeywell, Computer Control Division	31
Astro-Space Laboratories, Inc.	58	Hughes Aircraft Company, MOS Division	C37
Augat, Inc.	113		
Automatic Electric Company	4, 5		
		IMC Magnetics Corporation	C67
Beckman Instruments, Inc., Helipot Division	91	ISC Magnetics Division of Instrument Systems Corporation	C66
Bodine Electric Company	12	Indiana General Division of Electronic Memories & Magnetics Corporation	10
Buckbee Mears Company	C63	International Electronic Research Corporation	17
By-Buk Company	127		
		JFD Electronics Corp./Components Division	108
C & K Components, Inc.	64	Johanson Manufacturing Corp.	117
Cambridge Thermionic Corporation	56	Jonathan Manufacturing Company	89
Ceramic Magnetics, Inc.	125		
Cinch, Division of United Carr	Cover II	Keithley Instruments, Inc.	103
Cincinnati Milling Machine Co.	C68	Keltec Florida, A Division of Aiken Industries, Inc.	C57
Columbia Components Corp.	C65	Kepeco, Inc.	C3
Computer Microtechnology, Inc.	C16, C17	Kidde & Company, Inc., Walter	119
Curtis Development & Mfg. Co.	124	Krohn-Hite Corporation	16 A-B
Cutler-Hammer	43	Kurz-Kasch, Inc.	102
Dale Electronics, Inc.	C43	Lear Siegler Inc.	11
Datascan, Inc.	C2		
Digital Equipment Corporation	C24	3M Company, Scotchpar	60, 88
Douglas Randall, Inc.	119	MacBar Mechanisms Inc.	58
Dow Corning Corporation	48, 49	McLean Engineering Laboratories	109
Dumont Oscilloscope Laboratories, Inc.	C55	Malco Manufacturing Company, Inc.	C51
Dzus Fastener Co., Inc.	125	Mallory Capacitor Company	51
		Microsonics, Inc.	36
E-H Research Laboratories, Inc.	C49	Mid-Eastern Industries, A Division of Eanco, Inc.	56
EICO Electronic Instr. Co., Inc.	124	Mitsubishi Electric	123
Elco Corporation	C47	Monroe, A Division of Litton Industries	C22, C23
Eldre Components, Inc.	127	Monsanto Company	Cover III
Electro-Science Laboratories, Inc.	122	Motorola Semiconductor Products, Inc.	8, 9
Electronic Design	38, 39, 124		
Electronic Research Associates, Inc.	46	National Semiconductor Corporation	70, 71
English Electric Valve Co., Ltd.	64A	Nortronics Company, Inc.	104
Erie Technological Products, Inc.	7	Nuclear Corporation of America	C26
Fairchild Controls, A Division of Fairchild Camera and Instrument Corporation	C32	Oak Electro/Netics Corp.	58
Fairchild Semiconductor, A Division of Fairchild Camera and Instrument Corporation	96 A-B-C	Olsen Magnetics Inc.	118
Federal Scientific Corporation	47, 124	Owens-Illinois, Electronic Materials	33
Fluke Mfg. Co., Inc., John	50		

Design Data from Manufacturers

Advertisements of booklets, brochures, catalogs and data sheets. To order use Reader-Service Card.
(Advertisement)

Advertiser	Page
Penn Engineering & Mfg. Corp.	127
Portescap U. S.	56
Qualidyne Corporation	C34
RCA Electronic Components and Devices	16, 61, Cover IV
Raytheon Computer	C40, C41, C59
Raytheon Company, Semiconductor Operation	C20, C21
Remex Electronics Unit of Ex-Cello Corporation	C54
Rohde & Schwarz	64B
Roper-Whitney, Inc.	111
Schrack Electrical Sales Corp.	115
Siliconix Incorporated	57
Simpson Electric Company	99, 107
Singer Company, The, Diehl Division.....	C31
Singer-General Precision, Inc., Kearfott Division	C62
Skydyne, Inc.	123
Solitron Devices, Inc.	34, 65
Sprague Electric Company	18, 83
Standard Condenser Corporation	110
Sylvania Precision Materials, Parts Division	53
Syntronic Instruments, Inc.	115
Systron-Donner Corporation	2
TEC Incorporated	C66
Tektronix, Inc.	C30
Teletype Corporation	C18, C19
Teradyne	20
Texas Instruments Incorporated, Components Group	27
Tri-Data	60
Trio Laboratories, Inc.	C48
Triplett Corporation	93
Trygon Power Supplies	C64
Tung Sol Division, Wagner Electric Corporation	C45
United Telecontrol Electronics.....	C44, C58
United Transformer Co., Division of TRW, Inc.	120
Unitrode Corporation	29
Vactec Inc.	C60
Vector Electronic Co. Inc.	111
Veeder-Root	105
Vernitron Corporation	60
Welch-Allyn, Inc.	37
Weston Instruments, Inc., Newark Division	59
Wilson Technical Service, H. A.	52
Winchester Electronics, Division of Litton Industries	C35
Xerox Data Systems	C27
Zenith Radio Corporation	C64

Bus Bars For Noise Reduction



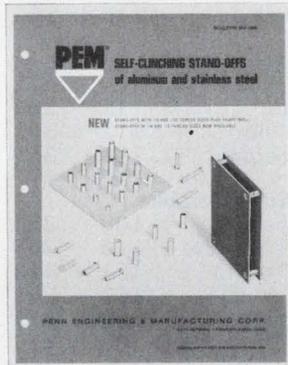
A 16 page Technical Bulletin is now available, describing a new concept in power or signal distribution. Basic mechanical and electrical design principles, along with descriptive pictures and diagrams, are included in this bulletin. These compact buses can replace bulky cable harnesses and repetitive wiring for computer or modular application. This method of construction satisfies the demanding requirements of low inductance and resistance of high speed, solid state systems, while controlling electrical noises.

Send For Free Sample

Eldre Components, Inc.
1239 University Avenue
Rochester, New York 14607

177

PEM® Self-clinching Standoffs



PEM self-clinching standoffs facilitate assembly and production of stacked components. With a firm squeeze, PEM standoffs are permanently mounted in predrilled holes in metal panels as thin as .040". They are made in aluminum and both 416 and 303 stainless steels in two styles — one with through threads and the other a blind design with threads terminated within the standoff. Both styles present a flush surface on one side of the panel after installation and the blind standoff provides a solid as well as a flush surface. PEM standoffs are available with 4-40, 6-32, 8-32 and 10-32 threads in lengths to 1-1/16".

Send for this free bulletin of PEM self-clinching standoffs — manufactured exclusively by —

Penn Engineering & Manufacturing Corp.
Doylestown, Pa. 18901

178

DRAFTING AIDS CATALOG



Send today for the By-Buk Printed Circuit Drafting Aids P-45 Catalog featuring the most comprehensive listings of basic pressure sensitive printed circuit drafting shapes, tapes and aids. Contains thousands of pads, tees, elbows, corners, donuts, connectors, fillets, colored tapes, multi-pads for dual in-lines, flat packs, TO cans and more. Here is your guide to better printed circuit drafting. Scores of ideas to speed master artwork preparation time and reduce drafting costs. Send for your free catalog and samples.

By-Buk Company
4326 West Pico Blvd., Los Angeles, Calif. 90019
Phone: (213) 937-3511

179

Product Index

Information Retrieval Service. New Products, Evaluation Samples (ES), Design Aids (DA), Application Notes (AN), and New Literature (NL) in this issue are listed here with page and Information Retrieval numbers. Reader requests will be promptly processed by computer and mailed to the manufacturer within three days.

Category	Page	IRN	Category	Page	IRN	Category	Page	IRN
Components			ICs, TTL (NL)	119	400	New Literature		
capacitors (NL)	121	407	level shifter	102	340	Allied catalog	123	419
chips, resistor	99	292	logic arrays, LSI	102	342	amplifiers, video	118	420
components (NL)	120	403	logic arrays, MSI	103	345	artwork, drafting	120	402
CRTs (NL)	119	398	memories, hybrid	101	299	capacitors	121	407
delay line, DIP	98	290	memory, MOS	102	341	capacitors, chip	119	397
encoder, incremental	97	285	photo-thyristors (NL)	122	416	comparators, voltage	121	411
filters, active (NL)	119	401	rectifiers, 500-A	102	343	components	120	403
filters, ceramic	98	288	rectifiers, bridge (NL)	117	390	computer handbook	117	389
filters, rfi (NL)	122	414	regulators, voltage	100	297	computer software	120	404
isolators, solid-state	98	286	semiconductors (NL)	121	412	connectors	117	391
motor glossary (AN)	116	388	suppressors, voltage	100	295	connectors, rf	119	399
readout tubes	98	289	switch, analog	100	298	converters, a/d	120	405
readout tubes (NL)	117	392	thyristors (NL)	121	408	CRTs	119	398
relay, reed	98	291	Instrumentation			display software	118	394
sensors, temp (NL)	123	417	counter, event	110	366	display, CRT	121	410
switch, 6-A toggle	98	287	generator, pulse	110	363	filters, active	119	401
switch, pushbutton	99	293	meters, panel (NL)	118	393	filters, rfi	122	414
switches (NL)	120	406	noise (AN)	116	387	hybrid IC devices	122	415
			supply, bias	110	365	ICs, TTL	119	400
			voltmeter, analog	110	364	information retrieval	118	395
Data Processing			Microwaves & Lasers			meters, panel	118	393
cassette, metal	C42	273	microwave devices (NL)	120	421	microwave devices	120	421
computer	C60	278	mixers, diode	111	368	photo-thyristors	122	416
computer, digital	C36	268	source, Ka-band	111	367	power supplies	121	413
computer manual (NL)	117	389	substrates, ceramic	111	369	programming costs	121	409
computers, terminal	C42	267	Modules & Subassemblies			readout tubes	117	392
converter, voice	105	351	converter, d/a	108	357	rectifiers, bridge	117	390
coupler, acoustic	C64	270	converters, a/d (AN)	116	385	semiconductors	121	412
data entry system	C62	283	displays, CRT (NL)	121	410	sensors, temperature	123	417
data terminal	C54	264	filter, active	109	361	switches, thumbwheel	120	406
data terminal	C58	253	hybrid IC devices (NL)	122	415	terminals	118	396
data transfer system	C58	280	modules, hybrid circuit	108	356	thyristors	121	408
display, time-shared	C42	260	multiplier, 2-quadrant	108	359	transformers	123	418
display terminal	C41	265	power supplies (NL)	121	413			
display terminal	C46	261	power supply, flatpack	109	362			
generator, display	104	346	readout, legend	109	360			
memories	106	252	voltage converter	108	358			
memories, core	106	353	Packaging & Materials					
memory, read/write	106	352	artwork, drafting (NL)	120	402			
modems and couplers	C60	271	artwork patterns (ES)	114	381			
multiplexer	106	258	breadboard system	112	372			
multiplexer	107	263	bushings, cable (ES)	114	382			
multiplexers	107	255	cable nomogram (DA)	115	384			
printer, computer	C62	251	circuits, flexible	112	371			
printers, on/off-line	C46	269	connectors	112	374			
reader, microfiche	104	349	connectors (NL)	117	391			
recording system	105	350	connectors, rf (NL)	119	399			
scan coverter	C64	274	foams chart (DA)	115	383			
storage terminal	C51	266	gasketing, emi	112	370			
tape cleaner/certifier	106	354	gaskets, rfi/emi (ES)	114	377			
tape drive, cassette	C54	256	glass, semiconductor	112	373			
tape drive, cassette	104	348	metal, high-temp (AN)	116	386			
tape reader/rewinder	106	355	mount, harness (ES)	114	380			
tape recorder	C58	250	tag, steel (ES)	114	378			
tape transport	C46	254	terminal blocks (ES)	114	379			
transmitters	104	347	terminals (NL)	118	396			
ICs & Semiconductors			Tools & Engineering Aids					
amplifier	100	296	desoldering kit	113	375			
amplifier, agc	102	344	meter, soldering	113	376			
amplifiers, video (NL)	118	420						
comparators, voltage (NL)	121	411						
decoder/driver	100	294						



**No matter how you look at it,
this new counter gives you the most performance
at the lowest cost of usership.**

The initial cost of the 110B—low as it is—is only half the story. It's the total cost of usership over the life of the instrument that determines the true performance value. With over 60% MSI construction for the ultimate in reliability, extensive use of plug-in IC's, wide-open, clean internal layout for optimum serviceability (and minimum downtime),

plus the no-nonsense Monsanto 2-year warranty, the Model 110B sets new records in low cost of usership.

OK, how about performance?... Glad you asked. Here are just six of the features available in the Model 110B Counter/Timer—

1. Frequency range: 0 to 150 MHz
2. Pulse pair resolution: < 7 nsec

3. TTL Logic
4. BCD output (TTL compatible)
5. All functions programmable
6. Human factors engineering inside and out for maximum convenience

Prices begin at \$1285. Write for technical details. Monsanto Electronic Instruments, 600 Passaic Ave., West Caldwell, New Jersey 07006.

The new RCA-TA7493 for 12-V service.

It's moisture-proof for reliable
2-way communications.

TA7493 is a high-power, low-voltage
RCA "overlay" transistor with emitter ballasting.
A completely hermetic, ceramic-metal package
prevents moisture contamination and
assures long-life performance.

It is ideally suited for VHF mobile
and marine transmitters.

The TA7493 offers a 25-watt (min.)
output at 175MHz. It features
low-inductance radial leads
(electrically isolated from the stud),
making this silicon device particularly
useful for stripline circuits.

It has been life-tested at full-rated output
to provide you with the most reliable transistor of
its kind: the dry transistor from RCA.

For more information, see your local

RCA Representative or your RCA Distributor.

For technical data, write RCA Electronic Components,

Commercial Engineering,* Harrison, N. J. 07029.

In Europe: RCA International Marketing S.A.,

2-4 rue du Lièvre, 1227 Geneva, Switzerland.

RCA

The Dry Transistor

