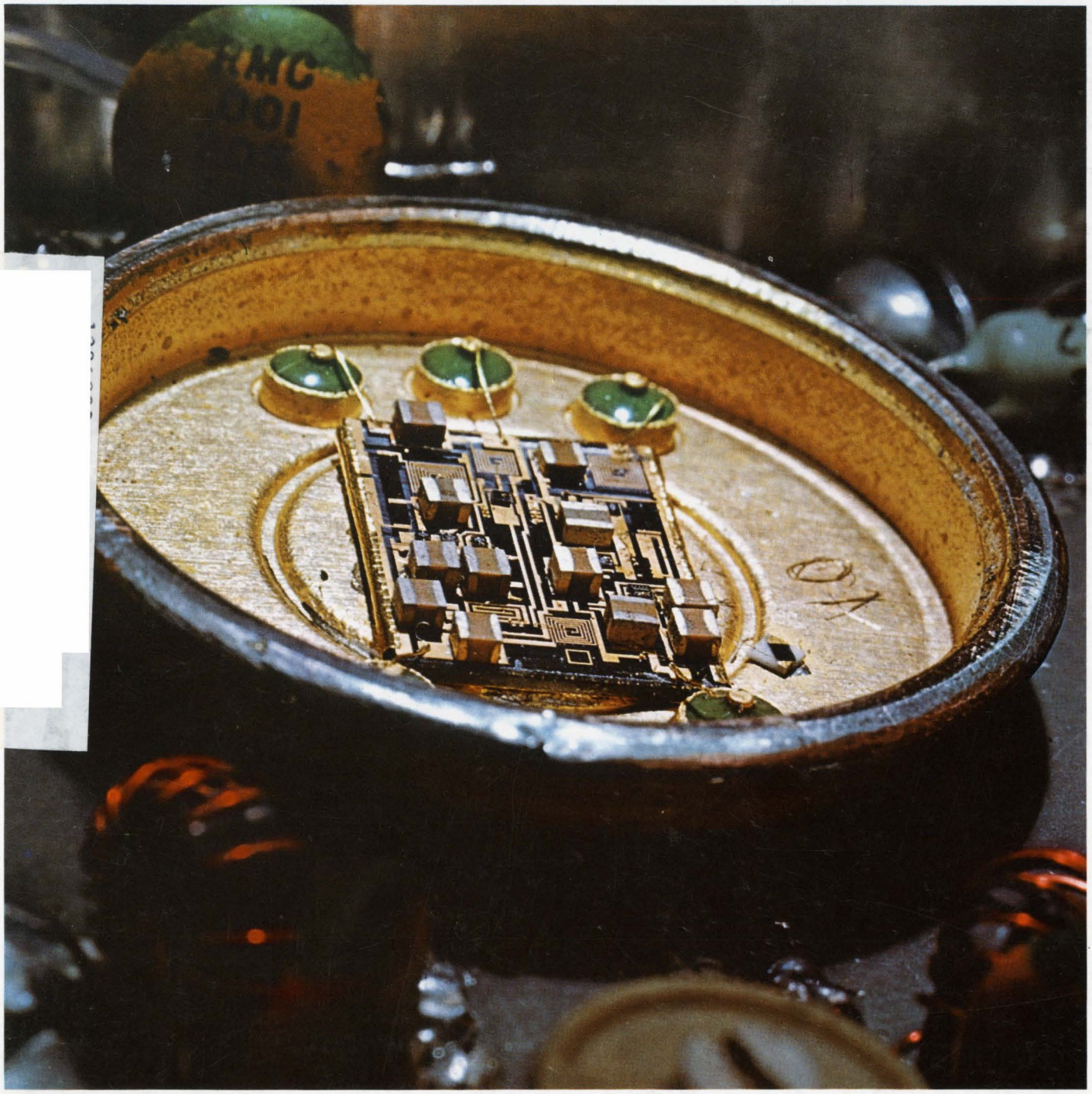
VOL. 18 NO. 8

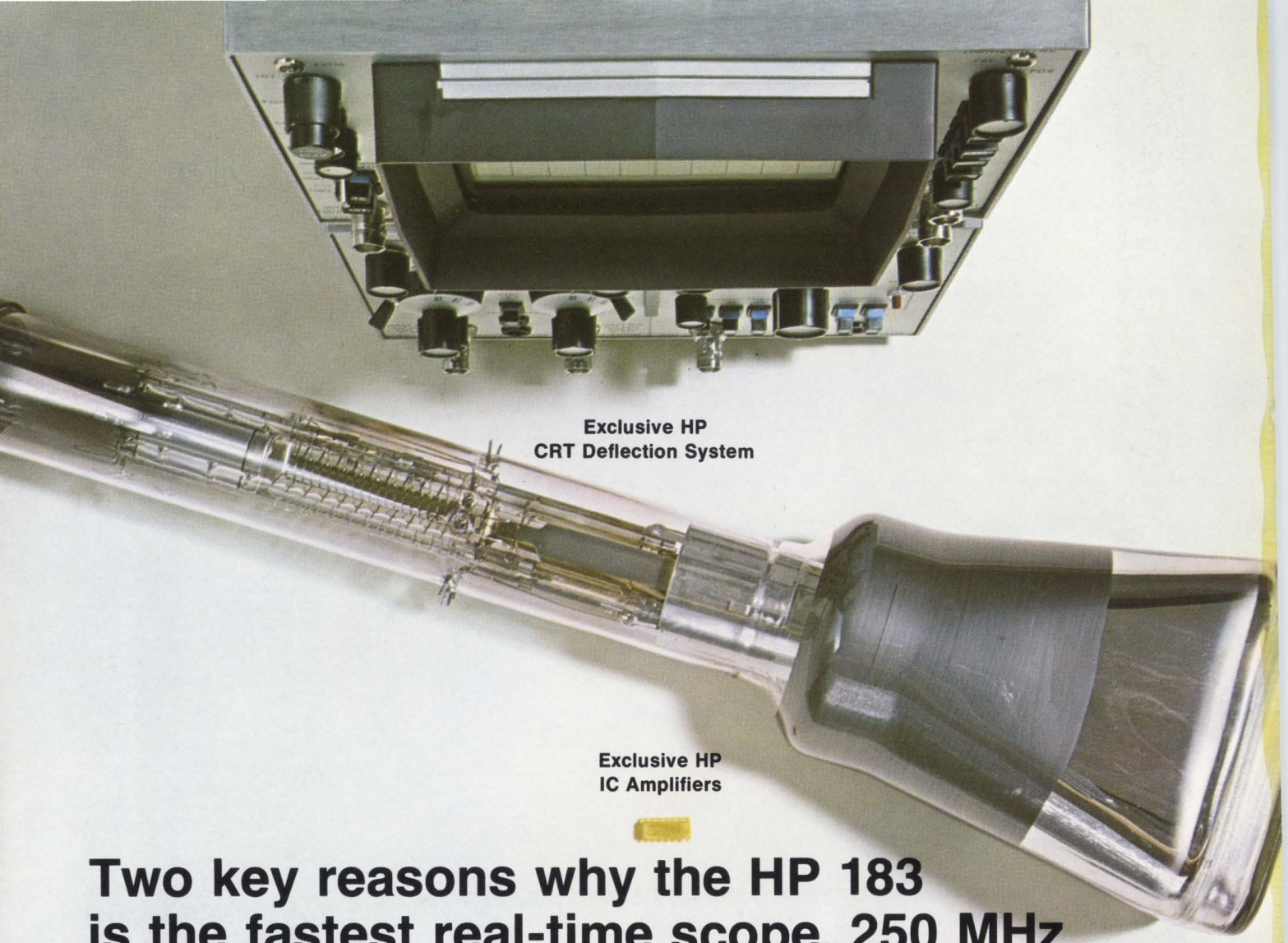
Electronic Design

FOR ENGINEERS AND ENGINEERING MANAGERS

APRIL 12, 1970

A new billion-dollar industry? Cable TV is aiming to become the broadband communications medium of the future. What will it offer American homes? Fire and burglar alarms, mail delivery, computer terminals? Already hybrid IC technology is pointing to better amplifiers and filters in cable equipment. Story on p. 62.





Exclusive HP CRT Deflection System

Exclusive HP IC Amplifiers

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

080/7

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

Here are some of the tasks performed by this new, DC-to-VHF real-time window—display intermittent pulse trains with nanosecond risetime, capture fast transients, take a look at amplitude-modulated carriers ahead of a detector.

This is a **big jump in real-time waveform displays.** HP's technical leadership, covering a wide area of disciplines, has made it possible. An in-house IC capability has produced **monolithic transistor arrays** for the vertical amplifier—key factor in achieving **good transient response with 250 MHz bandwidth** and high-fidelity reproduction of waveforms.

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

HP's step-ahead CRT technology produced a unique CRT to display fast signals. It utilizes two transmission lines for the vertical deflection system. They provide distributed deflection of the electron beam, **giving the CRT a cutoff frequency well beyond 500 MHz.** Other features of this exclusive CRT are a low deflection factor, high brightness and fast writing speed.

Because the vertical deflection system of this CRT is directly accessible to the vertical plug-in, the **183A mainframe can accept any of the 180 series plug-ins**—to make it a true, general-purpose scope. Since the 183A is **not mainframe limited** you can take advantage of HP innovations in higher frequency plug-ins as they become available.

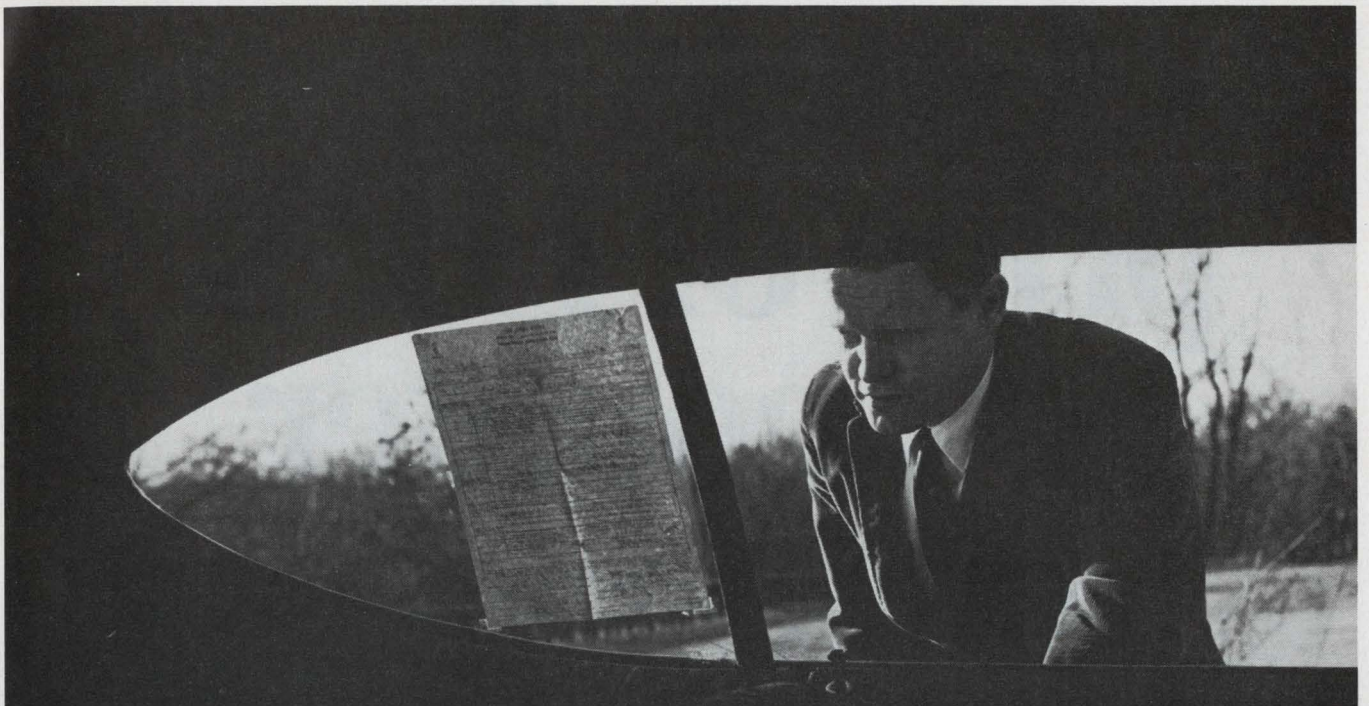
This is the year of the big change for the oscilloscope industry. You'll be making a buying decision that you will have to live with for some time to come. It stands to reason that the step-ahead thinking exemplified in the HP 250 MHz scope also exists in all HP scopes. **If you are not now convinced** Hewlett-Packard is best, try a side-by-side comparison with any other scope. Call your HP field engineer to arrange a comparison.

The HP 183 is only one of a family of high performance scopes—including sampling and storage. Write, Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland. Price, HP 183A with 250 MHz plug-ins: $3150.

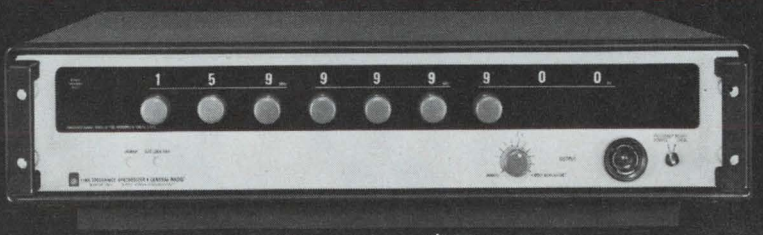
HEWLETT hp PACKARD

OSCILLOSCOPE SYSTEMS

INFORMATION RETRIEVAL NUMBER 242



THE "INTERMEDIATE" SYNTHESIZER



160 MHz for $5900

Buying a frequency synthesizer has been something like buying a car. There's a confusion of models, options, and price ranges. Except – there has never been a so-called "intermediate"-model synthesizer. That's because price and performance ranges of synthesizers have tended to cluster just at both ends of the spectrum. The choice was between lower-cost, limited-frequency-range models and those with everything, including a sky-high price tag. So, the buying decision was one based on either trade-off or over-capability.

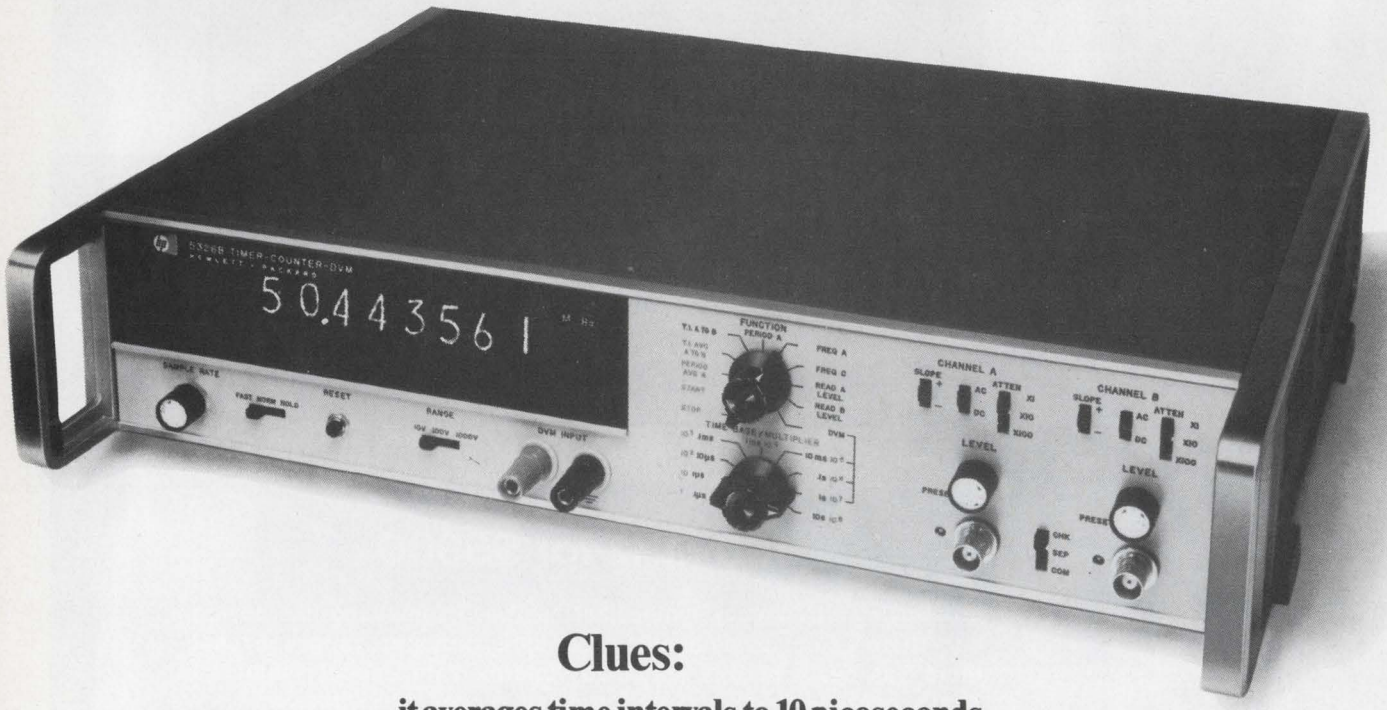
This is not true any longer! GR has filled the price-capability gap with the new 1165 Frequency Synthesizer. Frequency range is wide, 0.01 to 160 MHz in 100-Hz steps. The price is only $5900, less than half the price it used to cost to get 160 MHz. If you can furnish your own frequency reference signal (5 or 10 MHz), you can get a model for only $5300. In the $5900 model, frequency accuracy is maintained either by an internal precision 10-MHz oscillator (1 x 10^{-9} per day) or by an external drive or lock source. Output is 0.1 to 1 V into 50 ohms. Both frequency and level can be externally programmed; the 1165 is ideal for applications requiring remotely-programmed local oscillators. Harmonics are typically down 30 dB (at maximum output into 50-Ω load); spurious, discrete non-harmonic signals are typically down 60 dB.

For complete information, write General Radio, West Concord, Mass. 01781; telephone (617) 369-4400. In Europe: Postfach 124, CH 8034, Zurich, Switzerland.

GENERAL RADIO

INFORMATION RETRIEVAL NUMBER 2

Guess the price of HP's new counter



Clues:

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

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

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

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

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

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

HEWLETT hp PACKARD

ELECTRONIC COUNTERS

02003

INFORMATION RETRIEVAL NUMBER 3

Electronic Design

VOL. 18 NO. 8

FOR ENGINEERS AND ENGINEERING MANAGERS

APRIL 12, 1970

NEWS

TECHNOLOGY

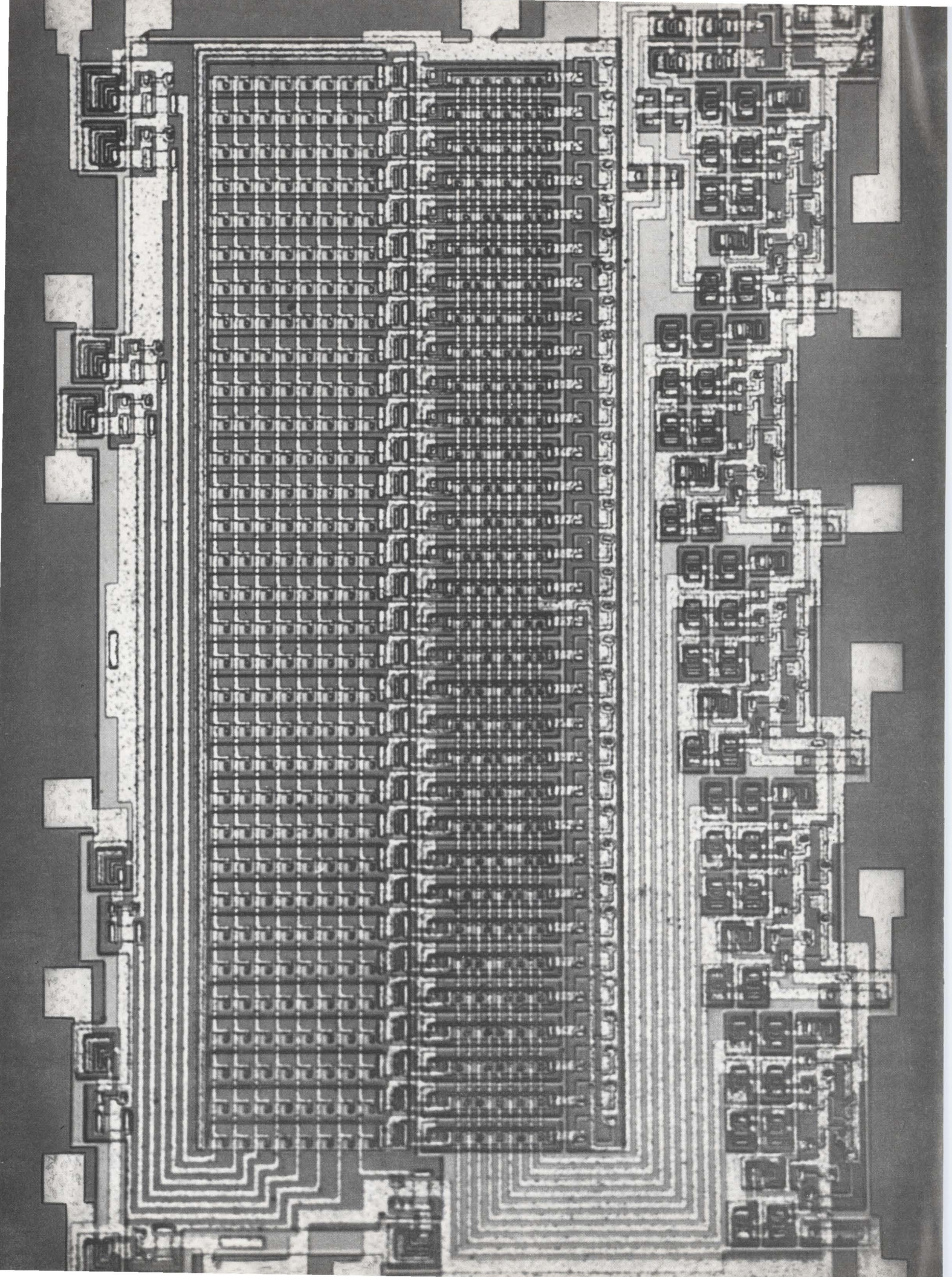
PRODUCTS

Departments

Cover: A hybrid IC cable TV amplifier developed by Anaconda Electronics

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

81,801 copies this issue.



If you think Sylvania only makes pre-programmed ROMs, you haven't begun to scratch the surface.

And that's exactly what you have to do to find out how useful our SM-320 read-only memory is.

We'll sell you one of these 256-bit (32 words by 8 bits) functional arrays in its virgin state. All the outputs will be a logic "0".

All you have to do is scratch the surface of the chip, breaking the emitter connection wherever you want a logic "1" to appear at the output.

That's all there is to programming your own special data into the SM-320 ROM.

Of course, this is fine for prototyping. But, it's not what you want for quantity production.

And that's where we come in.

After you get your ROM pattern perfected, send it to us and we'll make up a special mask to match your code.

You'll have your production quantities before you know it.

The SM-320 has on-chip decoding (5 bits for 32 words) and is completely compatible with SUHL logic circuits and other TTL systems.

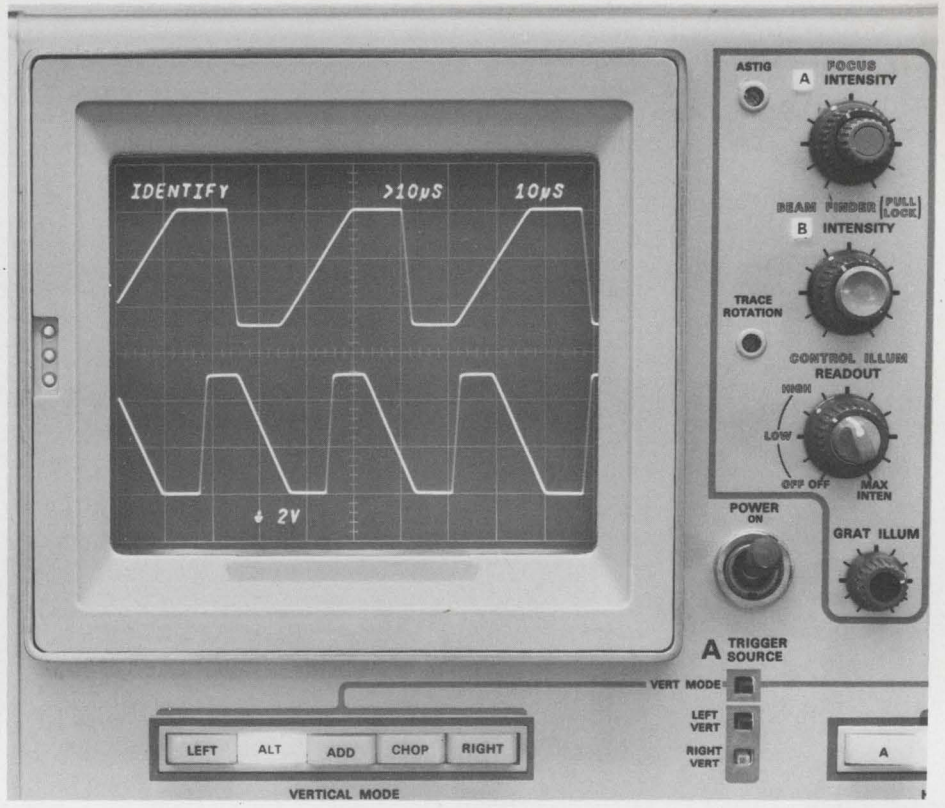
The next time you have an ROM problem, don't scratch your head, scratch a Sylvania SM-320. It just might get you out of a tough scrape.

Sylvania Electronic Components, Semiconductor Division, Woburn, Mass. 01801

SYLVANIA
GENERAL TELEPHONE & ELECTRONICS

INFORMATION RETRIEVAL NUMBER 4

Auto Scale-Factor Readout



means faster measurements with fewer errors

The New Tektronix 7000-Series Oscilloscope System has AUTO SCALE-FACTOR READOUT—just one of many new convenience features which refine waveform measurement ease. Auto Scale-Factor Readout labels the oscilloscope graph with deflection factors and sweep speeds, invert and uncalibrated symbols, and identifies the trace and its data. When magnified sweeps and the New P6052 or P6053 10X probes are used, the readout is automatically corrected. Press either a probe-tip or front-panel switch, the trace shifts vertically and its deflection factor is replaced by the word IDENTIFY to associate waveforms with scale factors. Scale factors of *inverted* and *uncalibrated* displays are prefixed by invert (↓) and uncalibrate (>) symbols. Now, you can forget the inconvenience of hand labeling photographs. With AUTO SCALE-FACTOR READOUT you look in only one place for accurate data. On the CRT where it's displayed automatically . . . with the waveforms!

New Convenience, a Wider Performance Spectrum, and Four Plug-In Flexibility are some factors which make the New Tektronix 7000-Series Oscilloscopes an asset to your measurement capabilities.

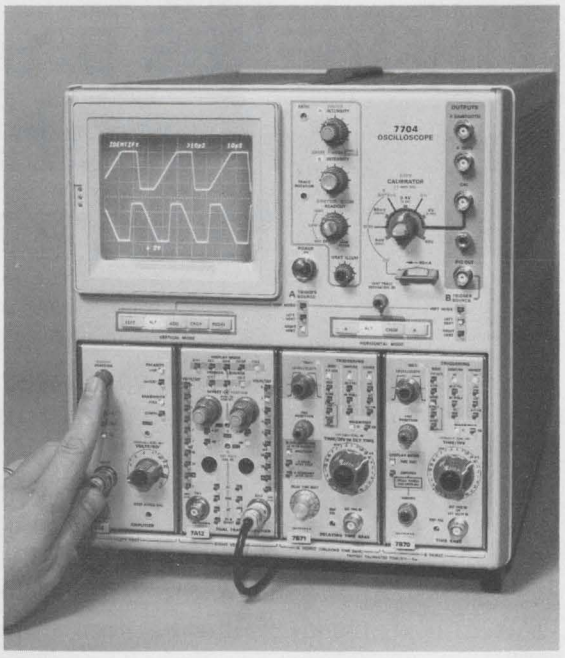
Prices of Instruments shown:

7704	DC-150 MHz Four Plug-In Oscilloscope	$2500
7A12	Dual-Trace Amplifier Plug-In	$ 700
7A16	Single Trace Amplifier Plug-In	$ 600
7B71	Time-Base Plug-In	$ 685
7B70	Time-Base Plug-In	$ 600

Note: 7504 DC - 90 MHz Four Plug-In Oscilloscope with Auto Scale-Factor Readout $2000

U.S. Sales Prices FOB Beaverton, Oregon

For information, call your local Tektronix Field Engineer or write: Tektronix, Inc., P. O. Box 500, Beaverton, Oregon 97005.



The Readout System presently displays up to 49 symbols and responds to various functional instructions. Less than half of the symbols are needed for today's plug-ins.

Tektronix, Inc.

committed to progress in waveform measurement

INFORMATION RETRIEVAL NUMBER 5

INFORMATION RETRIEVAL NUMBER 6 ►

Next time you spec a solenoid, odds are 61,034 to 1 that Guardian can provide the one that will do the job. Because we've got that many standards . . . solenoids in every imaginable shape and size to meet virtually any electro-mechanical requirement. AC or DC. Hefty 50 pound pull or a fraction of an ounce. Intermittent or continuous duty. Pull or push. Laminated, C-frame, box-frame or tubular. In 25 basic designs and 61 thousand variations. Not enough? Then we'll custom engineer a solenoid to fit your specialized application. (And you didn't know there was a Guardian Angel watching over engineers!)

NEW 44-PAGE GUARDIAN SOLENOID CATALOG is yours for the asking. Write for Bulletin G-3.

GUARDIAN® ELECTRIC MANUFACTURING COMPANY
1550 West Carroll Avenue, Chicago, Illinois 60607

Your Guardian Angel stacks the odds in your favor

(61,034 to 1)

The ZA801 is a low-cost FET-input op amp. It comes in four different packages. It has a DC gain of 100,000, ±10 volts output, and a full-power frequency response of 200 kHz. Voltage drift is 50 μV/°C and input bias current is 25 picoamps. In quantity, price is as low as $11.90.

Why four different packages? We had the idea that designers might like to get to know one op amp well, then use it whenever they could—without having to think about package density. So we put the ZA801 in a TO-8 can, a plastic DIP, a hermetically-sealed DIP, and a modular flat pack.

We're the first to offer this idea of total package capability. The competition will undoubtedly copy us. But before they can get the first one off the ground, we'll have another—and then another.

This sort of answers the question, "Hey Zeltex, what have you done for me lately?"

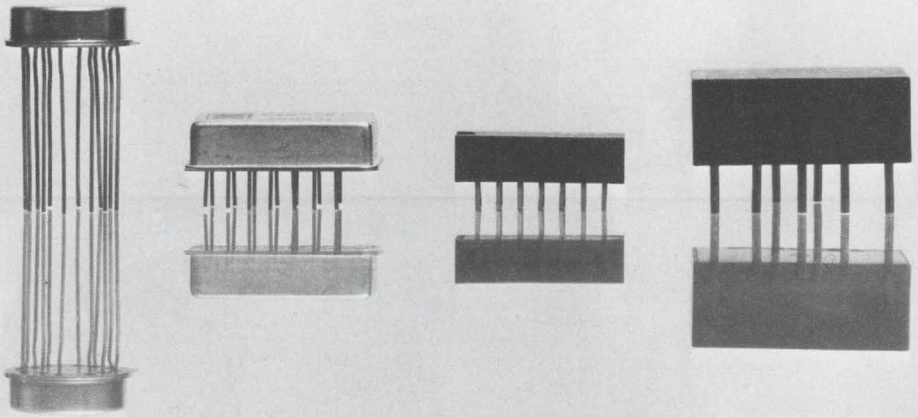
SPECIFICATIONS	
DC Gain (at rated load, min.)	100,000
Minimum output	±10V @ 5 mA
Unity Gain (min.)	4 mHz
Full-power output frequency (typ.)	200 kHz
Maximum voltage drift	50 μV/°C
Common mode rejection (±10V) (typ.)	10,000:1
Input Bias Current (max.)	25 pA
Input voltage noise (10 Hz to 10 kHz)	3 μV rms
QUANTITY PRICES	
ZA801M1 Modular Flat Pack	$11.90
ZA801D1 Plastic DIP	22.00
ZA801E1 Hermetically-sealed DIP	34.00
ZA801T1 TO-8 can	28.00

All four ZA801 packages are available from stock. Call your Zeltex rep for evaluation samples.

To receive a ZA801 data sheet, plus information about the complete line of Zeltex FET-input amplifiers, circle the reader service number below, or write

Zeltex INC.

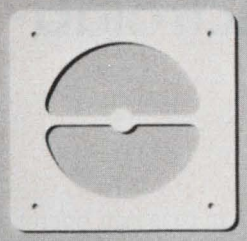
A SUBSIDIARY OF REDCOR CORP.
1000 Chalomar Road, Concord, California 94520
Phone (415) 686-6660



These are the ZA801

INFORMATION RETRIEVAL NUMBER 7

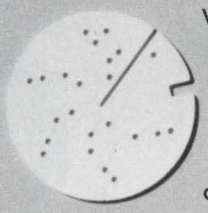
INFORMATION RETRIEVAL NUMBER 8 ►



an apology from

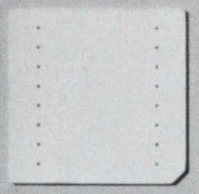
AlSiBase®

CERAMIC SUBSTRATES



We extend sincere apologies to our good customers where we could not fill your full substrate requirements in 1969.

1969 saw AlSiBase® substrate production at an all time high. We had foreseen a healthy increase in your demands, but you went far beyond our highest estimates.

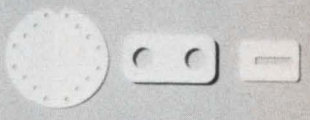


What to do? Should we relax our standards, use partly trained personnel, and make promises based on hope instead of reason?

We chose to do it the American Lava way. Quality was maintained, and expansions were started that are now coming on stream.

Our R&D engineers pioneered ceramic substrates almost twenty years ago. They developed the present standards of the industry, AlSiMag®614 for thick film and AlSiMag®772 for thin film, and continue their leadership with new items almost ready to be announced.

We, therefore, are very optimistic about the 70's and thank you for your business and patience with us during the trying year of 1969.



Now is a great time to talk with us about your new substrate requirements.

CODE IDENT. NO. 70371

American Lava Corporation

A SUBSIDIARY OF 3M COMPANY

PHONE 803/682-3215 • LAURENS, SOUTH CAROLINA 29360, U.S.A.
PHONE 615/265-3411 • CHATTANOOGA, TENNESSEE 37405, U.S.A.

For service, contact American Lava representatives in Offices of Minnesota Mining and Manufacturing Company in these cities (see your local telephone directory): Boston: Needham Heights, Mass. • Chagrin Falls, Ohio • Chicago: Elmhurst, Illinois Dallas, Tex. • Indianapolis, Ind. • Laurens, S. C. • Los Angeles, Calif. • Metropolitan New York: Ridgefield, N. J. • Up-State New York and Canada: Phoenix, N. Y. • Orange, Conn. • Philadelphia, Penn. • St. Louis: Lee's Summit, Mo. • South San Francisco, Calif. • Tempe, Ariz. • International: c/o American Lava Corporation, Chattanooga, Tenn. 37405, U.S.A., TELEX 558432

68th YEAR OF CERAMIC LEADERSHIP

Sunrise, Sunset Courtesy of Amersil–Spectrolab–NASA.

NASA needed an earthbound sun... technically, a Solar Simulator.

They went to Spectrolab.

Spectrolab needed a lens, 36″ in diameter, 6″ center thickness, that would conform to the stringent requirements set forth by NASA.

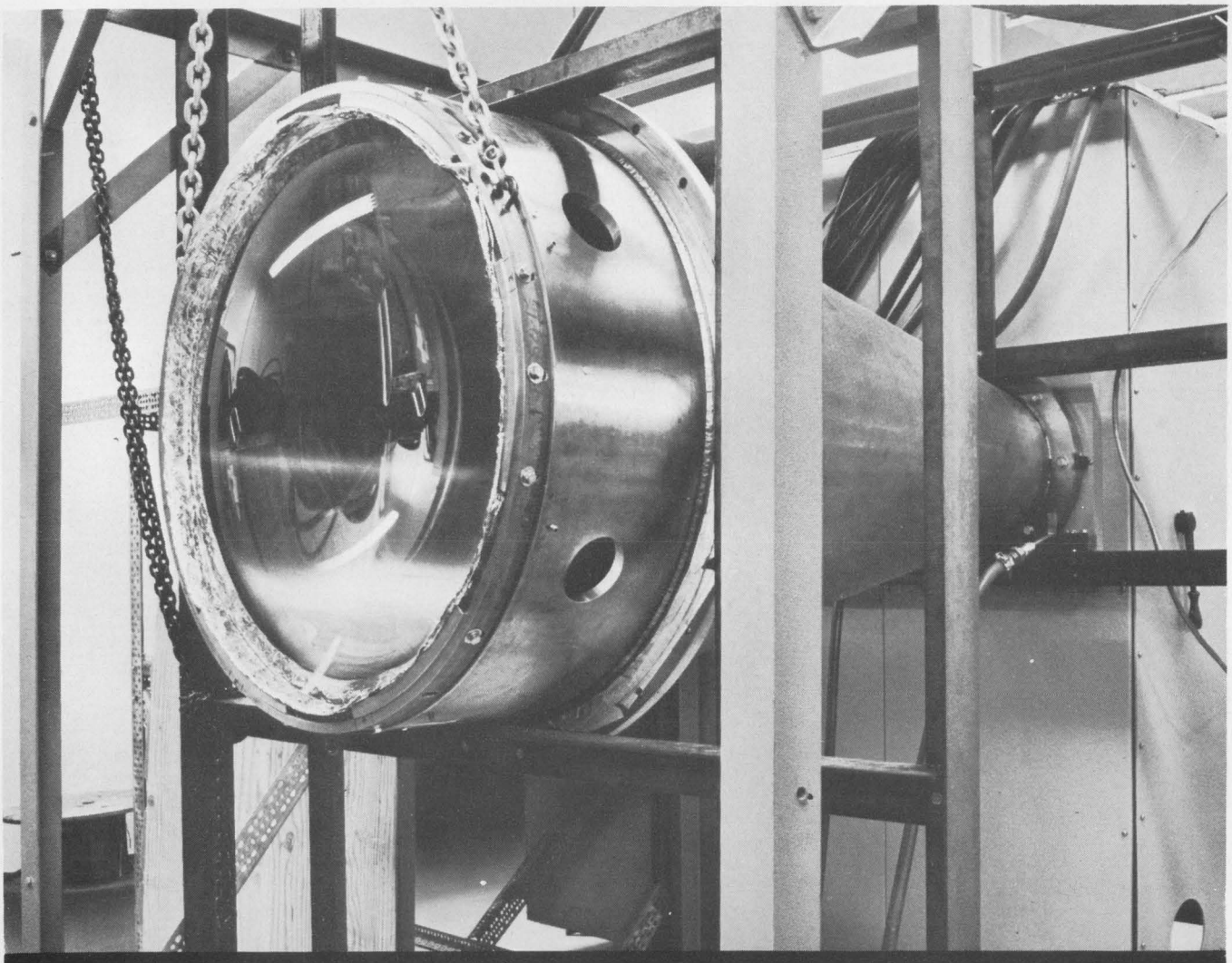
They came to Amersil.

Working closely with the Spectrolab designers and engineers, Amersil determined that Infrasil Grade T-18 Fused Quartz had the characteristics to meet the specifications for the Solar Simulator. The lens was molded by Amersil, assembled into the Simulator by Spectrolab, and is now being placed into research operation at the NASA *Langley Research* Center, Hampton, Virginia.

This cooperation from the raw material to the finished products is common practice at Amersil. Our scientists, engineers and designers have the experience, know-how and facilities to meet the needs of industry for high purity Fused Quartz and Fused Silica. These include the finest casting, molding and drawing equipment available.

Get full information and/or technical assistance by writing Amersil today.

30



AMERSIL INC. **FUSED SILICA AND QUARTZ**

685 RAMSEY AVE., HILLSIDE NEW JERSEY 07205

INFORMATION RETRIEVAL NUMBER 9

INFORMATION RETRIEVAL NUMBER 10 ►

Get One Free.

Comar now unveils its complete new CR-2 series: The only relays that give you single-pole, double-pole or three-pole specifications.

Undoubtedly, you've seen and heard of our new single-pole relay, (we call it our "one track mind"). That's when you need only one make-and-break. Now Comar initiative makes it even easier than ever. Need two makes-and-breaks? Specify the two-pole relay. Same for our new three-pole relay.

They're all the same compact size: 11¼" x ⅝" x 59/64". They're compatible with one another so that two 3-pole relays placed side by side, for example, will give you six poles . . . in less space than you needed before for two 4-pole relays.

Less expensive than the 4-pole relay too. Better balanced. Yet built with the same exacting quality that Comar builds into all their relays.

COMAR
ELECTRIC COMPANY

3349 Addison Street/Chicago, Ill. 60618
Phone: (312) JU 8-2410

Send me one free!
☐ Single-Pole ☐ Double-Pole ☐ Three-Pole
Available to qualifying purchasing agents and engineers. Please fill in completely.

Name _____
Title/Function _____
Company _____ Phone _____
Address _____
City _____ State _____ Zip _____
Your Product Line _____

Mix or match any of the new CR-2 relays to obtain the exact number of functions you need—for five poles combine our 2- and 3-pole relays. For seven poles use our 3- and 4-pole relays.

"Get one free" by mailing the coupon, but, if you have more in mind, just tell us your problems. You'd be amazed at what we have that we *haven't* shown you.

Contact Rating: 4 amps at 120 volts A.C. resistive and 4 amps at 30 volts D.C. resistive.
Coil Voltage Range: Up to 115 Volt D.C.
Complete with dust cover. Socket available.

New! Comar CR-2 Relays · Single-Pole · Double-Pole · Three-Pole

Why sacrifice power for size?

You might need a magnifying glass to closely examine RCA's new gallium arsenide high efficiency infrared emitting diode. But small as it is, the 40736R's power and versatility open a whole new world of applications for electro-optical systems designers.

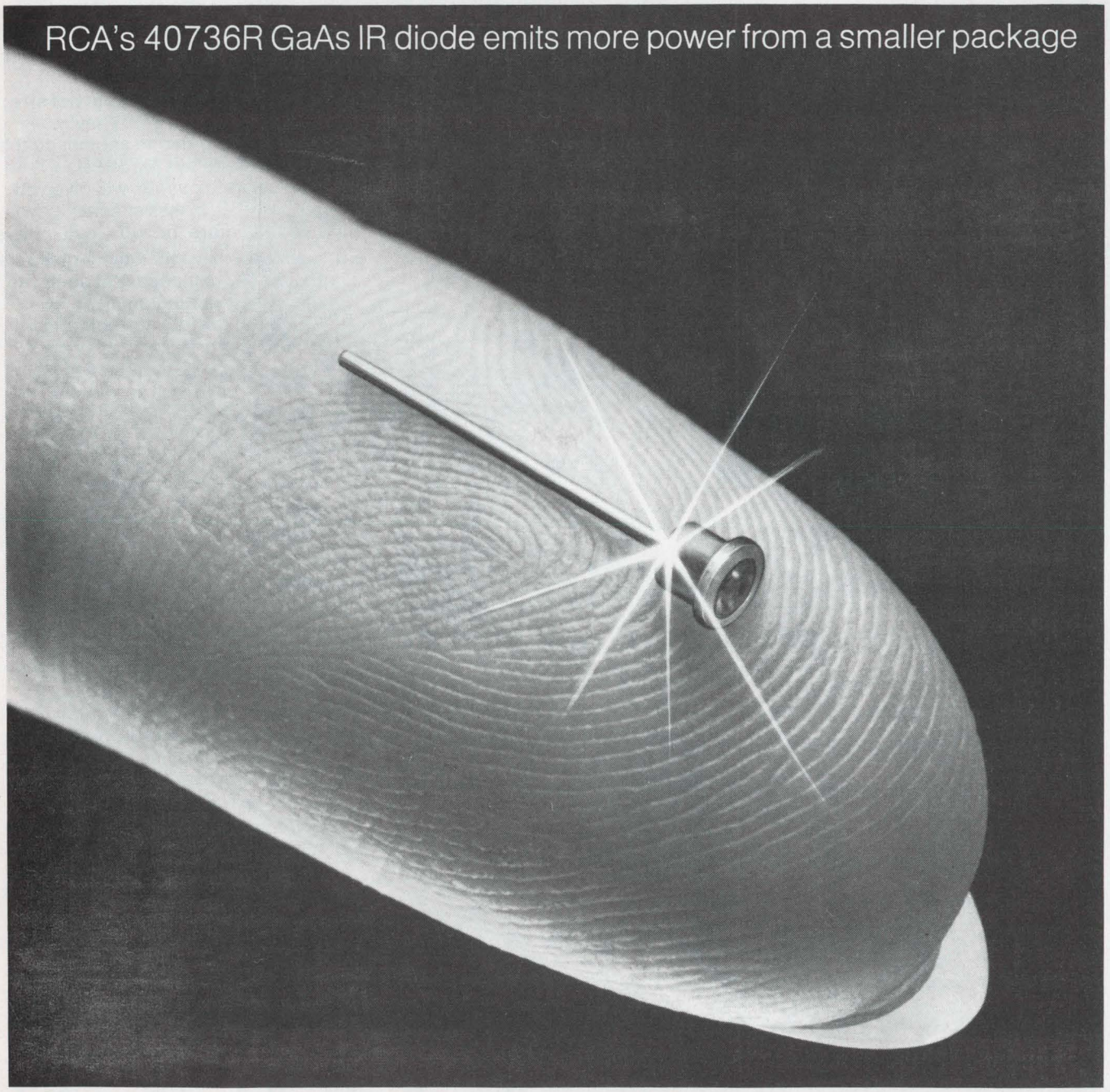
Here's why. The miniscule GaAs emitter is contained in a compact OP-10 package with an overall diameter of less than 0.095 inch. Thus, it is well-suited to closely-spaced printed-circuit board mountings where minimum crosstalk is a prime requirement. And the 40736R uses a unique parabolic reflector to pack 1.6 mW (typ.) radiant power output (at 50 mA drive current continuous service) into a narrow collimated beam pattern cone—15° half angle, half power. In pulse service, up to 1.5 A drive current may be used. Typical P_O is 24 mW at 1 A. Center wavelength for both continuous and pulse service is 9300 angstroms.

Use the 40736R to design: punched-card and tape readers • high speed counters • edge trackers • encoders • intrusion alarms • small bomb fuzes • end-of-tape indicators • line finders • data transmitters • circuit isolators • film coders.

Is your application one of them?
For further details, see your local RCA Representative or your RCA Distributor. Or write to RCA Electronic Components, Commercial Engineering, Section SG4-2/US5, Harrison, N. J. 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

RCA

RCA's 40736R GaAs IR diode emits more power from a smaller package



INFORMATION RETRIEVAL NUMBER 11

Designer's Calendar

APRIL 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		

For further information on meetings, use Information Retrieval Card.

Apr. 22-24
Southwestern IEEE Conference & Exhibition (Dallas). Sponsor: IEEE. A. P. Sage, Institute of Technology, SMU, Dallas, Texas, 75222.

CIRCLE NO. 435

Apr. 27-30
National Telemetering Conference (Los Angeles). Sponsor: IEEE. A. V. Balakrishnan, UCLA, Rm. 3531, 405 Hilgard Ave., Los Angeles, Calif. 90024.

CIRCLE NO. 436

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						

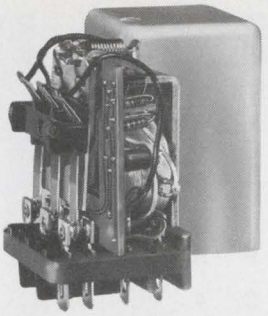
May 5-7
Spring Joint Computer Conference (Atlantic City). Sponsors: IEEE, AFIPS. AFIPS Headquarters, 210 Summit Ave., Montvale, N. J. 07645.

CIRCLE NO. 437

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. 438

New Potter and Brumfield magnetic latching/solid state **IMPULSE RELAY** has permanent memory



This hybrid impulse relay is unique.

Its basic structure is our KUL, a single coil latching relay employing a shunting-type magnetic circuit. To that we have added a solid state flip-flop circuit to obtain a truly modern, alternate-action, impulse relay.

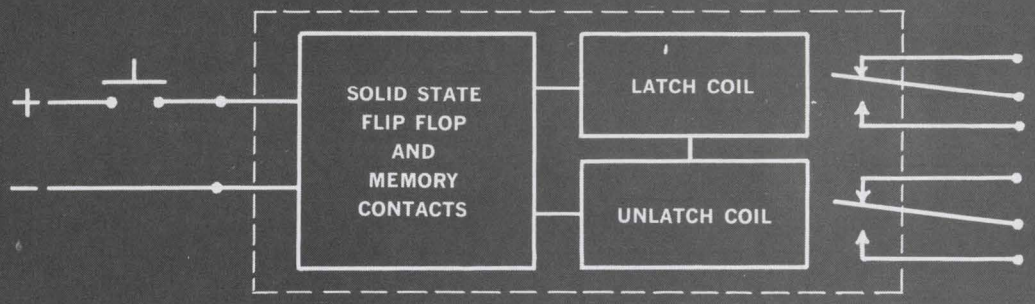
Consider the many features of this extraordinary device:

- A pulse width of 25 milliseconds (min.) effects transfer of the DPDT contacts to switch 5 or 10 ampere loads.
- Contacts will hold in their last position without power. This memory is obtained through the magnetic latching ability of the relay.
- There are no mechanical linkages as found in ordinary impulse relays, to wear out or malfunction.
- The assembly is neatly packaged in a popular-size case which provides a wide choice of mountings, terminations and readily available sockets. Mounted height is only 2.126″.
- An ordinary SPST switch will operate the KUR impulse relay. As coils are rated for continuous duty, there is no limit (except minimum) to the pulse length.

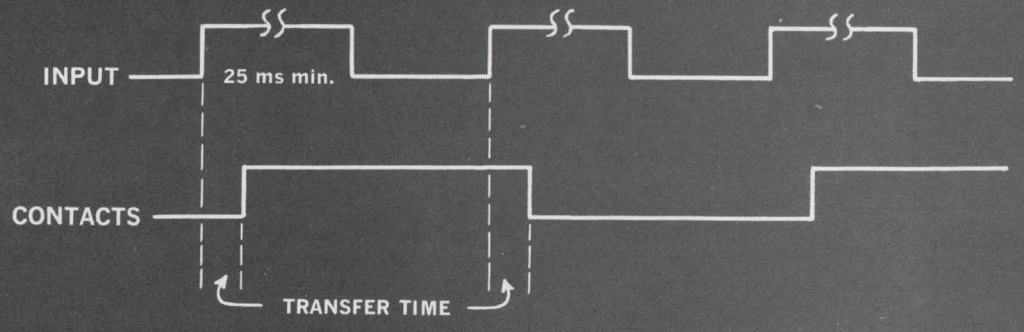
The price? A modest $15.00 in single lots. Quantity discounts apply. Today, call your local P&B sales representative for complete information.

Potter & Brumfield Division of American Machine & Foundry Company, Princeton, Indiana 47570. (812) 385-5251.

KUR IMPULSE RELAY



TIME SEQUENCE DIAGRAM



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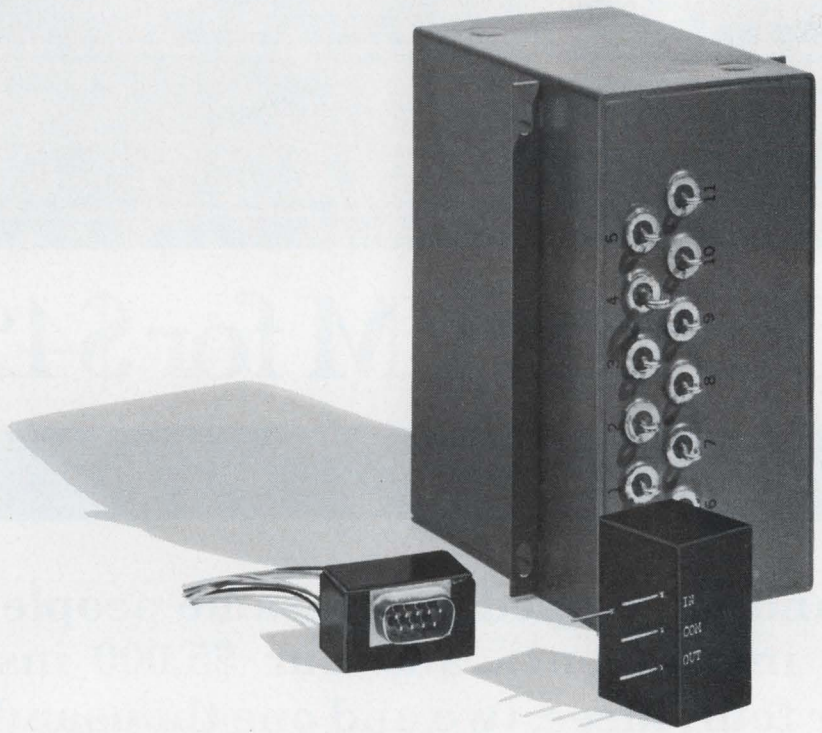

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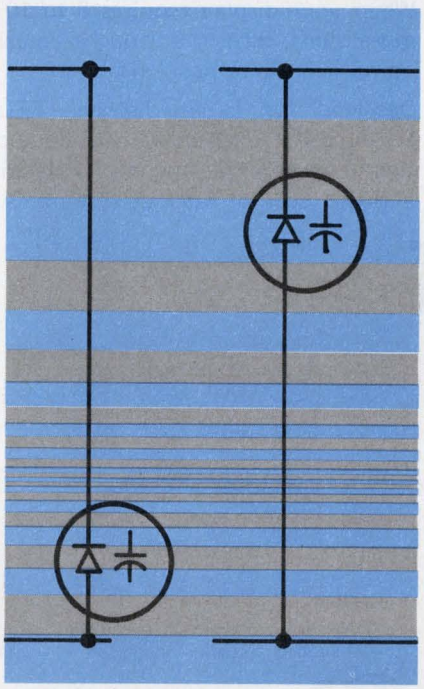
Highlighting
THE ISSUE

What started out as a way of transmitting quality television signals to selected, out-of-the-way areas—CATV—now looms as a potentially giant industry: broadband communications.

Community Antenna Television —also known as cable TV—will, in perhaps two or three years, begin growing into a new multibillion-dollar medium that will profoundly affect the life style of nearly every American, some manufacturers believe.

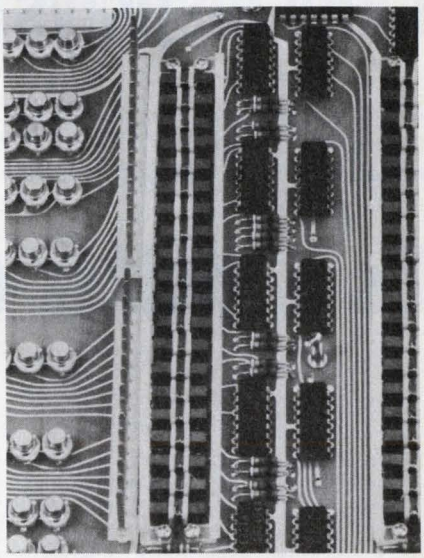
Page 62



Designing a varactor-tuned oscillator for high-power operation is complicated by a consideration that doesn't have much importance in low-power circuits—loading of the oscillator circuit by the diode.

Excessive loading not only wastes power, it can burn out the diode as well. Low loading, on the other hand, means low modulation sensitivity. These conflicting factors must be carefully weighed in arriving at a final circuit design.

Page 82



A new read-only core memory, which can have its program altered without being returned to its manufacturer, offers capacities to 20,480 bits at a cost of only 2.5¢ per bit. Called the VROM, it has a mechanically interchangeable braid and diode board, thus permitting users to maintain a library of plug-in fixed-program tables.

Page 133

Why NIXIE® tubes when we just developed SELF-SCAN™ panel displays?

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News Scope

ABM expansion may lose House committee support

A strong supporter of the Safeguard antiballistic missile system may soon join the ranks of opponents of its expansion. According to members of the powerful House Armed Services Committee, the committee chairman, Rep. L. Mendel Rivers (D.-S.C.), may not recommend that the $330-million expansion program for Safeguard be approved.

Privately, committee members are saying that Rep. Rivers doesn't believe the bill will pass the Senate or that the program actually has the full support of the Nixon Administration. In view of this, his colleagues don't believe he's going to waste his time fighting for what he considers to be a moribund issue. A meaningless fight would only mar his reputation for pushing bills through the House of Representatives.

Asked whether committee members were reporting his position accurately, Rep. Rivers declined to answer directly. He commented: "I'm more worried about the plight of the U.S. Navy than I am about the ABM at this point."

A spokesman for a Senate committee that will ultimately pass on the request for expansion of Safeguard agrees with the members of Rep. Rivers' committee. "Senate passage of the bill to expand the ABM system does look very dim," the spokesman, who wishes to remain anonymous, told Electronic Design.

This does not mean, however, he pointed out, that research and development of the system would be affected.

Meanwhile, a spokesman for Bell Telephone Laboratories, Murray Hill, N.J., has confirmed that the top executives from the company and Western Electric have been "holding discussions with the Army to consider limiting the scope of involvement in ABM work." Bell Labs serves as technical director of research, design and development for Safeguard and Western Electric is the prime contractor and system manager.

The spokesman noted that other companies now have the technology to take over the role Bell has performed over the past years.

NASA scientist offers new cancer theory

A NASA space scientist has come up with a theory that helps explain the source of uncontrolled malignant growth and indicates short cuts to the development of chemical countermeasures against cancer.

The scientist, Clarence D. Cone, Jr., head of the Molecular Biophysics Laboratory at NASA's Langley Research Center, Hampton, Va., described his new theory on cell division at a recent seminar of the American Cancer Society in San Antonio, Texas.

The Cone theory proposes that the division of body cells—a normal process that goes on continuously—is controlled precisely by the pattern of ion concentrations on the surface tissues of cells. The pattern is formed by the electrical voltage that normally exists across cellular surfaces and varies from one part of the body to another.

Cone explained the electrical aspect by detailing recent Langley studies concerned with space radiation blockage of cell division.

In that research, he noticed that cells having large negative membrane voltages seldom if ever divide while cells with small negative electrical potential divide at maximum rates.

The Cone theory proposes a central mechanism for control of body cell division. If it proves to be generally valid, it will provide a powerful new basis for research progress on many key biomedical problems, such as human conception, birth defects, growth, aging and, particularly, cancer.

Soviet puts lasers in telephone links

Telephone users in two areas in the Soviet Union are talking via laser beams during certain hours each day without even knowing it. The development was reported at the IEEE show in New York by Prof. Raphael Kazarian of the Armenian Academy of Sciences.

One link of 15 miles is being beamed over rough terrain from the Armenian capital of Yerevan to the Astrophysical Observatory in Burakan, he said. The difference in elevation of the two terminals is 350 meters.

The other Soviet laser link—a six-mile, 240-channel circuit—is in Moscow.

The lasers, helium neon with 40-milliwatt outputs in the single mode, use pulse-phase modulation, according to Kazarian.

The Armenian system has a bandwidth of 100 MHz but at present operates only 24 channels, each utilizing 3.5 KHz. Although television transmission has not been tried, Kazarian said, 20 to 25 channels could be transmitted at the same time, with each channel requiring from 4 to 6 MHz.

The Armenian laser operates from 10 a.m. until 2 p.m. for two reasons. There's more demand for circuits during these hours, and these are the most difficult hours for optical transmission and thus

News Scope CONTINUED

provide more research information. The main transmission problems, Kazarian said, are: fog; refraction from turbulence due to the changing temperature from 10 a.m. to 2 p.m.; snow and smoke.

Why weren't microwave links used instead of lasers? "Lasers are cheaper," Kazarian said, "and frankly we happen to know more about lasers in Armenia than we do about microwaves."

FCC official warns of dangers of EMI

"Police yourselves or we'll be forced to do it for you." This was the warning of Herman Garlan, chief of the rf devices branch, Office of the Chief Engineer of the Federal Communications Commission in Washington, D.C. to manufacturers of electric motors, toys, fluorescent lights and other devices that are known causes of electromagnetic interference.

Speaking at a technical session at the IEEE convention in New York, Garlan explained that the FCC currently imposes no regulations on these devices. He said the FCC hopes the industry will regulate itself so that the commission won't be forced to do the job. However, he warned, the increasingly acute EMI problem makes it essential that something be done quickly.

Garlan also said that better techniques for measuring EMI would be developed.

Army facing cutback in antitank missiles

The Army is in for a fight to hold on to both of its antitank missiles—the Shillelagh, already operational, and Tow, still being developed.

Rep. Samuel S. Stratton (D-N.Y.), chairman of a subcommittee of the Housed Armed Services Committee, has said that one antitank missile is enough, and that since the Shillelagh is farther along in development, the Army should go with it and dump Tow.

The Army contends that the two missiles are different and that it needs both. But if forced to, it says, it could give up Tow, if the Shillelagh were modified—a job it estimates would take four years and cost $40-million.

Tow is a wire-guided missile for short-range targets. It is to be used by infantry on the ground and from helicopters. It is being developed by Hughes Aircraft.

Shillelagh is a heat-seeker, shot through a 152-mm gun mounted on a tank. It is manufactured by Philco-Ford.

The Army has asked for $106.3-million for Tow for 1871.

Pollution control needs more technical push

Environmental pollution—largely a byproduct of advanced civilization—will be brought under control only by increased technical effort, according to Dr. Hubert Heffner, deputy director, Office of Science and Technology, Washington, DC.

Addressing an overflow audience at the IEEE show in New York, last month, Heffner listed the following areas of pollution as needing help from the electrical engineering community.

- Instrumentation to measure and record pollution levels.
- A systems approach using computer simulation techniques to clean up smog or handle sewage.
- Lasers for heavy industry that would eliminate the noise now associated with cutting and pulverizing.
- Ultrasonic oil emulsification to control future spills. No current methods of cleaning are satisfactory.
- Creation of an alternative technology that would eliminate the need for fossil fuel.

The electromagnetic spectrum is a resource becoming saturated beyond reason, according to Wilfred Dean, Jr., associate director, Frequency Management Office of Telecommunications Management, Washington, D.C. He criticized inadequate engineering, poor operating practice, outdated equipment and unintentional radiation (auto ignition, fluorescent lights, etc.) for creating the problem. He disclosed that a variance of 40 dB exists between rural and urban areas in certain popular communications bands. According to Dean, careful Federal Government examination of radio spectrum use is now under way.

Automatic caller reads meters by telephone

Nippon Telegraph and Telephone (NTT), Tokyo, has recently started an experimental program of using telephone lines to replace the meterman. In 360 Tokyo households, water and gas meters are read by an automatic telephone caller. Toshiba's TOSBAC DN-30 computer. The test is slated to last for several months and is intended to check the reliability and economy of telemetering such information.

Signal transmitters, activated by the automatic telephone caller, reads out utility meters in less than two seconds. The received signals are recorded on magnetic tape. As many as 30 meters can be readout on one telephone line.

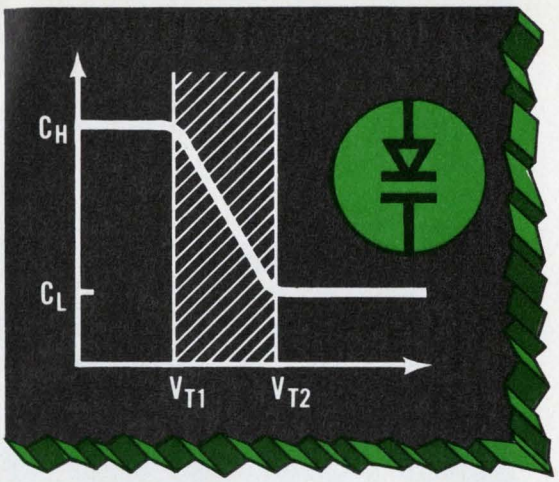
As goes the economy; so goes IEEE show

The drastic drop in attendance at last month's IEEE show in New York reflected the general slowing of the U.S. economy, especially in the military-defense areas, according to Donald Fink, IEEE general manager.

Attendance fell about 25% from 60,500 last year to 46,220. There were 589 exhibits this year, compared with 618 in 1969.

Fink cited in particular the closing down of NASA's Electronic Research Center in Cambridge, Mass., which, he noted, has clouded the sales outlook of many companies along Route 128.

Fink noted that though the Coliseum was not completely filled, 95% of the exhibitors showed up, as planned. There were some unexpected, last-minute cancellations, with "one or two pretty big companies pulling out of the show, even after having made a down-payment," Fink said.



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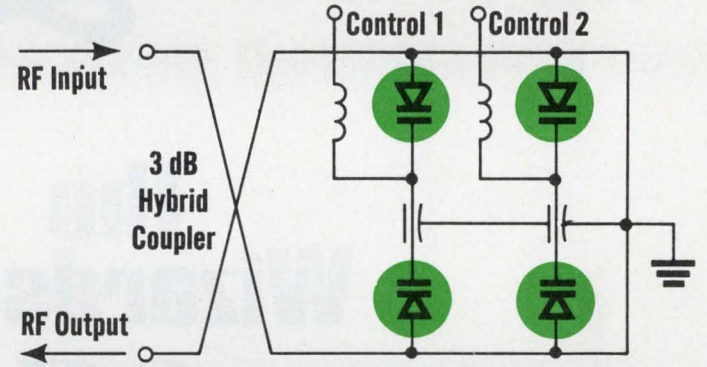

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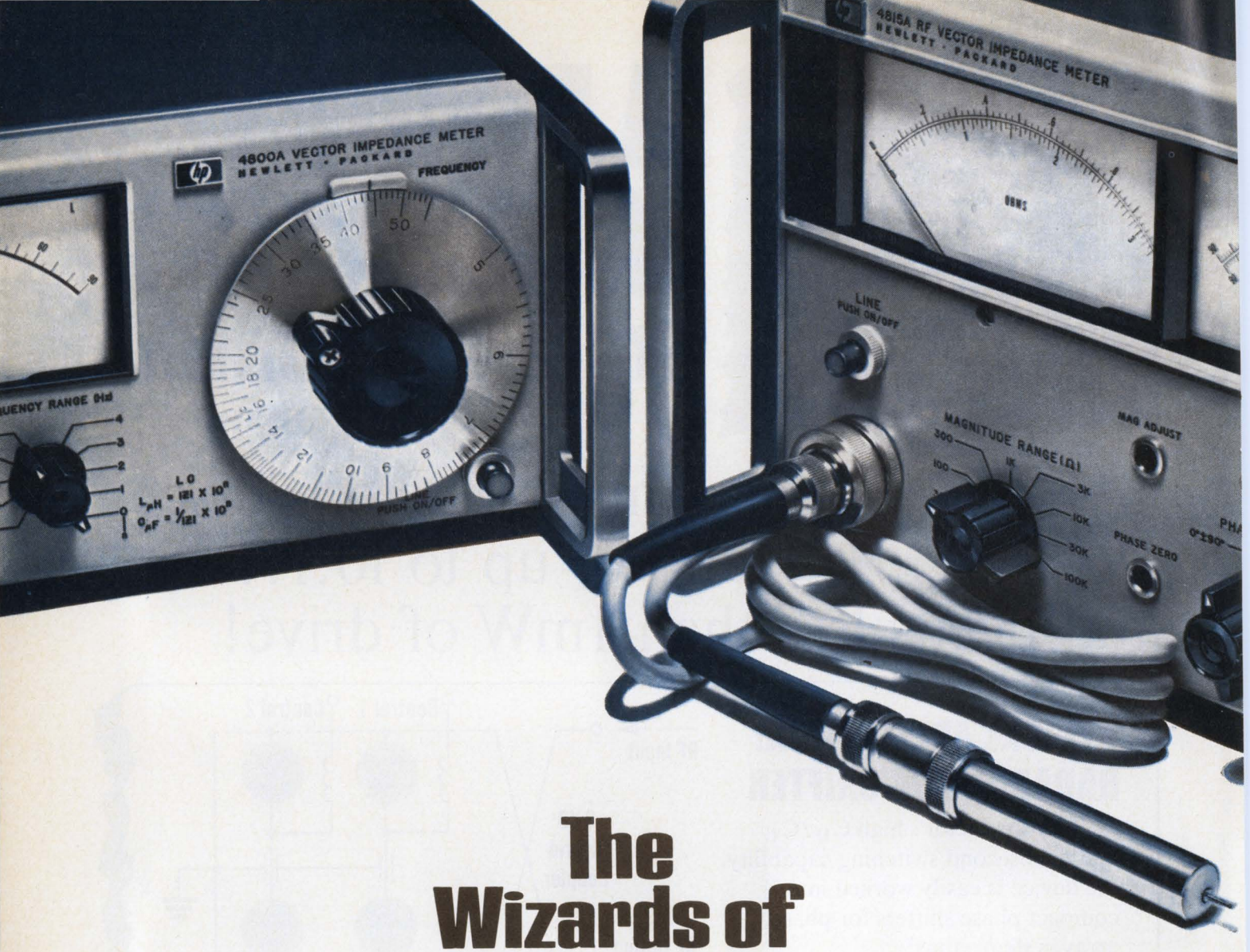

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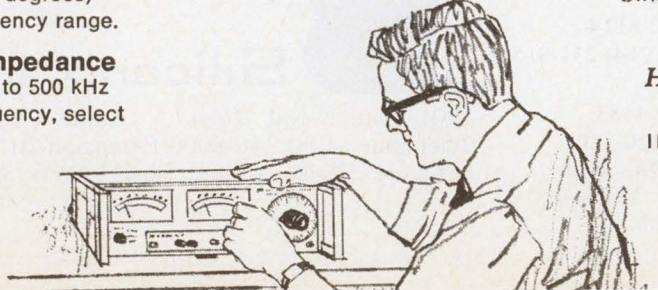
Application Note 86 describes many applications of the 4800A and the 4815A Vector Impedance Meters including the measurement of Z, R, L, and C. For your copy and complete specifications, contact your local Hewlett-Packard field engineer or write: Hewlett-Packard, Green Pond Road, Rockaway, New Jersey 07866. In Europe: 1217 Meyrin-Geneva, Switzerland.



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IMPEDANCE INSTRUMENTS

1091

Mini-antenna—but what a maxi performance!

1.5-inch electronic device offers gain that can match that of a half-mile monopole at 40 kHz

Jim McDermott
East Coast Editor

A new broadband, electronic receiving antenna is only 1.5 inches high, but it offers the pickup of a half-mile-high antenna at 40 kHz.

The mini-unit, called a Voltage Probe Antenna, consists of an inch-and-a-half rod, which feeds the electronic circuitry, and a small disc on top. The device has flat-gain characteristics from 10 kHz to 50 MHz.

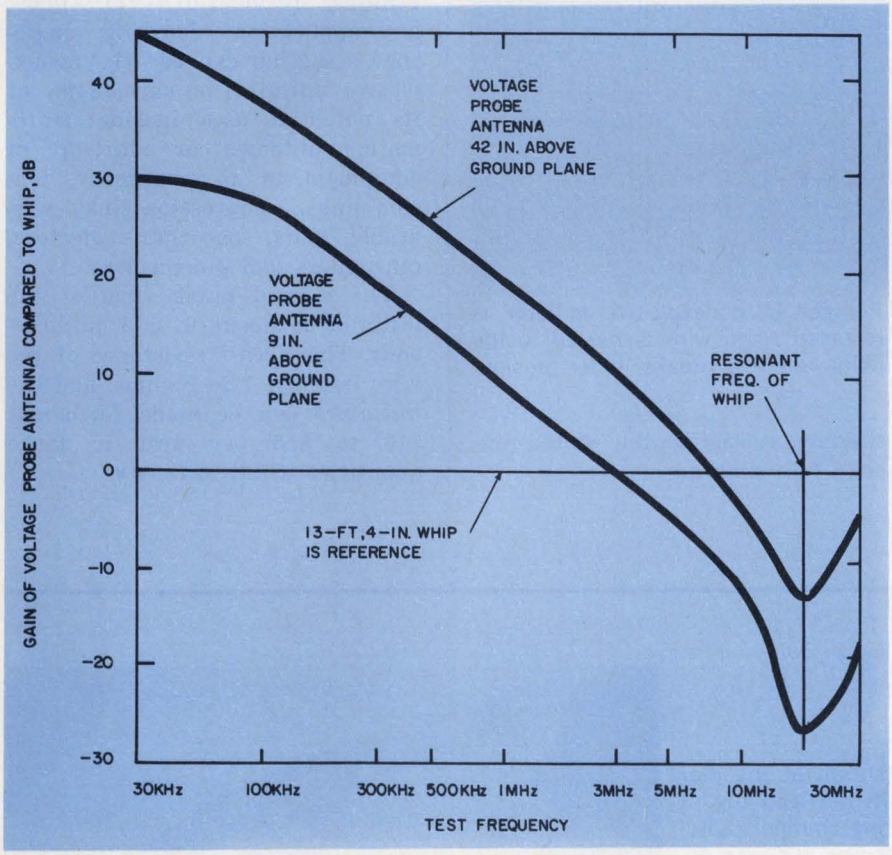
Developed by the Kollmorgen Corp. Electro-Optical Div., Northhampton, Mass., the device is particularly useful when lack of space prohibits the use of a one-eighth-wavelength or larger antenna, or when wide bandwidth response is required without tuning, or both.

Robert Fischer, staff engineer who worked on the design at Kollmorgen, sees its application in low-frequency, direction-finder arrays that utilize antennas hundreds of feet long. Here, a voltage Probe Antenna could substitute for each long antenna. It could be used also as an ultra-short, mobile receiving antenna in automobiles and aircraft in the range from MHz down to 12 kHz.

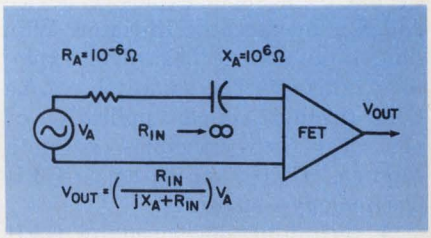
The mini-antenna generates less than 0.1 μV of noise for a 540-Hz input bandwidth, which is comparable to that of a good communications receiver. And it has a dynamic range of better than 100 dB, operating distortion-free with input voltages from 10^{-7} to more than 10^{-2} V.

The power gain in the output signal is not taken from the space wave but is supplied by the power supply. The output impedance is 50 ohms, and the amplifier power (80 mW) is supplied, by a special coupler, through the 50-ohm coaxial cable that connects the antenna to the receiver.

Fischer points out that the new antenna is effectively a vertical monopole responding to vertically polarized signals and possessing an omni-directional pattern in the plane of the horizon. Its gain is —10 dB, referenced to an isotropic antenna. Because the gain is flat over a broad band the device is most effective at frequencies substantially below the resonance of the quarter-wave whip—that is, the whip is a high-Q device with a gain that falls off 6 dB per octave in this region because of detuning, while the Voltage Probe Antenna



1. **The Voltage Probe gain is flat to 50 MHz,** but the effective gain over a whip antenna increases substantially with decreasing frequencies.



2. **Equivalent circuit** of the mini-antenna for a 1-meter stub at 20 kHz.

A disc-topped rod plus electronics make up the Voltage Probe Antenna

(**VPA,** *continued*)

gain remains constant.

This advantage exists despite the fact that the gain of the quarter-wave monopole, matched to a receiver, is 12 dB greater than that of the mini-device.

In tests conducted by Kollmorgen, the new antenna was experimentally compared with a 13-foot, 4-inch whip antenna, both mounted over a large metallic ground plane. A comparison of the gains is plotted in Fig. 1.

Note that the performance of the Voltage Probe is enhanced by increased elevation over the ground plane, because the device has the unique ability to integrate the energy impinging on the coaxial cable all the way down to true ground potential.

In general, Fischer explains, the performance of the new antenna equals that of a conventional whip at a critical frequency, f_c, in accord with the following formula:

$$f_c = \frac{1.2 \times 10^8}{\ell},$$

where ℓ is antenna length in feet.

The theory behind the Voltage Probe Antenna is this: If a quarter-wave monopole above a ground plane is made infinitely short, its power gain decreases only slightly from a theoretical maximum of 2.14 dB to 1.76 dB. But as the antenna gets smaller, transferred antenna resistance decreases while the unit's capacitive reactance increases. For example, a 1-meter stub over a ground plane at 20 kHz has an effective resistance (RA) of 10^{-6} ohm and a capacitive reactance (X) of 10^6 ohms.

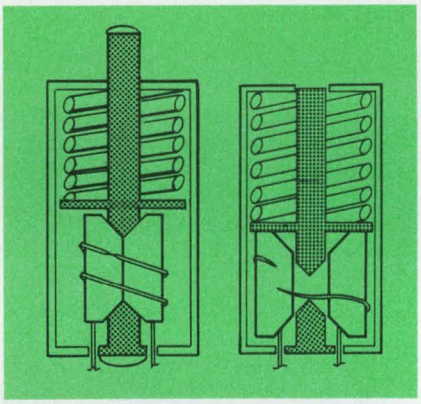
The Voltage Probe does not match impedances in the conventional sense. Instead, it makes X_A small compared with the input resistance (R_{IN}) of an ultra-high-impedance amplifier connected across the antenna. Consequently most of the signal appears across the amplifier input (Fig. 2).

The electronic circuits of the new antenna consist of three stages: a FET, low-noise input amplifier; a buffer-driver stage; and an output stage to match the Probe to the 50-ohm cable. ■■

Nonexplosive fuze releases mechanical energy

When two stages of a missile in flight separate, the electrical cables connecting these stages are disconnected by a small explosive device called a pyrotechnic initiator. Why not eliminate the hazard of explosive charges? The same job can be done through simple application of electrical fuze principles, a Santa Monica, Calif., company—G&H Technology—suggests.

A technique developed by G&H allows a small amount of electrical energy to do a great deal of mechanical work. Basic to the method is a very thin wire built into a mechanical assembly that stores energy. Current is passed through the wire to heat it to the point where it breaks under tension,



Plunger in nonexplosive initiator is released when wire is heated to the point where it breaks under tension.

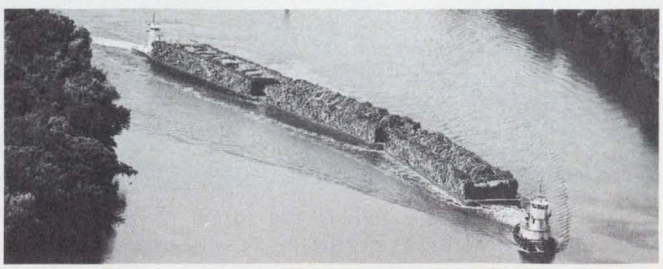
thereby releasing the stored energy (see diagram).

This principle can be applied in several different mechanical configurations, according to John Phillips, president of G&H. Almost any application requiring single-shot actuation can use the nonexplosive initiator, he says. Some of its potential uses include: automatic shutdown or start-up of equipment in an emergency, tension links, compression links, separable bolts, parachute ejectors, pin pullers and pin pushers.

The normal break time of the initiator is about 6 or 7 milliseconds. The circuit resistance of the wire is about 1 to 2 ohms, and the initiators can be made for about $10 to $15 per unit in large quantities, G&H says. ■■

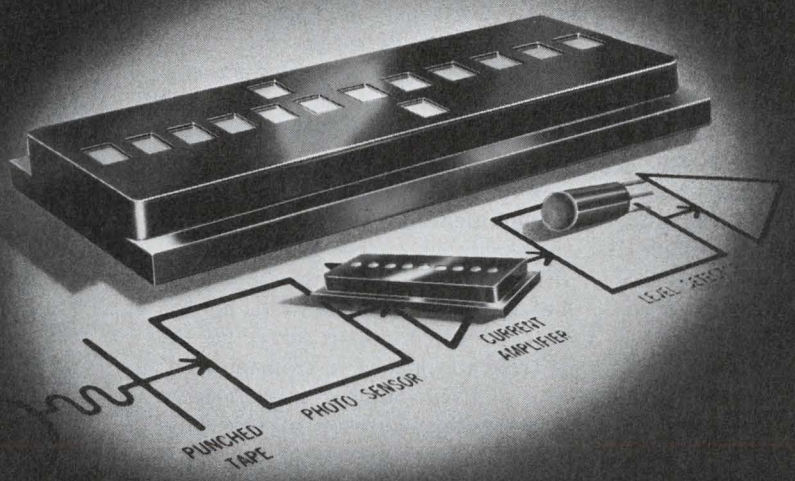
Tug operation made easy

A diesel-driven marine jet-powered tug (shown at the rear of the barges) is controlled by radio from the lead tug. It enables a barge captain to navigate twisting channels safely and with little reduction in speed. The new tug was developed by International Paper Co.'s Southern Kraft Div., in Georgetown, S.C.



microcircuit reliable, these new opto-hybrids

offer nominal light sensitivity thresholds of 7.0 ("A" version 1.5) mW/cm² ● maximum channel matching ratios of 2.0 or 1.2 to 1 ● minimum high output of 4.5 Vdc and maximum low output of 0.4 Vdc; inverted logic also available ● speed of response 1 microsecond or less.



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INFORMATION RETRIEVAL NUMBER 21

Stamping out crime by the numbers

Digital communications system in San Francisco increases police message capability a hundredfold

Elizabeth de Atley
West Coast Editor

A digital communications system just installed by the San Francisco Police Dept. can transmit 100 code messages in the same time it used to take to send a single voice message.

Said to be the first digital communication system ever put into operation by a police department in this country, it is called Digicom by its developer, Sylvania Electric Products, Inc., a subsidiary of General Telephone & Electronics Corp. It consists of a remote control panel in each patrol car and a computer (Hewlett-Packard 2115), a video data terminal and magnetic tape transport at each base station. An interface with the regular mobile radio telephone network of the police department is also included.

Developed with funding by the Law Enforcement Assistance Administration of the U.S. Dept. of Justice, Digicom works like this in a typical police situation:

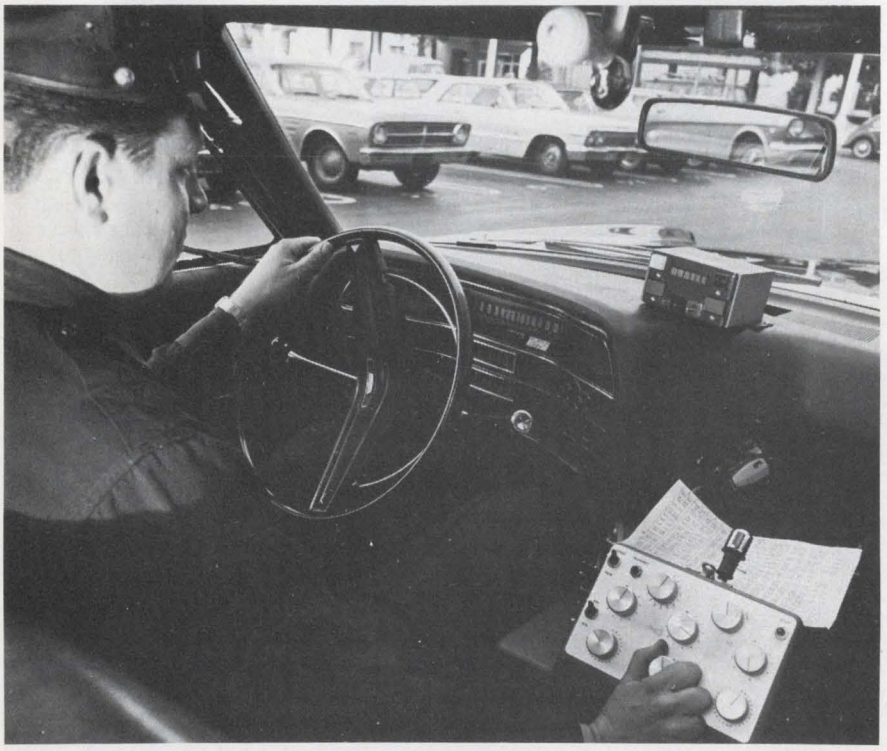
A cruising patrolman spots a car he believes might have been stolen: The driver is acting suspiciously. With knobs on the multifunction box beside him, the patrolman enters the license number of the car into the digital communications systems, watching each number appear on the remote display panel on the dashboard as he dials it. Satisfied that he has entered the number correctly, the patrolman pushes a transmit button, and the number is radioed to a computer operator at the state motor vehicle agency for a check against cars reported as stolen (California maintains such a computer setup in Oakland, 20 miles from San Francisco).

Thirty seconds later the code number "1030" flashes onto the display panel in the police patrol car, telling the patroman that the car he is tailing has been stolen. He signals the driver to the side of the road, and, as a precaution, enters the code number "1096" into the multifunction box before stepping out to approach the suspect. This code appears on the video screen at the central dispatcher's station.

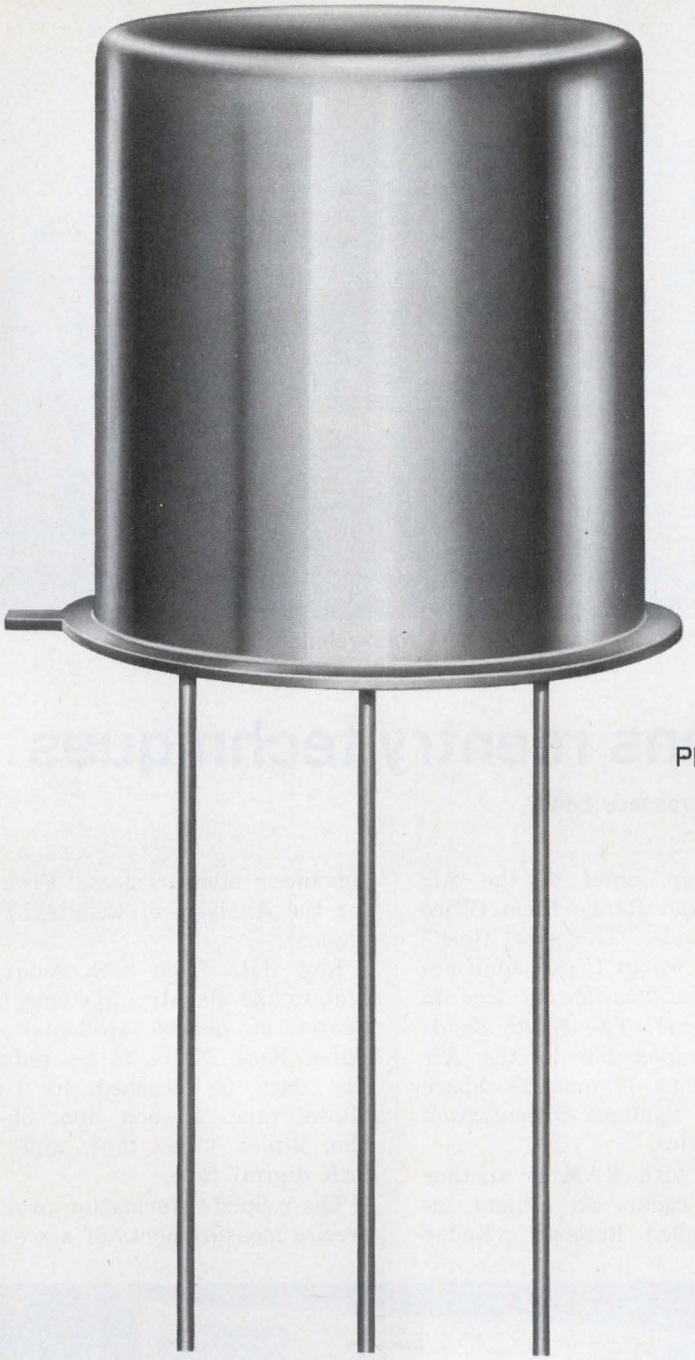
As the patrolman gets out, the driver bolts and heads for a nearby warehouse. The patrolman follows with drawn pistol. Exactly five minutes later, when the computer at the central station has received no signal to indicate that the patrolman has returned to his car, the "1096" code number on the video screen starts flashing, alerting the dispatcher. The latter checks his written records for the patrolman's location, sends by voice a 904 Code 2 to all patrol cars in the area, and reinforcements are speeded to help the the patrolman make the arrest.

Lt. Mario Amoroso of the San Francisco Bureau of Communications told ELECTRONIC DESIGN that the number of vehicle checks has increased 30 to 40% with the new system. Because he is able to make a routine check on every suspected car, a patrolman knows before he approaches it that the situation is dangerous and can take precautions.

A command and control system at each base station, planned for late spring installation, will supplement the San Francisco police Digicom. Like the system installed by Sylvania at Mountain View, Calif., last fall (see "Computer Dispatches Police Cars in Seconds," ED 25, Dec. 6, 1969, p. 36), this command and control system will process calls for assistance and dispay a map of the area in question on a TV screen. Alphanumeric symbols superimposed on this map will show the location of each patrol car. ■■



A San Francisco police officer who suspects a car may be stolen can get a license check within 30 seconds by dialing the State of California computer with a new digital communications system called "Digicom." The system also transmits digitally coded messages to and from the central dispatcher.



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INFORMATION RETRIEVAL NUMBER 22

A 105-foot steel fence allows vhf radar 10 extra seconds of clutter-free data from reentering payloads.

Missile range sharpens reentry techniques

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

What would an enemy radar operator see when a Minuteman III releases a number of projectiles, all heading in different directions? Could he determine which ones are decoys, which are bundles of chaff, and which are guided and carry bombs?

To find out, the Air Force has added more capability to its Abres (Advanced Ballistic Reentry Systems) program and has requested $105-million for fiscal year 1971. In 1970 the program cost $107-million.

To monitor the reentry behavior of every possible aspect of Athena test missiles launched in Green River, Utah, a vhf radar has been added to the uhf RAM radar at White Sands Missile Range, N.M., where the missiles impact. Around the radar has been built a fence that's 2200 feet in circumference and 105 feet high.

The electromagnetic radar shield, or clutter fence, is built of steel covered with one-half-inch woven steel mesh. When grounded, it keeps unwanted ground returns, particularly from the surrounding mountains, from reaching the radar's 84-foot parabolic antenna.

"The fence assures us up to 10 seconds more of 'clean' data during the critical reentry phases of missiles in flight," says Col. Leonard R. Sugarman, chief of the Air Force's Inland Range Field Office at White Sands. "This short time," he says, "is worth 15,000 additional bits of information to feed to the computers." The White Sands office is responsible to the Air Force Systems Command's Space and Missile Systems Organization in Los Angeles.

Working with RAM is another Air Force radar, an S-band instrument called Rampart (Radar Advanced Measurements Program for the Analysis of Reentry Techniques).

Raw data from both radars is sent to the Reentry Systems Data Center at nearby Holloman Air Force Base, N.M., to be reduced. The data is recorded on 1-inch digital tape, 12-inch film, 35-mm film, 2-inch video tape, and 1/2-inch digital tape.

The refined information provides precise measurements of a reenter-

A-scope (foreground) in RAM radar blockhouse shows cross section of a 12-inch sphere released by Loki rocket at 230,000 feet.

ing payload such as its peak cross section, average cross section and trajectory.

Data goes to Defense

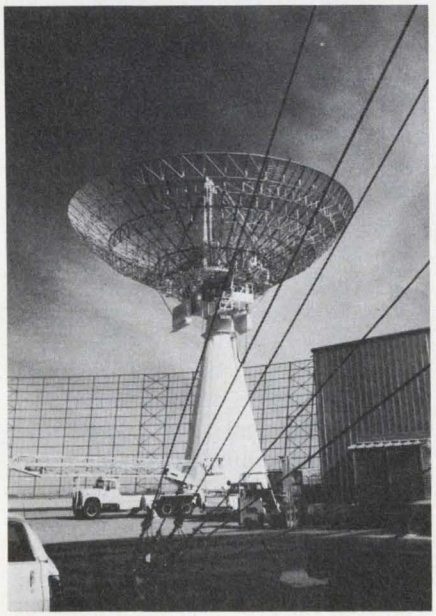
All this data is sent to Defense agencies responsible for the design of ICBMs that can penetrate sophisticated enemy defenses, and for antiballistic missile systems that can destroy enemy ICBMs.

One recent project at White Sands was to develop hardened reentry-vehicle technology applicable to small lightweight reentry vehicles. The Athena was suited for these tests, since it is about one-tenth the size of an ICBM. By October the Athena H, with a payload capacity four times as large as the present Athena's, will be available. Full-scale ICBMs, such as surplus Atlas missiles, are launched now for the advanced ballistic reentry systems program at the Western Test Range in California.

Every reentry payload is studied by radar using a variety of frequencies.

Rampart, built and operated for the Air Force by Raytheon, is a precision, high-powered S-band tracker that is said to be excellent for collecting target payload signature data and other reentry information.

An Air Force spokesman says,



RAM vhf/uhf radar measures cross section of reentering payloads.

"Its outstanding characteristics are: its high target resolution through application of step-frequency and pulse compression techniques; its ability to produce large signal returns on long-range targets; and its ability to record digitally multiple target returns. This data is used to determine accurate trajectory and cross section measurements."

The radar has an unambiguous range capability of 2150 nautical miles and a maximum transmitter power of 24-MW peak when operating in its primary mode or 10-microsecond pulse compression mode. The nominal pulse repetition frequency of 100 pulses per second (pps) automatically switches to 90 pps temporarily to avoid undesirable synchronous effects at range multiples.

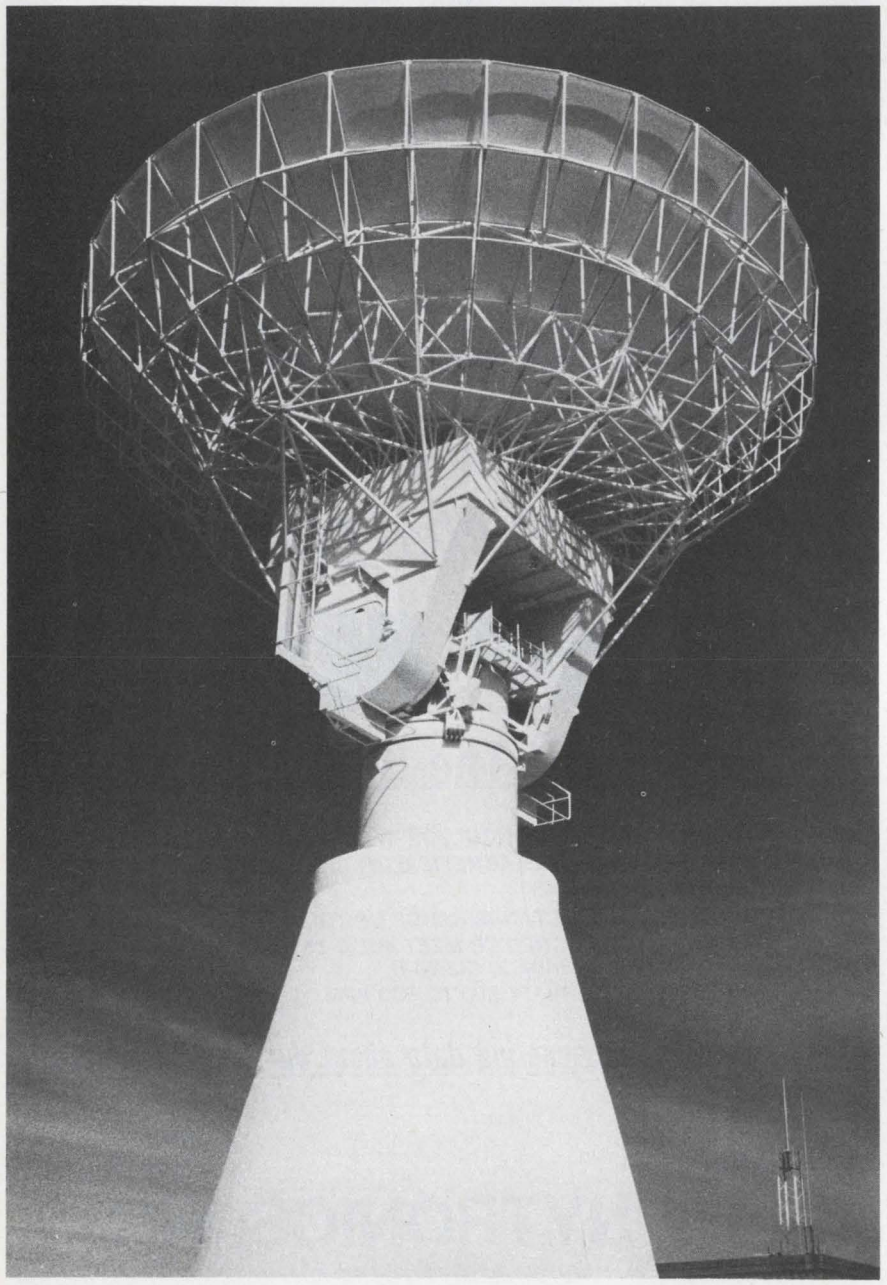
The main reflector of the four-horn Cassegrain antenna is a paraboloid 60 feet in diameter, with a focal length of 15 feet and a reflector surface that does not deviate more than 0.25 inch from the true paraboloid.

The signature data is recorded on 7-track IBM compatible tape in conjunction with A-scope 35-mm records. On the 7-track tape the following are recorded: azimuth, elevation, range to target, 2-channel automatic gain control, differential range, time of day, modes, gate width, and 2-channel monopulse error signal.

The RAM uhf/vhf radar, built and operated by Continental Electronics Manufacturing Co., a subsidiary of Resalab, Inc., in Dallas, is slaved to the Rampart and is dependent on it for tracking commands.

The two RAM radars, which use a common antenna, transmit simultaneously and are used to determine accurate payload cross sections. The vhf transmitter is capable of developing 10 MW peak power and the uhf, 30 MW. The vhf transmitter can be tuned at all center frequencies between 153 and 163 MHz. The uhf transmitter operates at 435 MHz.

The RAM radar, transmitting on two frequencies, radiates polarized rf energy. The returns are focused, and the feedhorn discriminates between polarized energy components at both frequencies. Each energy component is routed to one of the four separate receiver channels. The video outputs from the four receivers are displayed on oscilloscopes and 35-mm Mitchel movie cameras.



Rampart S-band radar acquires reentering payload, measures cross section and trajectory, then passes directional data on to RAM radar.

A 230,000-foot target

As one of the prime radar-signature sensors for the Athena reentry study program, the RAM radar must be calibrated with extreme accuracy. Generally, the Air Force must take a 12-inch sphere up to 30,000 feet in an aircraft and release it. The return on the A-scope is matched against the known cross section of the sphere.

Recently, however, the Air Force took advantage of a target that was released at 230,000 feet and didn't cost the Air Force a cent. The Army Atmospheric Sciences Office, an agency of the Army Electronics Command at Fort Monmouth, N.J., sent up a 12-inch inflated sphere by Loki rocket to 230,000 feet to check the atmospheric density. Primed and waiting, the Air Force was able to calibrate the RAM's cross-section measurement capabilities. ■■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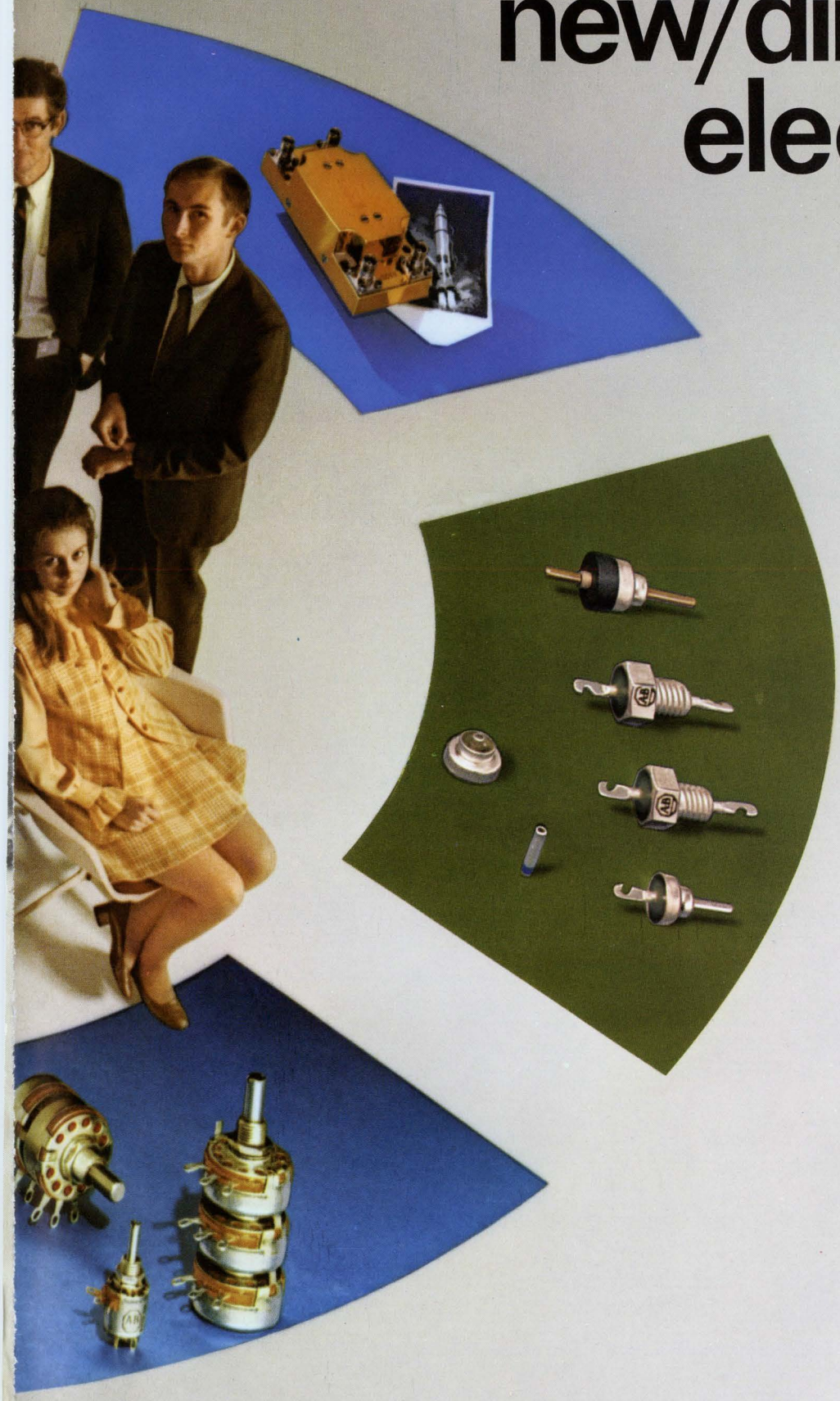

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Technical excellence is built around sophisticated equipment like the electron microscope (a) and microprobe (b). Completely automatic equipment helps assure the quality of potentiometers (c) and fixed resistors (d). Specialized tools like the Borrowdale camera (e) give Allen-Bradley complete internal control over production operations.

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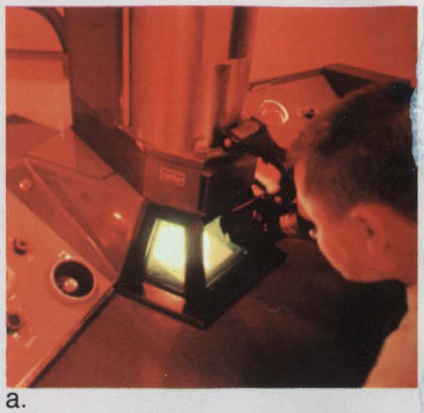

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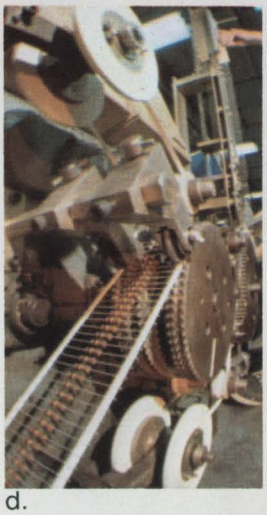

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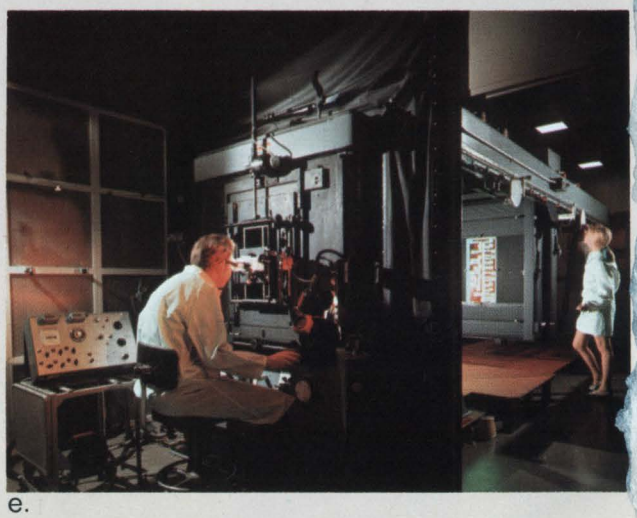

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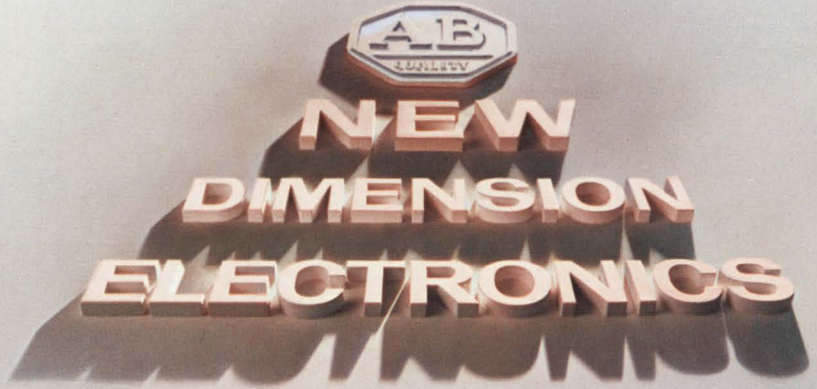

EC70-5

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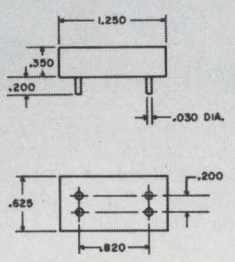
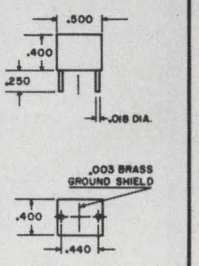
Bandwidth, 3 dB:	6 KHz min.	15 KHz min.	6 KHz min.	15 KHz min.
Bandwidth, 60 dB:	18 KHz max.	40 KHz max.	18 KHz max.	45 KHz max.
Ripple, Max.:	1 dB	1 dB	1 dB	1 dB
Insertion Loss, Max.:	6 dB	6 dB	6 dB	6 dB
Spurious Returns:	> 55 dB down	> 50 dB down	> 55 dB down	> 50 dB down
Terminations (Resistive):	2.0 kilohms	5.1 kilohms	0.38 kilohms	1.3 kilohms
Ultimate Atten.:	80 dB	70 dB	80 dB	70 dB
Op. Temp. Range:	0°-60° C	0°-60° C	0°-60° C	0°-60° C
Case Size:	"A"	"A"	"A"	"B"

CASE "A" 0.274 cu. in.



CASE "B" 0.080 cu. in.



DAMON

INFORMATION RETRIEVAL NUMBER 25

Letters

Let's clear the air— on design consultants

Sirs:

I've been misquoted in the news item "Are Company Designers Becoming Obsolete?" (ED 25, Dec. 6, 1969, pp. 34-36). Unfortunately, the impression given could frighten away those who could benefit from consultants' services, so I'd like to correct the story.

Electronic consultants certainly "are being called in increasingly by systems manufacturers," but not "to replace designers at company design-review sessions." They're being called in to work *with* the client's staff, bringing their special skills to bear on certain parts of the total task of getting a system conceived, sold, designed, fabricated, documented, installed, and into useful operation.

Regarding "retraining of engineering staffs," I didn't say that it "won't be economically feasible; these companies will simply call on the consultants to do the design work, and the engineers with obsolete skills will be out of jobs." What I said was that *large* companies could set up such internal computer-aided design groups (my company has assisted several of them in setting up and training these groups) but that it may not be economically worthwhile for smaller companies to set up, train and maintain such groups. These companies can call on consultants to do the computer-aided portion of the design work.

Regarding discussion of the design-review function of consultants, my company hasn't "'replaced' the customer's electronic designer in every case" in the sense the reader might infer. We frequently work with the designers. The "replace" refers to the dispassionate final review of the design by an outside firm which has no emotional or political stake in the design, instead of the final review being performed by the designer himself.

Nathan O. Sokal

President
Design Automation, Inc.
Lexington, Mass.

Somebody forgot to track down TRAC

Sir:

In reading your special report on the Fall Joint Computer Conference (ED 23, Nov. 8, 1969, p. C115), I was somewhat surprised at the complete lack of mention of the TRAC (Transient Radiation Analysis by Computer) program in your summary. TRAC was written at the Autonetics Division of North American Rockwell Corp. by Ellmar Johnson. This program was documented and released in June, 1968, under contract DAAG39-68-C-0041, issued by Harry Diamond Laboratories. This work was funded by the Defense Atomic Support Agency. Over 100 copies of TRAC have been distributed in the U. S.

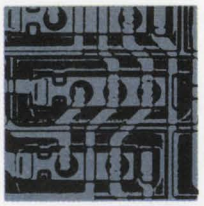
TRAC is similar to NET-1 and CIRCUS in its circuit formulation; however, it uses an implicit integration method that results in solution times that are considerably shorter than NET-1 or CIRCUS. In general, TRAC is 70 to 100 times faster than CIRCUS. Versions of TRAC currently exist for the IBM 7090/94, IBM 360 and UNIVAC 1108 computers.

Robert Puttcamp
Research Physicist
Department of the Army

Editor's note: Comments have been received about computer-aided programs that were not listed in the Nov. 8 Special Report. Among these are LOGSIM, a logic simulation program, and LOGMIN, a logic minimization program, both from Tymshare, Inc.

These programs had not been announced at the time the report was written. Fairchild Space and Defense Systems, Syosset, N. Y., has a program called FAIRSIM which is a logic simulator, and Autonetics Division of North American Rockwell, Anaheim, Calif., has SYSCAP, a circuit analysis program. These two last named programs are not available on any time-sharing service, but may be obtained from their developers on a commercial basis.

To put a priority encoder on a single chip,



Fairchild introduces the first MSI 8-input priority encoder ever put in a single package. In fact, it's the first encoder of any kind ever put in a single package.

The new 9318 accepts data from eight active low inputs, selects the most significant input signal, and provides a binary representation of it on the three outputs. Input and output enables permit encoders to be cascaded without using additional components. This allows priority encoding of any number of input signals. Also, a group signal output is provided to show when any input is active.

In the tradition of Fairchild's MSI family, the 9318 is a highly versatile, highly reliable device. It can be used in code conversions, multi-channel D/A conversions, and decimal to BCD conversions. It will find application in priority interrupt systems, associative memories and keyboard encoders as well as a number of control applications.

The 9318 is TTL and DTL compatible and has a typical power dissipation of 200mW. It comes in DIP and Flatpak in both military and industrial temperature ranges.

To order the 9318, call your Fairchild distributor and ask for:

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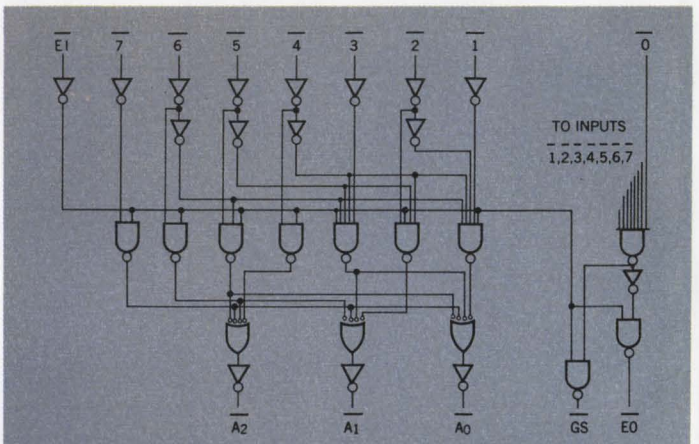
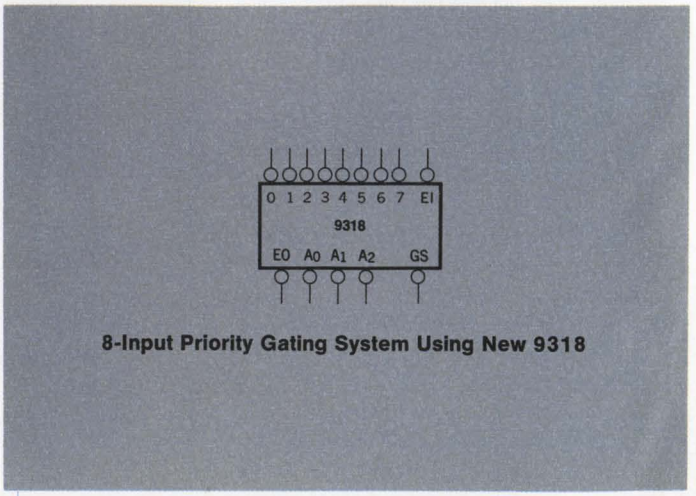
U7B931859X	DIP	0°C to + 75°C	$15.35	$11.80	$10.25
U7B931851X	DIP	−55°C to +125°C	30.70	23.60	20.50
U4L931859X	Flat	0°C to + 75°C	16.90	13.00	11.30
U4L931851X	Flat	−55°C to +125°C	33.80	26.00	22.55



8-Input Priority Gating System Using Discrete ICs



8-Input Priority Gating System Using New 9318

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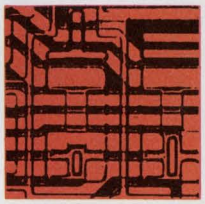
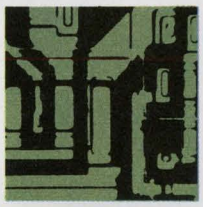
First we looked for functional categories. We found them. Time after time, in a clear and recurrent pattern, seven basic categories popped up: Registers. Decoders and demultiplexers. Counters. Multiplexers. Encoders. Operators. Latches.

Inside each of the seven categories, we sifted by application. We wanted to design the minimum number of devices that could do the maximum number of things. That's why, for example, Fairchild MSI registers can be used in storage, in shifting, in counting and in conversion applications. And you'll find this sort of versatility throughout our entire MSI line.



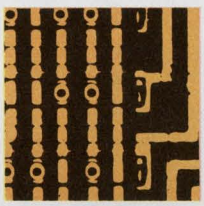
OPERATORS
9304 – Dual Full Adder/Parity Generator

Finally, we studied ancillary logic requirements and packed, wherever possible, our MSI devices with input and output decoding, buffering and complementing functions. That's why Fairchild MSI reduces – in many cases eliminates – the need for additional logic packages.

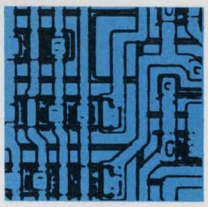


LATCHES
9308 – Dual 4-Bit Latch
9314 – Quad Latch

REGISTERS
9300 – 4-Bit Shift Register
9328 – Dual 8-Bit Shift Register



MULTIPLEXERS
9309 – Dual 4-Input Digital Multiplexer
9312 – 8-Input Digital Multiplexer



DECODERS AND DEMULTIPLEXERS
9301 – One-Of-Ten Decoder
9315 – One-Of-Ten Decoder/Driver
9307 – Seven-Segment Decoder
9311 – One-Of-16 Decoder
9317 – Seven-Segment Decoder/Driver
9327 – Seven-Segment Decoder/Driver

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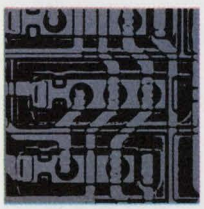
COUNTERS
9306 – Decade Up/Down Counter
9310 – Decade Counter
9316 – Hexidecimal Counter

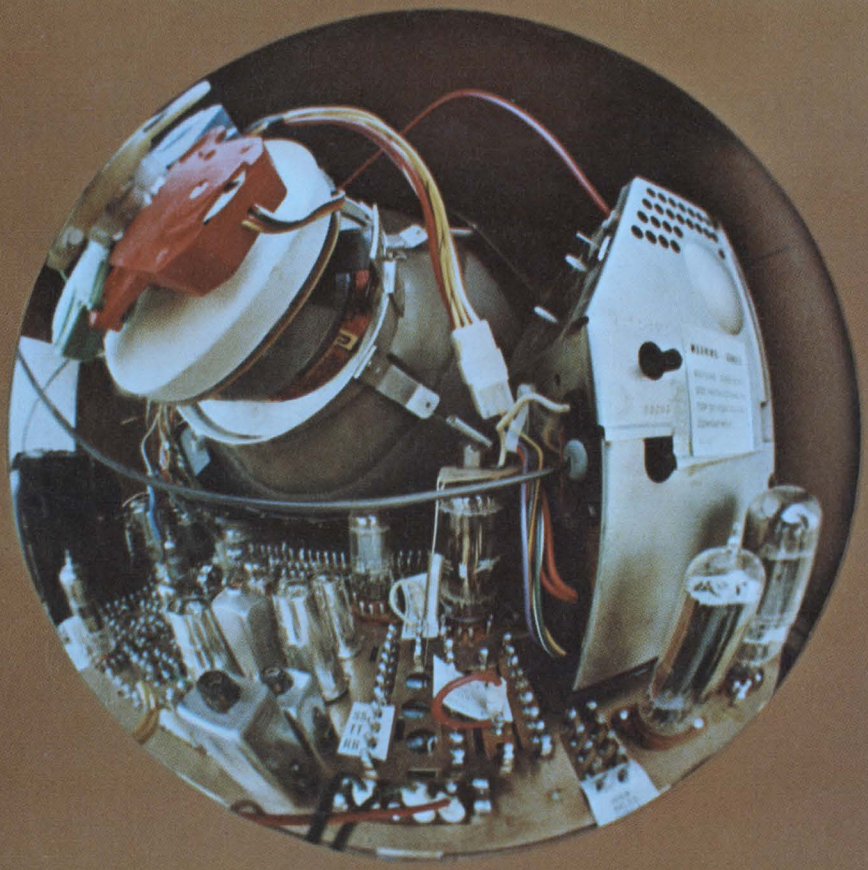


ENCODERS
9318 – Priority 8-Input Encoder

FAIRCHILD
SEMICONDUCTOR

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

INFORMATION RETRIEVAL NUMBER 28



It takes guts to build a TV set

Lots of 'em. Dozens of assemblies and sub-assemblies and components. Each as important as the other. From plug to picture every item must perform. And perform well. The customer buys what he sees. And what he sees is determined by what he does not see. That's the guts of the story.

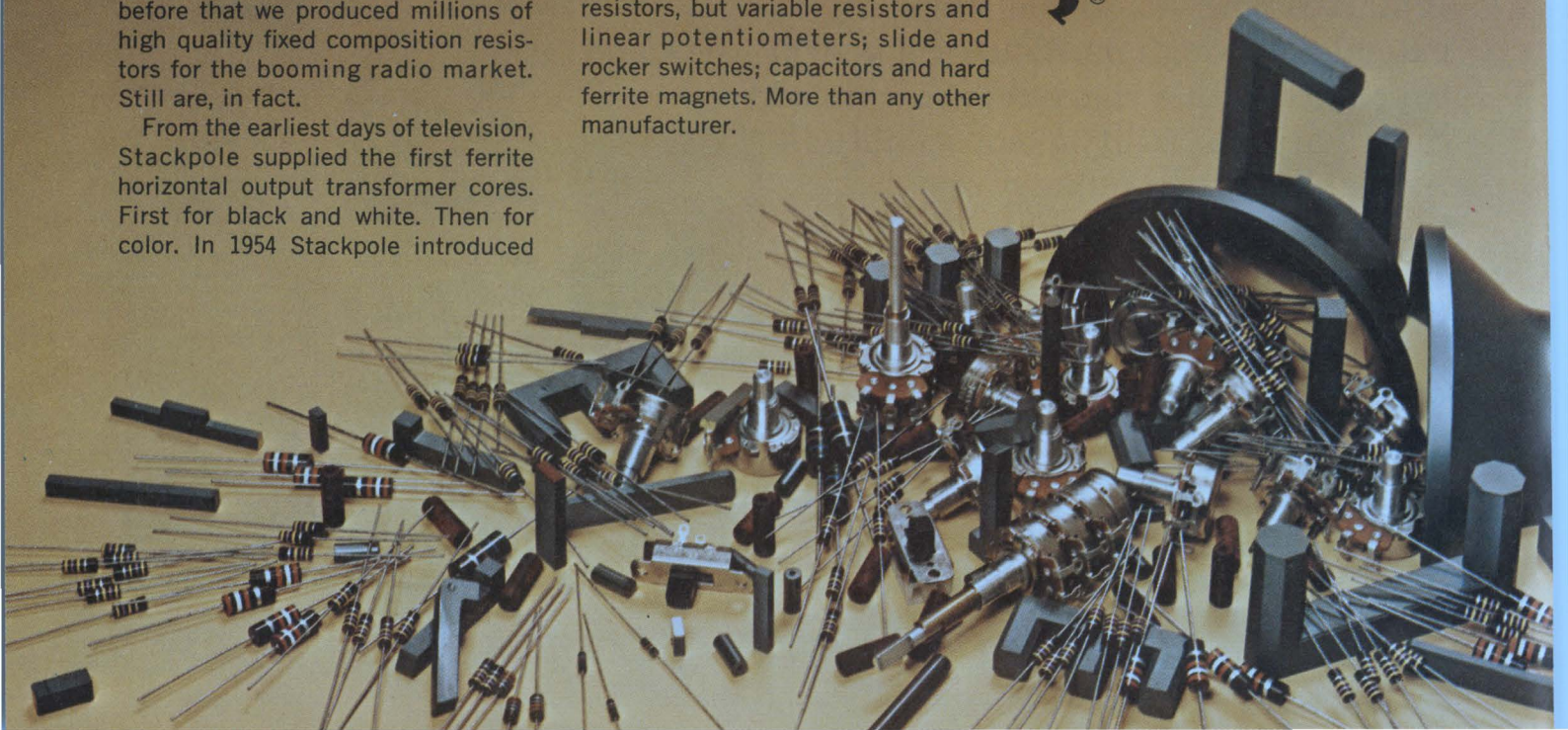
Stackpole makes more than a dozen types of components for black and white and color television receivers. Since 1947 mostly. But even before that we produced millions of high quality fixed composition resistors for the booming radio market. Still are, in fact.

From the earliest days of television, Stackpole supplied the first ferrite horizontal output transformer cores. First for black and white. Then for color. In 1954 Stackpole introduced Ceramag® ferrite components for the 70° color deflection system. And again in 1964, the 90° color components. Today we're working on the color 110°. In addition, we've been involved with such major television advances as Automatic Pincushion Correction.

Stackpole engineering and production know-how has contributed much to the technology of television. Our components can be found in every domestic TV set. Not only ferrites and resistors, but variable resistors and linear potentiometers; slide and rocker switches; capacitors and hard ferrite magnets. More than any other manufacturer.

Have you got what it takes to build a good TV set? Be sure. Specify Stackpole electronic componentry wherever possible. You'll get the value and performance you need. Write or call: Stackpole Carbon Company, Electronic Components Division, St. Marys, Pa. 15857. Phone 814-834-1521. TWX: 510-693-4511.

STACKPOLE®
ELECTRONIC COMPONENTS DIVISION



Washington Report

Government takeover of Lockheed considered

"There is a very real possibility" that the Defense Dept. will take over the direction of Lockheed's military contracts, well-informed sources indicate. The very least that Lockheed will be expected to do is to revamp its corporate leadership. The aerospace company has asked the Government for some $600-million, which it says, the Government owes for work performed. The Government says the amount is in dispute.

The Defense Dept. and concerned Congressional committees are convinced that Lockheed must be kept afloat, at least until 1975, so that programs under contract—the C-5A air transport, SRAM missile and S-3A patrol aircraft—will not die.

Meanwhile, the Defense Dept. is bringing mild pressure on the 24 banks, from which Lockheed has borrowed millions, to ease their heat on the company by not calling notes and perhaps even issuing new credit. Deputy Defense Secretary David Packard is meeting with Lockheed officials to pour over the books. Packard will report his findings to Defense Secretary Melvin R. Laird, who, in turn, will make a report and recommendation to Congress.

The crisis at Lockheed, informants have told ELECTRONIC DESIGN, will lead to a change in Defense Dept. procurement policy, with fewer eggs being put in each basket. "The gravy will be spread around," was the way it was put.

Volpe planning air-cushion transportation test

Transportation Secretary John A. Volpe is expected to announce very shortly a demonstration program involving a 150-200-mph tracked air-cushion transport system, to be operational by 1972. It is expected that the demonstration program will be set up between a downtown city site and an airport. Although no site has been announced yet, Kansas City and Denver are reported to be possibilities.

Volpe has also announced the award of a $3-million contract to Grumman Aerospace Corp. for a second-generation, 300-mph air-cushion vehicle and guideway.

On more lofty matters, Volpe told a recent audience at the National Press Club here that the supersonic transport program is alive and well in Washington and that when the plane flies, it will be a nonpolluter, a nonsonic boom maker, and a money-maker.

Bill would bar polluters from U.S. contracts

A tough bill introduced by Sen. Marlow W. Cook (R-Ky.) would bar air and water polluters from Government contracts. The bill, S.3614, was co-sponsored by Senate majority leader Michael J. Mansfield (D-Mont.) and referred to the Public Works Committee. Essentially the bill would order the Government to terminate immediately any contract with a company or person found in violation of federal laws on air and

water pollution. However, if the polluter files a schedule of conformance with those laws, the contract may proceed to its conclusion.

Defense contracts could be exempted, if the Secretary of Defense said they were vital to national security. If a portion of a corporation having many contracts with the Government was found to be a polluter, all other contracts might be run to their conclusion, but then the ban on further contracts would be company-wide. The Public Works Committee has not set a hearing date yet.

Comsat role as Intelsat manager challenged

The second meeting of the International Telecommunications Satellite Consortium has ended without agreement on what future satellite communications will look like or who will manage them. The door, however, has been opened for the Communications Satellite Corp. to get a little competition in its role as Intelsat manager.

The Japanese and Australian delegations have advanced a plan to create a new governing office in the consortium that will open up technical and operational functions, now handled by Comsat, to bids from other companies and countries.

According to the plan, a director general would be appointed at the end of a six-year period to act as contracting officer for the functions now performed by Comsat. Comsat would remain in its present role in the interim, and would not only be able to bid on continuing as manager but would be in an advantageous position to do so.

Transportation takes over NASA's Cambridge center

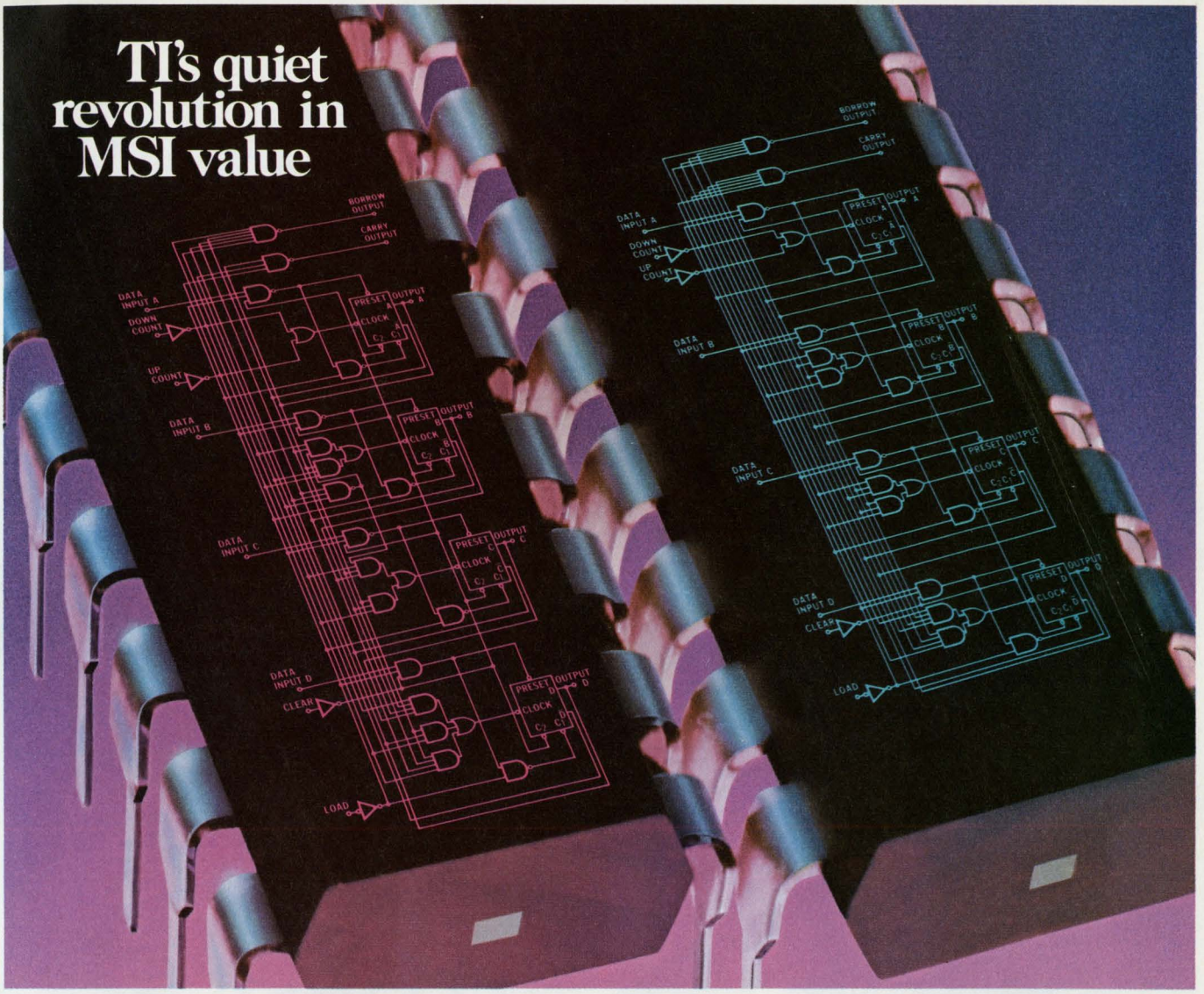
The Transportation Dept.'s new Development Center in Cambridge, Mass., which on July 1 will officially take over NASA's Electronic Research Center, will initiate a mix of ground and airborne programs. The center will attempt to develop a collision-avoidance system, a reliable automatic landing system, sensors to monitor pollution from transportation vehicles, systems analysis of urban transit systems and highway traffic control, a system of oceanic buoys, and make automobile accident studies. It will also automate and expand the domestic air traffic control network.

Most of NASA's 750 research personnel, including the director, James C. Elms, will be retained. The annual budget will be $20-million.

NASA's budget facing battle in Congress

Action by the House Independent Offices Appropriations Subcommittee, increasing NASA appropriations to $3.63-billion from the $3.33-billion asked by the Administration, guarantees a floor fight when the bill comes up, probably next month. House majority leader Gerald Ford (R-Mich.) will try to keep the money to the level requested by the President, and he has strong support among committee members. Most of the increase asked for by the subcommittee is in the area of manned space flight.

NASA officials themselves believe, however, that after the bill makes its way through both houses and resultant conferences, the space agency will probably wind up with less than the President has asked for.



Your choice in up/down counters is up. And the price is down.

Count on TI to introduce new TTL/MSI counters priced at about a third of what you usually pay.

The SN54/74192 is a BCD 4-bit up/down counter. The SN54/74193 is a binary 4-bit up/down counter. In 100-999 quantities, the SN74192 and SN74193 both sell for a down-to-earth $7.70, plastic DIP. That's the lowest price going—brought down by TI's big yields and manufacturing know-how.

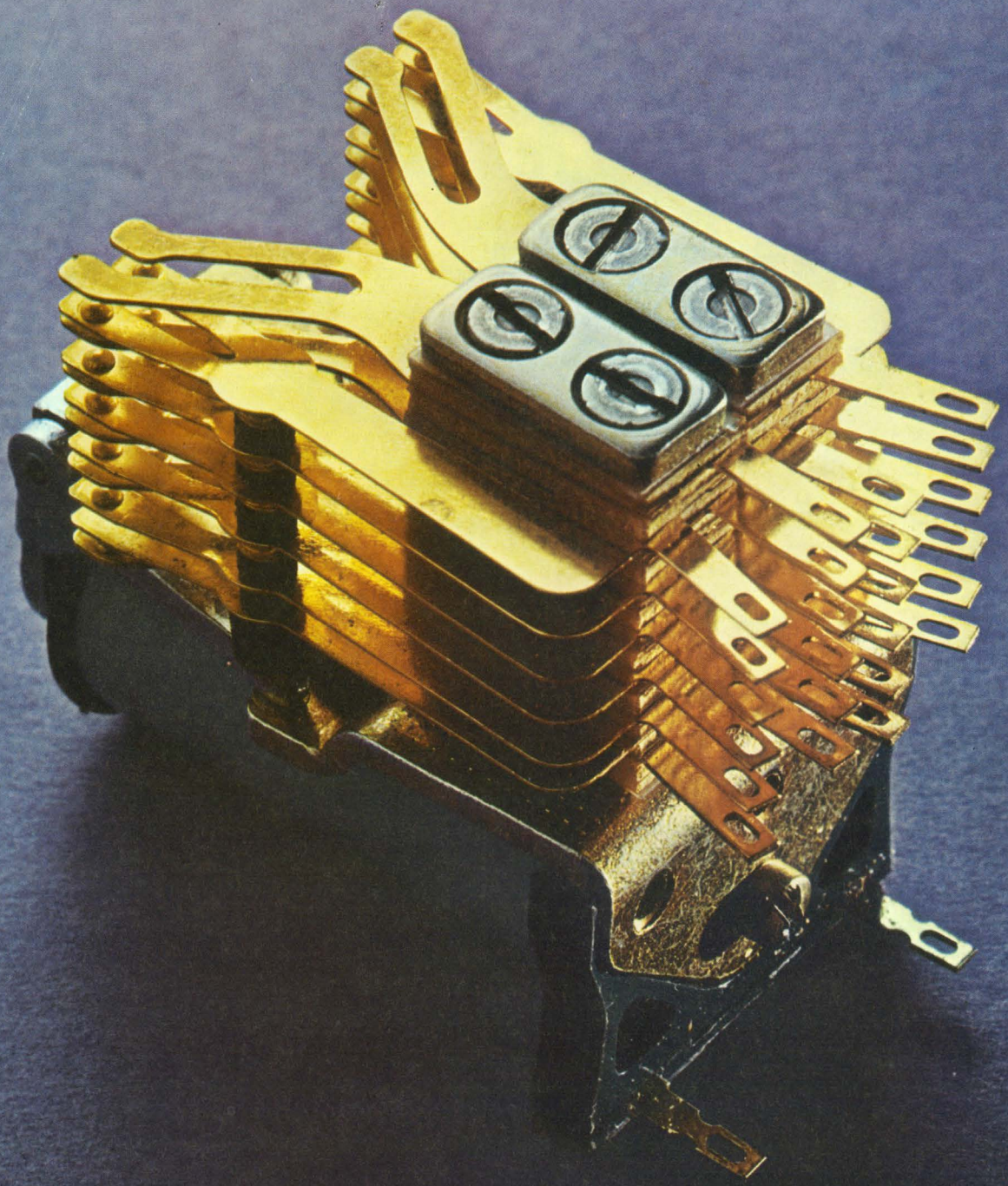
And these counters are ready now for immediate delivery. That's why you may want to order them instead of the equivalent DM8560 and DM8563. Not to mention the price.

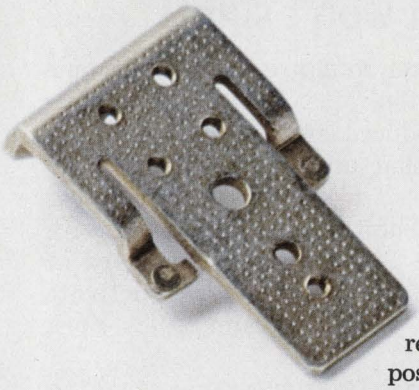
These 54/74 devices are virtually universal counters. They are synchronous and fully presettable. They may be cascaded to n bits, and have fully independent clear. Propagation delay is 27 ns typ; count frequency is 32 MHz typ. You can choose the full military temperature range of −55°C to 125°C or the industrial range of 0°C to 70°C...in either plastic or ceramic DIPs.

Be one-up on up/down counters. Send now for the new 184-page supplement to our TTL catalog. Circle 280 on the Reader Service Card or write Texas Instruments Incorporated, P.O. Box 5012, M.S. 308, Dallas, Texas 75222. That's where the quiet revolution is going on. Or see your authorized TI Distributor.

TEXAS INSTRUMENTS
INCORPORATED

Reliability is six things we do that nobody else does.





We're fanatics.

We build our relays stronger than we have to. That way, they last lots longer than they ever have to. Our Class E relay (shown on the opposite page) is a good example of our way of thinking.

The industry's strongest heelpiece.

We make the strongest heelpiece in the industry. A gigantic machine bangs them out extra fat and extra flat.

Extra fat to carry a maximum of flux. To handle big loads. Extra flat so that once an AE relay is adjusted, it stays adjusted.

Since our backstop is part of the heelpiece, it's just as thick and flat. But, tough as it is, the slightest wear here would throw the entire contact assembly out of whack. So, to be safe, we weld two tiny, non-magnetic pads where the armature arms meet the backstop. You might say we created the no-stop backstop.

Three parts that'll wear like crazy.

When you build a relay like a small tank, you have to think of everything. We try. Right down to the tiniest part. For example, we make our armature arms and bearing yoke extra thick.

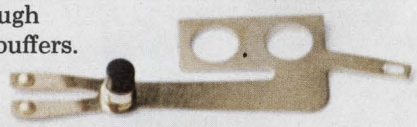
Thicker than years of testing and use say they have to be. Then, to make sure they don't cause wear problems, we insert a hardened shim between the hinge pin and the frame. The pin rides on the shim, instead of wearing into the heelpiece. (You can forget the bearing, it's permanently lubricated.)

Buffers with lots of muscle.

We make our buffers of a special tough phenolic material that lasts. And lasts. And lasts. All without wear or distortion. Another reason why our relays stay in whack.

To make sure our buffers stay in place, we weld the buffer cups to the armature arms. We weld, instead of using rivets, because our lab found that rivets have a habit of falling out.

For the very same reason, we weld buffer cups to the contact springs. And also use the same special tough phenolic buffers.



No, we didn't forget the contact springs.

We have some strong feelings as to what makes a contact spring reliable. Our sentiment is that two contacts are better than one. So, we bifurcate all the springs, not just the make and break. This slotting and the addition of another contact to each spring means you get a completed circuit every time.

We make each set of contact points self-cleaning. The bad stuff doesn't have a chance to build up.

Now, what's different about our bobbin?

Our bobbin is one piece—molded of glass-filled nylon. This provides the maximum in insulation resistance.

Because our bobbin is nylon, we don't have to impregnate with varnish. Moisture and humidity have no effect on the stubborn nylon material. No effect means no malfunctions for you to worry about.

What all this means to you.

What this all adds up to is reliability. The kind of toughness no one else can give you. It means an AE relay works when it's supposed to, longer than it has to.

Isn't this the kind of reliability you really need? Automatic Electric Company, Northlake, Ill. 60164.

AUTOMATIC ELECTRIC

SUBSIDIARY OF GENERAL TELEPHONE & ELECTRONICS

INFORMATION RETRIEVAL NUMBER 30

Computer does taxes—but won't sign

Now you can get a computer to figure out your income tax. Dial Data, Inc., of Newton, Mass., a computer time-sharing company, has introduced such a program as a service to its client firms that are located east of the Mississippi River.

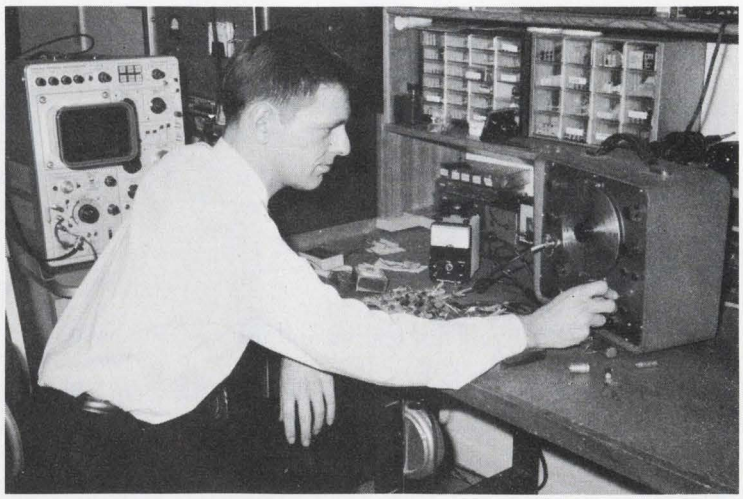
Here's how it will work. The taxpayer, prepared with his facts, will sit down at a teletypewriter keyboard at his own company and press a button that will activate the computer at a Dial Data office in Boston, New York or Washington.

The computer will ask nearly 100 questions, covering such ground as how many miles each year you use your own car for business purposes, your charitable contributions, and how much you calculate you paid in state sales taxes the previous year. If the figure is not as high as that allowed by the government for the appropriate income level, the computer will select the higher figure.

"We expect that the dialogue between taxpayer and computer will take about 15 minutes and that the computer will print the results within 30 minutes. The total cost to the taxpayer will be about $10," said Lewis Clapp, president of the company. "Right now, we are trying to determine if we can get the computer printout on the actual Internal Revenue Service form.

"Just one hitch!" Clapp pointed out. "Don't expect the computer to sign its name at the bottom of the tax form as the preparer of the income tax form."

Doing his homework paid off in prize money



Winner of the $1000 Idea of the Year award for 1969 is Thomas Skopal, shown doing a little experimenting. Skopal developed his winning idea, a feedback-controlled tuned circuit, in his own home workshop. (See ED 2, Jan. 18, 1969, p. 76.) His working day is spent as assistant sales manager and applications engineer with the Acopian Corp. in Easton, Pa. The award was presented at a special luncheon during the IEEE show.

INFORMATION RETRIEVAL NUMBER 32 ►

BOURNS
bridges the generation gap in...

PANEL CONTROLS

...*with* CERMET

Bourns introduces a new generation of Panel Controls with cermet resistance elements for top performance in high-grade commercial, industrial and RV4, RV5, RV6 type applications.

The hang-up of the hot molded carbon element control (that's the older generation) is it weakens, can't stand the heat.

Bourns found a way to cool it . . . with cermet!

What you get is stability, a better temperature coefficient, a higher power rating in a smaller package.

One ½" and two ¾" diameter units constitute the basic model line which covers all RV4, RV5 and RV6 type applications. Their profiles are the thinnest in the industry. All models show excellent high frequency characteristics, extremely low noise and good setability.

COST? Less than a dollar for Model 3859 in production quantities. Then subtract the price of rejections, complaints and delays common with the older generation. Delivery is off the shelf.

Turn on with Bourns. Send for Data Packet on cermet Panel Controls or call your local Bourns sales office for a sample.

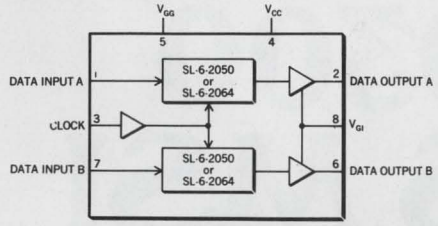
Model 3862, ½" dia., ¼" standard or locking bushing with or without panel seal, 1 watt at 125°C. **Model 3852,** ¾" dia., standard or locking bushing — ¼" with or without panel seal for Mil Spec type uses, ⅜" for industry; 2 watts at 70°C. **Model 3859,** ¾" dia., ⅜" tough plastic bushing; also snap-in version; 2 watts at 70°C.

BOURNS

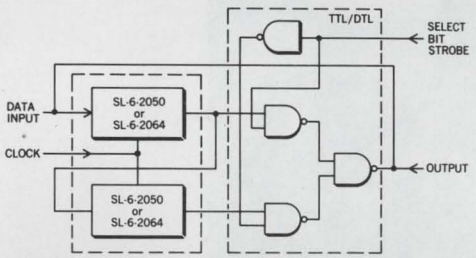
BOURNS, INC., TRIMPOT PRODUCTS DIVISION • 1200 COLUMBIA AVE., RIVERSIDE, CALIF. 92507

Now... GIANT Dual Registers – with exclusive TTL, DTL and MOS compatibility – provide performance, reliability and cost advantages previously unattainable in serial storage applications.

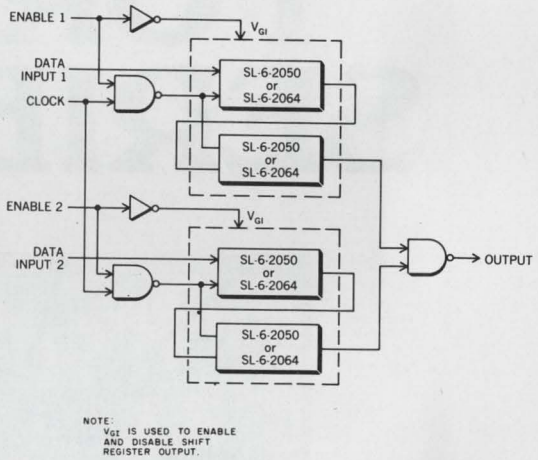
LOGIC DIAGRAM
DUAL 50-BIT (SL-6-2050) AND DUAL 64-BIT (SL-6-2064) STATIC SHIFT REGISTERS



RECIRCULATING STORAGE APPLICATION



MULTIPLEXING SHIFT REGISTER APPLICATION



Among their various and marked advantages over bipolar and delay line serial storage systems, General Instrument's GIANT Dual 50-bit and Dual 64-bit DC shift registers operate with the lowest power dissipation available for static registers . . . a mere 7 milliamps typical.

The GIANT Dual 50-bit and Dual 64-bit shift registers operate over the full military temperature range of −55°C to +125°C.

The well known performance and reliability advantages inherent to all MTNS (Metal-Thick Oxide-Nitride-Silicon) devices are, of course, present in these GIANT shift registers. They are directly compatible with TTL, DTL and MOS and require no interface electronics.

A perusal of the comparison chart (above right) should make clear the fact that in serial storage applications insofar as performance, reliability and cost savings are concerned . . . "GIANTS do it better."

The GIANT Dual 50-bit (SL-6-2050) and the Dual 64-bit (SL-6-2064) DC shift registers are available from your authorized General Instrument distributor. For full information write General Instrument Corporation, Dept. 56, 600 West John St., Hicksville, L.I., N.Y. 11802. (In Europe to General Instrument Europe S.P.A., Piazza Amendola 9, 20149 Milano, Italy; in the U.K., to General Instrument U.K., Ltd., Stonefield Way, Victoria Rd., South Ruislip, Middlesex, England.)

Parameters	Delay Line & Interface Electronics	GIANT Dual Shift Registers
Power Requirements	200 mA Typical @ ± 12 V	7 mA Typical @ +5V, −12V
Size	6" x 1" x ½" Typical	.370" Dia x .260" H (TO-77)
Weight	1-5 lbs.	1 gram
Number of Parts	50-75	1
Operating Temperature	25°C +20°C, −10°C	−55°C to +125°C

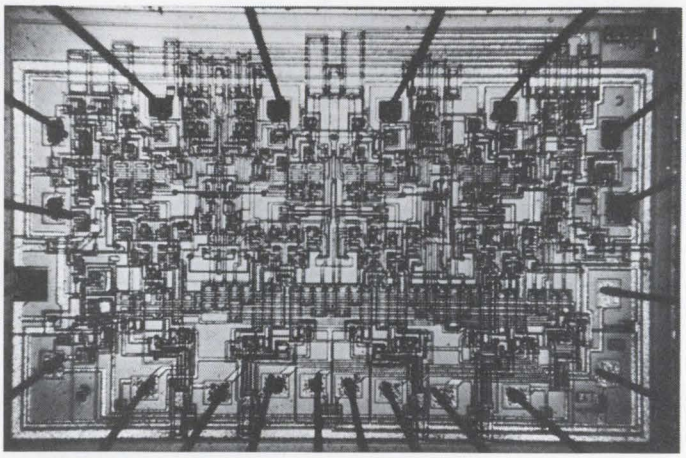
Price in quantities of 100 pcs.: SL-6-2050 @ $13.00 ea.; SL-6-2064 @ $16.75 ea.

GENERAL INSTRUMENT

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

INFORMATION RETRIEVAL NUMBER 33

ANNOUNCING A FIRST-CLASS SECOND SOURCE FOR 9300 SERIES MSI



Now for the first time you can get 9300 T²L MSI circuits . . . today's high-versatility logic with optimum speed-power product . . . made by Philco-Ford, the people long identified with high reliability in IC production.

We're bringing you the most wanted MSI types first: registers, counters, decoders, and multiplexers. Versatility is built in; additional logic requirements are pared way down . . . in some cases eliminated. Then there's the packaging. Ceramic DIP with proved hermeticity . . . by the people who know Cerdip.

Here are the first six, with more coming soon:

PD9300	4-bit universal register
PD9306	BCD up/down counter
PD9311	1-of-16 digital decoder
PD9312	8-bit digital multiplexer
PD9316	binary hexadecimal counter
PD9328	dual 8-bit shift register

For information, write Bipolar Products Marketing, Microelectronics Division, Philco-Ford Corporation, Blue Bell, Pa. 19422. Or call 215-646-9100.

The better idea people in bipolar products. **PHILCO** Ford

INFORMATION RETRIEVAL NUMBER 45

Sonotone—the industry's broadest line of nickel-cadmium sealed cells—now has our name on it.

The new name for Sonotone sealed cell nickel-cadmium batteries is Marathon. The name is the only thing that has changed. The batteries are still made in the same way. In the same plant. By the same people. And they are still available through the same sales representatives and distributors.

Marathon has been growing and expanding for 47 years. Now we have added the world's most versatile rechargeable to our diversified battery line.

Because you have relied on Sonotone for so many years, we want to be certain that you know the name — and only the name — is changed. So the next time you need Sonotones, ask for Marathon. Cold Spring, New York 10516.

marathon battery company

INFORMATION RETRIEVAL NUMBER 46

Catch the blip among the garbage.

The new IDR-200 instrumentation disc recorder is designed to isolate information for detailed analysis. It's great for catching and evaluating that one significant little blip among all the garbage. It's ideal for replacing endless loop instrumentation recorders, and its applications extend far beyond. In fact IDR-200 applications are only limited by the imagination.

Unpredictable Transients

The IDR-200 is ideal for recording unpredictable events like powerline transients or radar signals. They can be replayed and analyzed for power, peak voltage, duration and other characteristics. The IDR-200 can be programmed to turn-off after the event is recorded and can operate unattended as long as necessary.

Predictable Momentary Events

A rocket launch. The regular tape units begin. The shot's delayed, then fired. But, the tape ran out. Can't happen with the IDR-200. The recorder disc keeps recording 20-second blocks, continuously, until stopped.

Event Comparison

On both single- and dual-channel recorders, a multi-track option allows recording of multiple 30 millisecond events. They can easily be replayed and compared because all are "synced." This capability is unequalled in applications where similarities and differences in test results are critical.

Tape Analysis and Data Conversion

Volumes of telemetry or other data recorded on tape can be analyzed in detail by transferring portions to the disc for continuous replay. This data can then be repeatedly stepped through an A-to-D converter or a signal analyzer for noise reduction, signal enhancement and extensive manipulation.

Delay Line

Imagine a 20-second, 2 MHz delay line. Or, a multi-channel, 30 millisecond, 2 MHz delay line. The IDR-200 can even be made into a programmed delay line.

1000 Hour Warranty

The DMI 1000-hour warranty on heads and discs is possible through outstanding manufacturing capability and advanced engineering achievements. All heads and discs are manufactured by DMI using proprietary techniques and outstanding quality control.

Operation

The IDR-200 features DMI in-contact recording. Through perfecting this technical innovation DMI achieved high band-pass, short wave-length response and outstanding signal to noise ratios. Frequency response is from 400 Hz to 2 MHz, ±1.5 dB midband.

The recorder is available in single or dual channel models. The dual channel model, stores 10 seconds of data on each channel. For more information, or assistance in applying the IDR-200 to solving your particular problems, contact DMI today.

The Disc People dmi DATA MEMORY INC.

1400 Terra Bella Avenue, Mountain View, CA 94040 (415) 961-9440 TWX (910 379-6474)

INFORMATION RETRIEVAL NUMBER 47

INFORMATION RETRIEVAL NUMBER 48 ►

did you know?

General Electric volt-pac® variable transformers help you vary voltage dependably...year after year,*

after year, after year, after year, after year, after year, after year, after year...

Send in this coupon for free bulletin giving complete details on Volt-Pac transformer features, ratings and application data; or see your GE sales representative today.

* Laboratory tested for over one million failure-free operations.

GENERAL ELECTRIC

Section 413-34
General Electric Company
Schenectady, New York 12305

Please send me free bulletin GEA-8110 on Volt-Pac Variable Transformers.

NAME _____

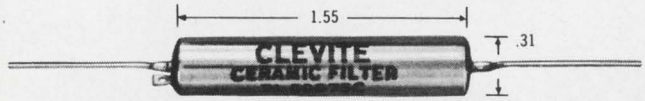
COMPANY _____

TITLE _____

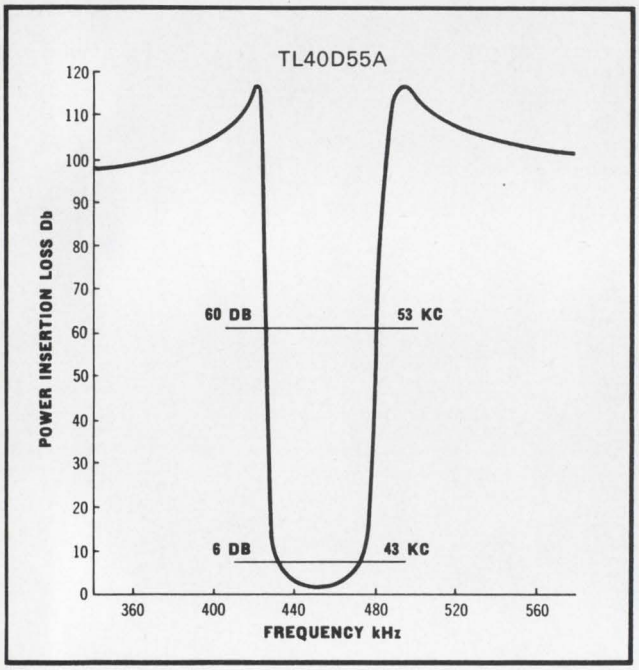
ADDRESS _____

CITY _____ STATE _____ ZIP _____

Still using LC's? This might change your mind:



Clevite's ceramic ladder filters deliver 80 db rejection in 0.1 cu.in.!



Here's a fixed-tuned filter that offers more selectivity for its size than any conventional i-f filter on the market!

Clevite's non-magnetic, non-microphonic, 17-disc ceramic ladder filter is ideal for i-f stages of high quality superheterodyne radio receivers used in airborne or ground AM and FM communications equipment. Stop band rejection: 60 or 80 db. Center frequency tolerance: ± 1 kHz for 20 kHz B/W and below; ± 2 kHz for 30 kHz B/W and above. Stability: within +0.2% for 5 years; within 0.2% from −40°C to +85°C. Impedance (in and out) 2500 ohms for 12 kHz bandwidth and below; 1500 ohms for 13 kHz to 29 kHz B/W; 1200 ohms for 30 kHz bandwidth and above.

Following models standard at 455 kHz (A) or 500 kHz (C) (custom models on special order):

Model Number	B/W Min. @ 6db	B/W Max. @ 60db	Model Number	B/W Min. @ 6db	B/W Max. @ 60db
TL-2D5 (A)	2 kHz	5 kHz	TL-20D32 (A)	20 kHz	32 kHz
TL-4D8 (A)	4 kHz	8 kHz	TL-30D45 (A)	30 kHz	45 kHz
TL-6D11 (A)	6 kHz	11 kHz	TL-40D55 (A)	40 kHz	55 kHz
TL-8D14 (A)	8 kHz	14 kHz	TL-45D65 (A)	45 kHz	65 kHz
TL-10D16 (A)	10 kHz	16 kHz	TL-50D75 (C)	50 kHz	75 kHz
TL-16D25 (A)	16 kHz	25 kHz			

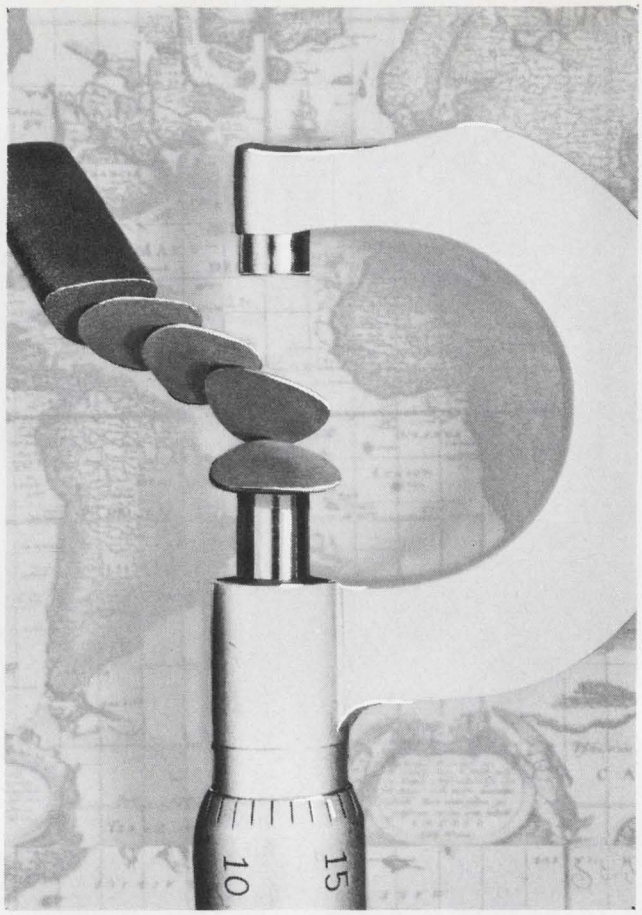
PRICES: 1 — $52.50; 25 — $42.00 ea; 100 — $36.75 ea; 500 — $31.50 ea; 2000 — $26.00 ea.

(Prices subject to change without notice.)

Send order or request for Bulletin 94017 to: Piezoelectric Div., Gould Inc., 232 Forbes Rd., Bedford, Ohio 44146, U.S.A. Or: Brush Clevite Company, Limited, Southampton, England.

GOULD **CLEVITE**

INFORMATION RETRIEVAL NUMBER 49



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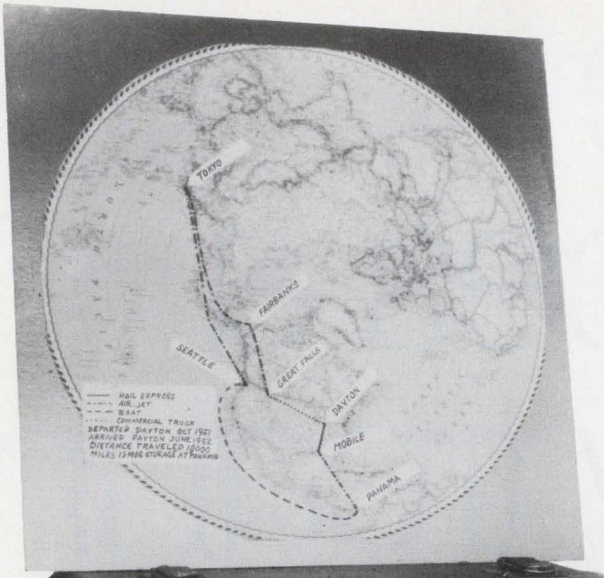

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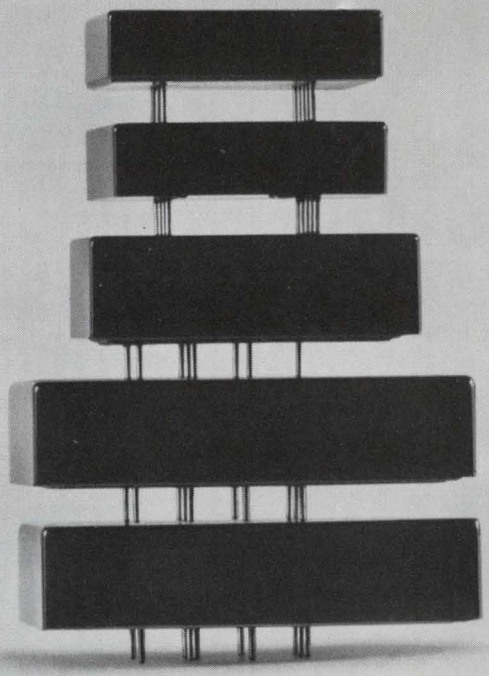
The new ideas in op amps



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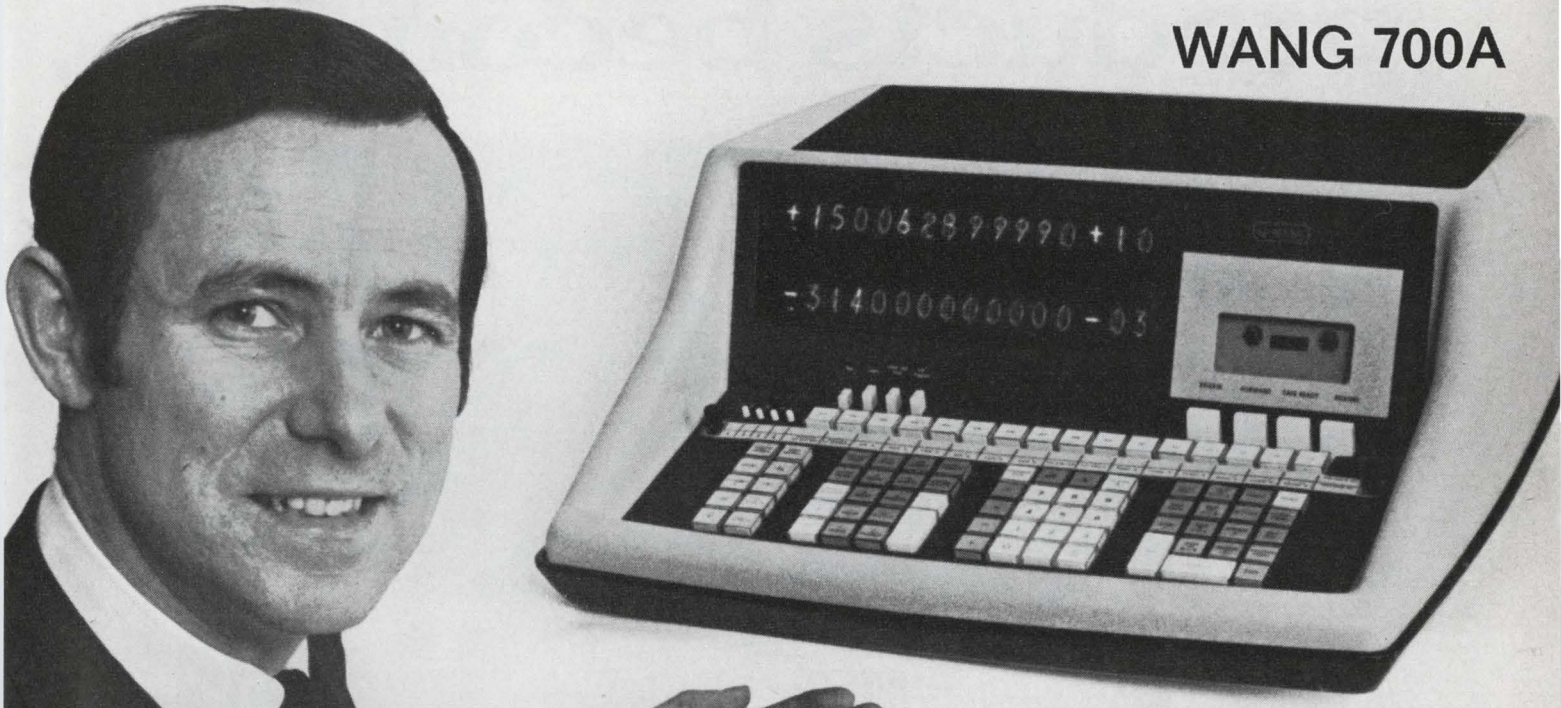

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Photo courtesy of Fairchild Semiconductor, Mountain View, California.

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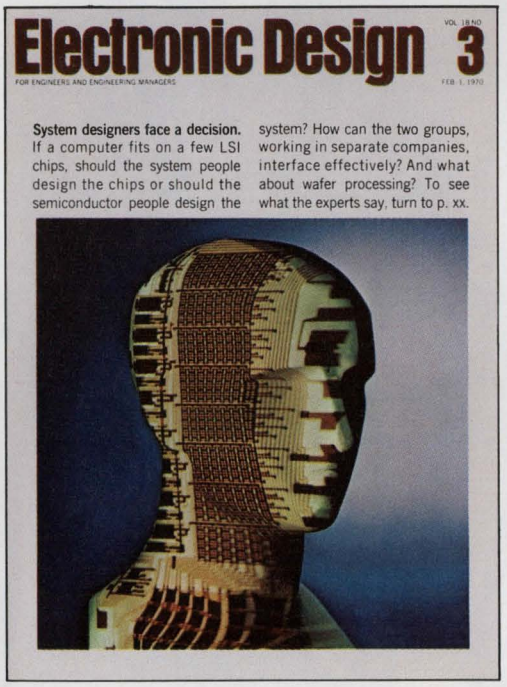

NEW INFORMATION LENDS PROOF A new (1969) study to determine *how the electronics industry buys* has been conducted by Dr. James J. Mullen, President, University Research Associates. The study examined buying practices for 25 product categories in 87 representative plants. *Engineers and engineering managers* stand out clearly as the men who "select and specify brand." These men select 84.2% of the power supplies; 80.2% of the capacitors; 84.9% of the integrated circuits! Engineers and engineering managers are your primary prospects—the men whose job function is to examine, specify, authorize purchase, or in many cases, purchase directly from your advertising. In fact, studies show that in a large percentage of cases, advertising alone produces the sales.

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Genate Piccinetti

Engineers' problems are also industry's problems

From all indications, at least through the first quarter, it looks as though 1970 will be a sobering year for the electronics industry. Headlines such as "Little Growth Expected in Electronics Industry," "Defense Cuts Resulting in Job Cuts" and "Outlook Dim For New EE Grads" are far from uncommon. There will be a few bright spots, of course, but the over-all trend is to lower sales and profits.

To many it was obvious that the rapid growth of the sixties, spurred by military and NASA spending and a tolerable inflationary level, could not be sustained indefinitely. But this is little consolation to those ultimately affected.

To design engineers, the effects of such a "down" year can take many forms: salary freezes, travel curtailment, purchase limitations and, most extreme of all—job layoffs. It is safe to say that before the year is out headaches, heartaches and frustration will move into many engineering departments throughout the industry and that, as a natural corollary, more engineers will leave their chosen field and seek both economic and personal rewards elsewhere.

In the face of this situation it is a shame that some in the industry, believing they are unaffected by it all, appear to feel smugly superior to those who are hurt by the economic squeeze. With no prodding whatsoever, they will detail the root causes and surefire remedies for all engineers' problems. And they do this, from their "objective" standpoint, without regard to the personal upheavals their solutions require.

Such people would do well to remember that the vitality of the electronics industry is equal to the sum of its individual parts —and these parts are mainly people, many of them engineers. Every time an engineer leaves the industry, whether for economic or other reasons, the industry is the worse for it. The situation, we feel, is akin, although on a more limited scale, to John Donne's famous lines:

No man is an island, entire of itself;
every man is a piece of the continent,
a part of the main; . . . .
and therefore never send to know for whom the bell tolls;
it tolls for thee.

FRANK EGAN

Cable TV: Slumbering electronic giant—A multibillion industry?

David Kaye, West Coast Editor

What started out as a way of transmitting quality television signals to selected, out-of-the-way areas—CATV—now looms as a potentially giant industry: broadband communications.

Community Antenna Television—also known as cable TV—will, in perhaps two or three years, begin growing into a new multibillion-dollar medium that will profoundly affect the life style of nearly every American, some manufacturers believe.

Others in the business are not so sure. They agree that there's considerable talk about the potential of broadband communications. But it takes action to make such dreams come true. And right now, the pessimists say, there's little action—no new hardware for broadband communications, no legislative approvals, no agreement on standards.

These views of an industry in which some of the more glowing optimists see themselves as new "AT&Ts" have emerged from a coast-to-coast ELECTRONIC DESIGN survey of cable TV. The investigation included interviews with manufacturers of equipment and representatives of service organization, as well as talks with officials of the Federal Communications Commission in Washington.

Some of the services that are being considered for sale to American homes over a two-way cable system—a system in which there could be transmission in either direction—include these:

- Burglar and fire-alarm systems.
- Remote utility meter reading.
- Preference polling.
- Home merchandising.
- Teaching machines.
- Facsimile reception of mail, newspapers, and library information.

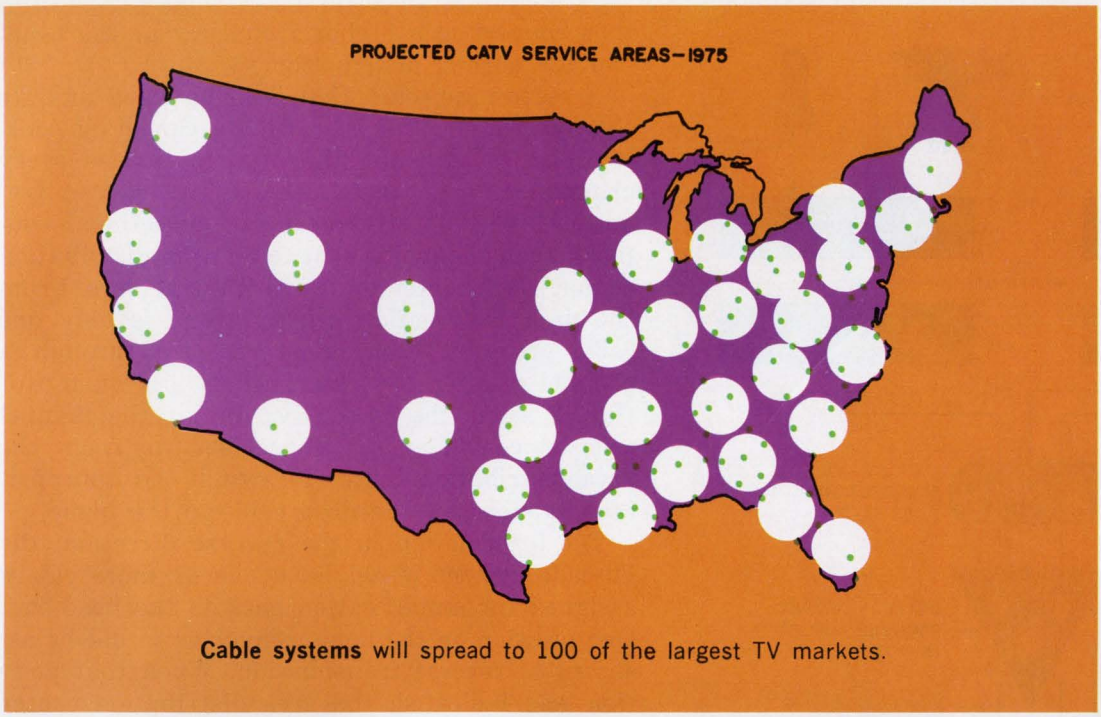
Estimates of the market potential merely for manufacturers of hardware and cable, without including subscriber sales by system operators, run to between $900-million and $1.4-billion over the next five years, a sampling of opinion by ELECTRONIC DESIGN shows.

It is estimated that by 1974 there will be between 300,000 and 350,000 miles of cable in place in the United States. It is further estimated that by 1974 between 20% and 25% of the 65 million homes with TV (57 million have sets today) will be tied into a cable system. In 1974 close to 70% of the sets in use should be color, manufacturers say, as against about 40% now.

Sol Schildhause, director of the FCC's Cable Television Bureau in Washington, says: "Cable TV is firmly an important part of our national communications structure."

George W. Green, group vice president of Vikoa, Inc., a CATV system operator and big manufacturer of equipment in Hoboken, N.J., puts it this way: "The industry has grown beyond the point where bringing in 'I Love Lucy' is the most important thing. The great future is in two-way communications services to the home along a coaxial cable system."

Irving Kahn, president of Teleprompter Corp. in New York, says: "We consider the growth of cable TV to be much more in the area of broadband communications than in the area we are now involved in. Our corporate policy is now to get away from the words CATV, cable TV and even from cable. For example, we're now allowed to use such things as the AML [amplitude modu-



Cable systems will spread to 100 of the largest TV markets.

lated microwave link] developed by Hughes Aircraft Co."

First systems for TV only

In the early days of Community Antenna Television (the first system in the United States was founded in Lansford, Pa., in 1949) the procedure called for a large antenna tower to be built either on top of a mountain or in some other good reception area. The TV signals picked up at the tower were cleaned up, amplified and sent from the head-end along a system of coaxial cables to all homes that were subscribing to the service. This service was eagerly sought in areas where the TV reception was either very poor or nonexistent. The head-end is the central distribution point where the signals are received, processed and sent on to the homes in the system.

But as CATV grew, the industry quickly realized that to expand into a position of real importance, it would have to provide services for areas blessed with good TV reception. The first attempts at additional services included such things as bringing in distant stations that were out of the range of the normal TV antenna, providing channels for the stock-market ticker and for continuous time and weather information, and offering programs originated by the cable system itself.

It is not commonly believed in the industry that cable will supplant broadcasting, but that the two mediums will complement each other.

"Whereas broadcasting can reach great numbers of people from a single source," says Nathaniel E. Feldman, consultant on engineering sciences for the Rand Corp. in Santa Monica, Calif., "narrow-casting along a cable system allows you to control your broadcasting to a very specialized and limited audience and to cater to their local needs."

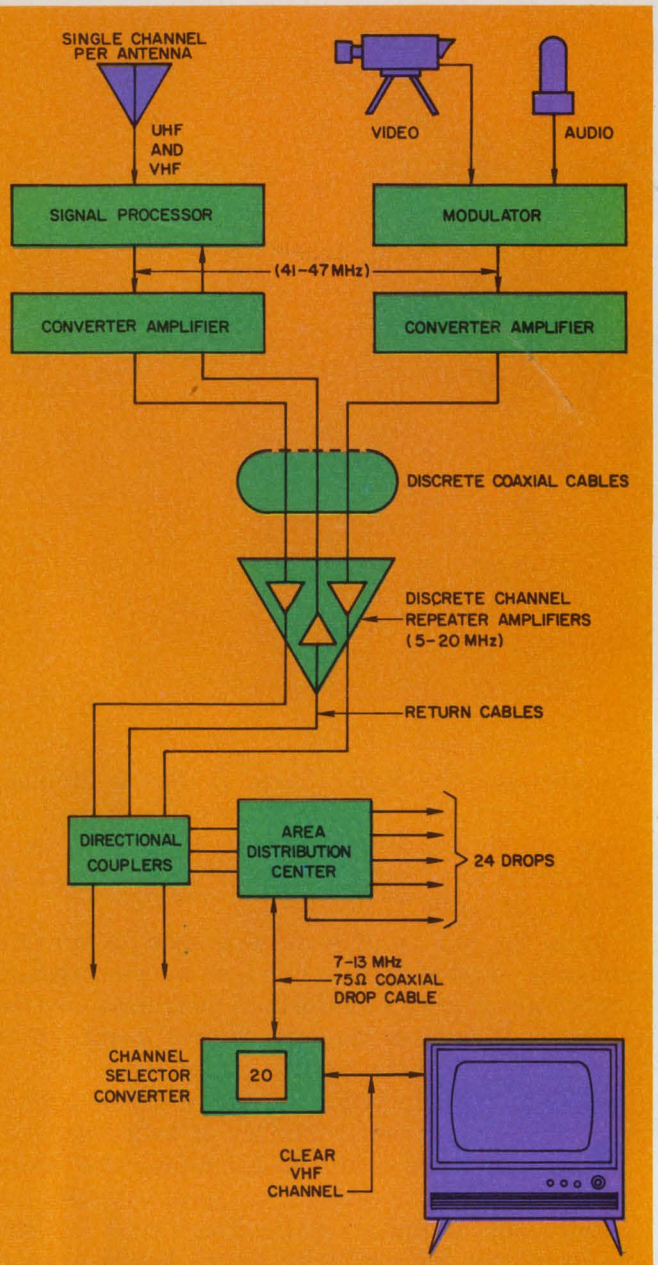
It is the ability of a cable system to provide not only narrow-casting but also narrow-gathering (transmitting of information from a limited number of sources to one central point) that gives it the big potential for expansion.

Due to the limitation of the electromagnetic spectrum, only a small number of broadcast frequency bands are available for public use. Even though the uhf spectrum has been opened for public use, technical difficulties—such as the necessity for rather large guard bands around each channel—have precluded the widespread use of uhf. No city at present is using more than six uhf channels. Therefore the maximum number of channels in use for sending TV is 13 (seven vhf and six uhf).

Because of the very wide frequency spectrum that a coaxial cable can carry, a large number of channels can be carried by a single cable. Even with present cable systems, in which the amplifiers are good only up to about 265 MHz, 35 to 40 6-MHz television channels could be carried comfortably. The most capability that any present cable system is offering is 21 channels.

Since so much information can be carried in a narrow-casting mode, considerable specialized programming can be sent to a given area without infringing on widely used spectrum space.

In the narrow-gathering mode, services can be offered that require transmission back from the home to some central location. Today's cable dis-



1. **In the Discade system** each channel is carried on a separate cable at reduced frequency.

tribution systems can be used only for transmission in one direction. The reason for this is that the amplifiers are unidirectional. Three basic techniques are being considered for converting cable systems to two-way transmission.

The simplest is merely to run a separate cable with amplifiers in the reverse direction. But if this were done for every home in the system, it would be extremely costly. However, in the case of a program originating from the cable studio, E. G. Gramman, president of Dynair Electronics, Inc. in San Diego, points out:

"It will probably be cheaper to string an extra cable to get from the studio to the head-end. It would be desirable to transmit from the studio at a sub-channel frequency of about 30 MHz and then convert to a higher frequency at the head-end for normal distribution."

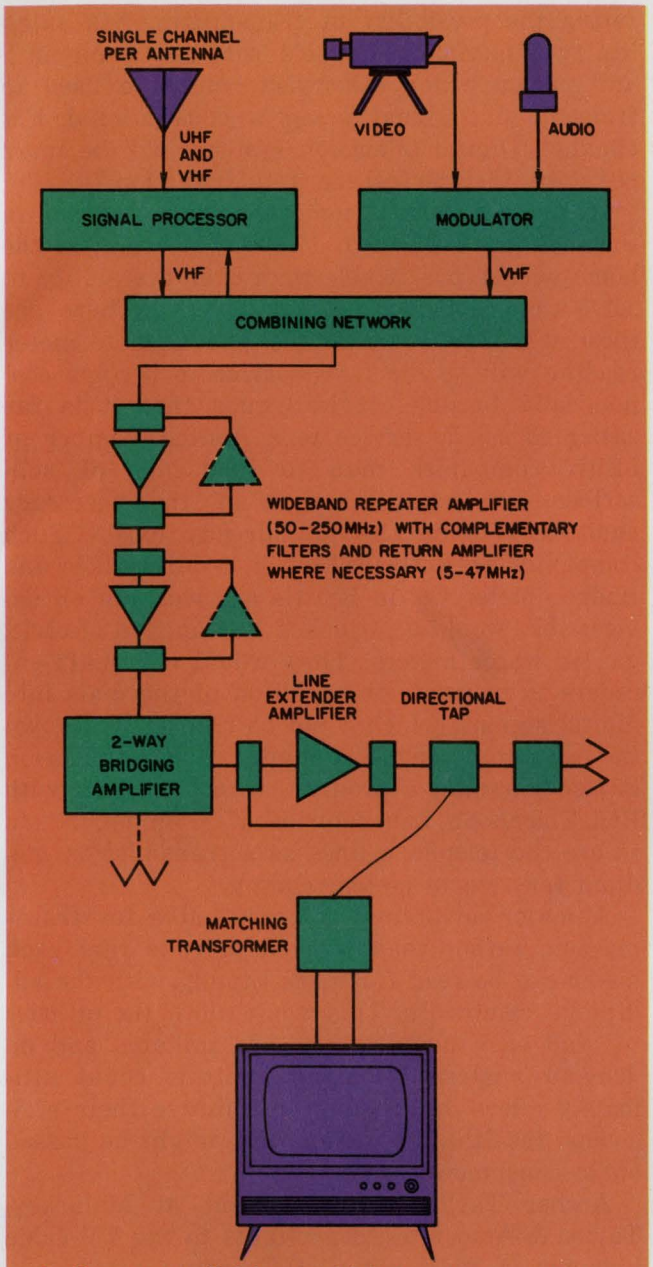
A second approach that is being tried in Daly City, Calif., is called Discade. Developed by Ameco Corp. of Phoenix, this system carries every channel on a separate cable at a reduced frequency (Fig. 1). By means of directional couplers, each channel is sent to an area distribution center. Each center serves 24 TV receivers. From the area distribution center, there is only one cable going to each home receiver through a channel selector converter, which sits on top of the TV set in the home. By running the channel selector converter the subscriber instructs the area distribution center to switch the appropriate channel onto the drop cable to the home.

For information in the reverse direction, the Discade system would have one or more cables assigned for amplification back to the head-end. One position on the home converter would be assigned to reverse transmission. When that position was indicated, the area distribution center would switch the signal to a reverse cable.

The main advantage of Discade is that transmission along the main distribution lines is at a lower frequency—between 5 and 20 MHz—and therefore can be transmitted with lower loss through the cables. Since there is less cable loss at the lower frequency, fewer amplifiers are needed than in more conventional systems. On the other hand, many more cables must be strung along the system. In addition area distribution centers must be used for every 24 sets. And finally, it seems a shame not to use all of the spectrum that a single cable is capable of carrying; it seems wasteful to take a cable that can carry dozens of channels and restrict it to just one. One of the great promises of cable is that ultimately it will allow transmission of dozens of channels, yet it does not appear to be practical to consider running dozens of cables in a future Discade system. More will be known about the capabilities of this type of system by the end of the year, when the Daly City experiment will have reaped some results.

The technique that got the consensus vote among specialists interviewed by ELECTRONIC DESIGN is one that Michael J. Rodriquez, director of engineering at Vikoa, calls "frequency division multiplexing." With this scheme it is possible to bypass every unidirectional amplifier for reverse transmission. That is all that is necessary, since every other component of a conventional cable systems is bidirectional (Fig. 2).

A complementary filter pair is placed both in front of and behind each amplifier. The filter pair consist of a high-pass and low-pass filter, with a minimum guard band between them that splits the incoming spectrum frequencies into a high band and a low band. The complementary



2. **Frequency division multiplexing** is one scheme for bypassing the forward amplifiers.

filter pair is reciprocal and therefore acts as a combiner as well as a splitter. The high-band port of each filter is connected to the forward amplifier. The low-band ports can be connected together—with a straight run of cable—as a low-frequency bypass, or a reverse direction amplifier can be inserted. Since there is less loss at lower frequencies in the reverse direction, fewer amplifiers are needed.

According to Gaylord G. Rogeness, director of engineering for Anaconda Electronics of Orange, Calif., a manufacturer of cable TV equipment: "For the return-path, low-frequency amplifiers, you may be able to run 30 to 34 dB of gain, since you would need fewer amplifiers than in the forward direction. This would allow us to run one low-frequency amplifier for every four high-frequency amplifiers. In the forward direction 22 dB of gain works out to give minimum distortion and maximum signal-to-noise ratio."

Cable goes microwave

Until Oct. 27, 1969 cable systems could not use microwave links as part of their systems. On that day the FCC revised its rules and allowed certain types of microwave links to be included in cable systems. The major specifications were that the frequency range be 12.7 to 12.95 GHz and radiated power from the antennas no more than 5 W.

Pioneering work on cable microwave links was done as a joint venture of Hughes Aircraft Co. of Culver City, Calif., and Teleprompter Corp. This was a likely combination, since Hughes owns about 15% of Teleprompter. The first system built was designed to operate in the 17.7-to-19.3 GHz frequency range. The link utilized single-sideband, suppressed carrier amplitude modulation and had a capacity of simultaneous transmission of 12 vhf TV channels and the entire fm band. This system was built prior to the FCC approval, and the demonstration of its capabilities was instrumental in the FCC's decision to allow microwave links. But Hughes guessed wrong, and the 12 GHz band was selected instead of the higher band.

According to Nicholas A Begovich, vice president of Hughes:

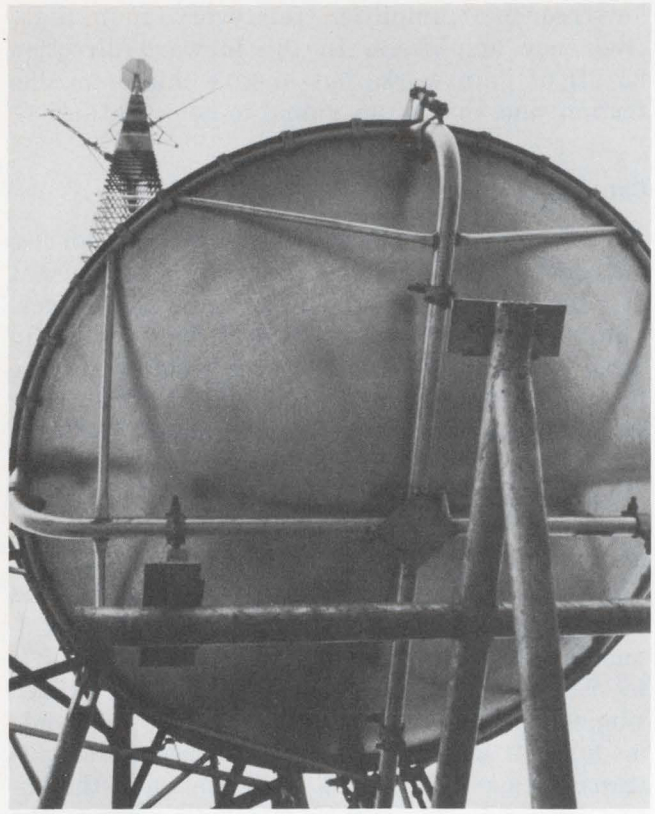
"We are working on the development of a 12-GHz AML right now. We're looking into solid-state oscillators for our transmitters. The 18-GHz system used TWTs. TWTs, or even klystrons and their associated power supplies, are far more expensive and less reliable than solid-state units. However, we haven't made a decision as of yet. The longest links that we are planning on are about 20 miles.

"The biggest problems that we face in building equipment for a cable system are intermodulation and cross-modulation distortion. Actually one of the main reasons that we chose AM rather than fm was because of the increased distortion added by converting from AM to FM and back again."

Microwave links so far developed allow transmission only in one direction. Return links for two-way service are to be developed in the future.

Problems of distortion have even got the communication satellite people concerned. At Comsat in Washington, D.C., work is being pressed on a digital color television system. Dr. Joseph V. Charyk, president of Comsat, says:

"We are developing in our laboratory a digital communications system for color television, of-



Cable companies hope to bring in distant signals with major tower installations such as this.

The 'bird in the hand' appeals to cable TV

While interest in the broadband communication potential of cable TV is high, the industry appears more concerned at the moment with an immediate source of expanded revenue: putting distant commercial television programs into the top 100 markets in the country.

Cable TV is being sold today mainly to people who are having trouble getting good reception in an area. Subscribers get the same commercial stations that nonsubscribers in the locality get and sometimes an extra: an occasional program originated by the cable company. If cable TV could offer its subscribers a wide choice of nationwide commercial programs that could not be received with normal home-TV antennas, many nonsubscribers might sign up for the service.

The Federal Communications Commission has proposed, however, that cable-TV systems not be permitted to retransmit the programs of stations outside their local areas unless the distant stations give their consent for each of the programs. The CATV industry considers this impractical.

A U.S. Senate bill, S543, would lift the restriction by providing for copyright payments for distant signals, but it would also impose limits on the number of programs that could be retransmitted.

fering the possibility of transmitting via satellite two television channels with the bandwidth and power which otherwise would be used to transmit one signal using a conventional FM channel. Digital television systems will be more resistant to interference and distortion."

At present there is sometimes more concern in the industry over what two-way services to the home will be practicable than over the ability to solve the mechanics of the systems. There are those who feel, for example, that remote meter reading will be the first service to become economically feasible. It is argued that it is far easier to sell a service to a limited number of utility companies than to thousands of subscribers. In addition much of the necessary equipment to do the job already exists. Such companies as McGraw-Edison in Milwaukee and Badger Meter Co. in Seattle are working on devices that would be attached to standard electric, gas or water meters. They would use shaft encoders to translate the position of the dials into digital signals, which could be transmitted down the cable to a central computer. McGraw-Edison is also pursuing a program in conjunction with Bell Telephone Laboratories of Holmdel, N. J., to use the telephone lines as a transmission medium for remote meter reading.

A major advantage of using cable for transmission, rather than twisted pair, is that each meter can be read far more rapidly with the additional bandwidth. This would allow the utilities to read each meter every few minutes and do demand analysis. Demand analysis could ultimately allow the utilities to improve their efficiency, resulting in savings that might be passed on to consumers.

Archer Taylor, vice president of Malarkey, Taylor & Associates, consultants to the TV cable industry in Washington, D.C., says:

"The feasibility of automated meter reading lies in being able to feed the data directly into a computer, taking the human hands out of it. Meters would be automatically read, automatically billed and the bills automatically sent out, processed and even the accounts receivable taken care of. Then all they have to do is send a man out to turn off the service when the bill isn't paid.

"It looks to me like remote meter reading is the ripest service. It will likely come first."

On the other side, though, there are those in the industry who contend that remote meter reading will never catch on because, to make it practical, every house must be wired into the system. The pessimists do not foresee that condition ever existing.

Others argue that every house could be connected up routinely when the trunk lines are put in. It is felt that this would be cheaper than

Local origination of specialized programming is expected to contribute to the rapid growth of cable TV. Origination equipment available from Telenetics Inc. sells for less than $10,000.

sending out a crew every time a new subscriber signed up. All that would be required would be some way to keep the nonsubscribers from using the cable. There is also a legal point to be cleared up as to whether a cable can cross a person's property without the person's permission.

One of the stronger arguments against remote meter reading is put forth by Dieter Lohr, senior research engineer at Stanford Research Institute, Menlo Park, Calif.

"I have my doubts about remote meter reading," he says. "Since it only costs the utilities about $6 a year to read a meter and bill the person, it would be hard to effect much of a savings. The gadget itself would have to cost under $30, if it were amortized over five years, in order to be practical. After you add in the political problems generated by the meter readers' union and figure at least one service call a year for the device, I am not too enthusiastic about this prospect."

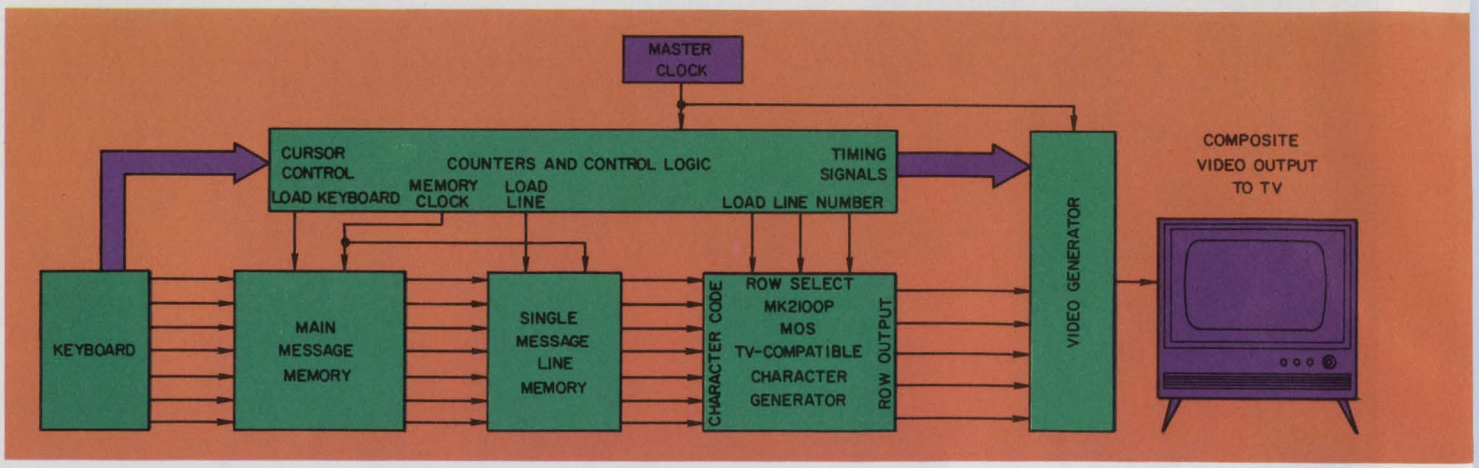
Taking a step out of character for a cable-industry member, James R. Palmer, president of C-COR Electronics, Inc., State College, Pa., says: "I feel that remote meter reading will be better handled by a two-wire system."

Rogeness of Anaconda Electronics feels that the first practicable services over two-way cable will be remote sensing by burglar and fire alarms. Alarm-sensing systems that would be compatible with cable already exist. Actually any system that merely closes or opens a switch of same kind would be acceptable. The problem is: What is the best way to get the information back to a central location?

As for preference-polling services, these could take several forms. One requires that the person in the home push a button, turn a dial or flick a switch to respond to a question posed from the outside. Another provides for automatic response when the home is interrogated by a distant device. Applications using the first method include: response to survey questions, use of the TV as a teaching machine, use of the TV as a time-shared computer terminal, home merchandising and audience reaction to programs or commercials. The primary application of the second method would be to determine automatically which channel a TV set was tuned to at any given time—information that is useful in program evaluation and market research.

Opinion is fairly uniform in the cable industry that preference polling will be one of the first two-way services to be offered. It is so easy to do that even the most cynical in the industry feel that as soon as a black box that can process the information and send it back to a central location is fully developed, preference polling will have arrived.

The technology required for a manual response



3. Mostek technique for connecting a standard keyboard to a TV set. An MOS 2240-bit, read-only memory functions as a TV-compatible function generator. It generates a 5×7 dot matrix for TV monitors.

in preference polling involves, in its simplest form, some kind of switch and, in more elaborate form, a keyboard. The switch is easy to design. What is required for a keyboard?

If the response is to be displayed on the TV screen, the primary need is for a TV-compatible character generator. Such a device exists today. Mostek in Dallas, Tex., makes a 2240-bit, read-only memory that was designed to generate a 5 × 7 dot matrix for character font presentation on TV monitors. This MOS integrated circuit generates the 5 × 7 dot matrix one row at a time. A given row is selected for the duration of one horizontal sweep of the raster. The access time for one line of one character is 800 nanoseconds. One row of 80 characters in a horizontal line can be displayed in 64 microseconds (Fig. 3).

Computer Communications, Inc., of Inglewood, Calif., has on the market a terminal for remote time-sharing of a computer that utilizes a standard Sony TV set and a character-generation scheme. James D. Johnson, vice president of the company's Laboratories Div., says:

"CCI is going to come out with a very-low-cost, broadcast-oriented character generator for the cable TV industry and the broadcast industry. It will utilize MOS technology."

Subscription Television, Inc. of South Pasadena,Calif., is the first company to demonstrate publicly a system that employs manual response to preference polling. According to Edward Harmon, assistant to the company's president:

"In addition to preference polling and burglar and fire-alarm systems, we will be offering a home merchandising service. We are able to get a moving white spot on the television receiver. We do it at rf levels without having to go into the set. As part of the black box, you have an X and a Y switch, which can put this spot into any one of 16 positions on the screen. At that time you will hit one command button, and then your name, address and the coordinates of that white spot are sent back to the computer. The computer then takes those coordinates and relates them to some time spot and identifies the object. There are two buttons. One starts the merchandising operation, and one activates the 'buy' operation.

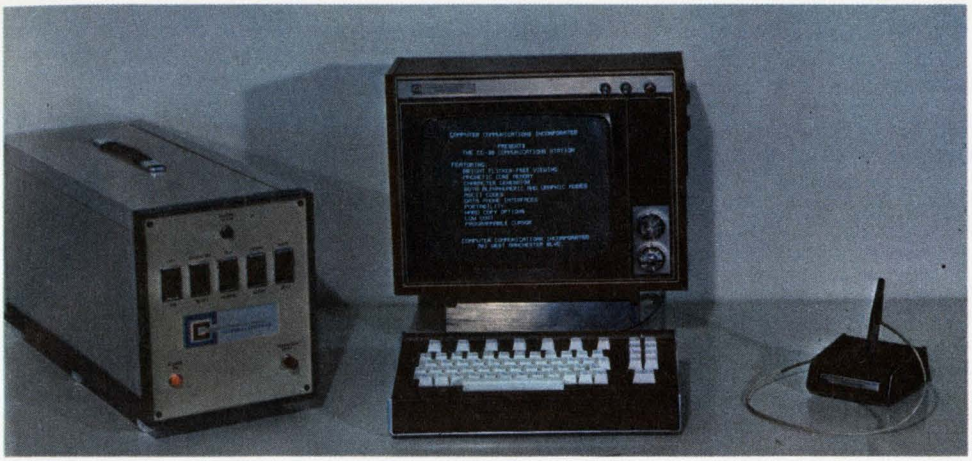
"This moving-dot scheme also lends itself to educational applications. We can have a two-way flow of information between an instructor and a student. We really don't care what the video information is. It can be a question with a bunch of multiple answers or a yes-no type of question."

Home merchandising as a type of manual response preference polling is also being looked into at Stanford Research Institute. According to Lohr: "Our research people have developed a 'mouse.' It is a little gadget which you roll on the table. If you roll it to the right, a pointer on the screen goes to the right, if you roll it to the top, the pointer goes to the top. This can be used for home merchandising."

Technology for automatic response to preference polling requires some means for detecting which channel the set is tuned to and getting that information to the black box for transmission back down the line. One method requires connecting a mechanical device to the set's tuner, and another requires detection of a signal emanating from the set itself.

Donald E. Haselwood, chief engineer for A. C. Nielson Corp. of Chicago, says: "We have a switch on the tuner which has 13 contacts and a common wiper. Each position results in a code that indicates the channel which the set is tuned to. We believe that a shaft-encoding switch is the cheapest and most reliable method of determining which channel the set is tuned to."

William Bresnan, president of H & B American Cablevision, Inc., in Los Angeles, reports: "We have developed a technique for determining which programs the sets on our cable systems



Remote console made by Computer Communications, Inc., shows that the present TV set can be used as a computer terminal.

are tuned to. We sense the front-end oscillator signal, which is radiated by the tuner. That sends a signal back out our drop line from the house. Normally it is blocked by our directional coupler, to keep it out of the main line. However, we detect the signal at that point and use it to modulate a low-frequency signal, which is sent backwards down the line. Each device is coded so that the readout device knows which home the signal is from. We have a location number for each home. The location number, time and channel are printed out at our readout device.

Nielson doesn't like that approach, Haselwood says. "The problem with detecting local oscillator leakage," he explains, "is that it varies widely from set to set. In addition the set manufacturers are constantly working to reduce LO leakage. Another problem is that the harmonics of your oscillator in the lower band may appear as valid stations in your upper band. By the same token, a very strong FM station may fall around where some of these LO signals may be."

Facsimile services for the home

Since a two-way broadband link to the home would allow rapid flow of data along its lines, it has been proposed that first-class mail, newspapers, educational materials and computer printout could be transmitted to and from the home via facsimile. The present state of the art precludes the thought of transmission from the home. However, with an economic breakthrough, it doesn't seem too far out to consider limited transmission to the home with hard-copy printout.

Green of Vikoa sees facsimile services as a big growth area. Lohr of Stanford Research Institute is skeptical. "If you can generate paper out of the air and then let it evaporate when you don't want it any more, then you've got a great prospect for facsimile," Lohr says.

Photophysics Data Systems in Mountain View, Calif., believes that the breakthrough in facsimile has already come. "Our customer will be the cable company," says Floyd Nordin, vice president. "We have an inexpensive, simple copying machine which will make a copy in two seconds off a cathode-ray tube."

One limitation that Nordin points out is this: "If a camera just aimed at a picture and transmitted it, the resolution probably would not be sufficient to give good hard copy at the other end. I see this as more of a message medium than as a picture medium. However, for printed hard copy, it is practical right now."

Some in the industry feel that the useful facsimile service will be one in which the viewer can skim the copy and print only what he desires. Along these lines, Kahn of Teleprompter tells of a device that his company is looking into. "I'd like to be able to put a full color page in every home on some material, which could be projected and then later made into hard copy," he says.

Hubert J. Schlafly, senior vice president of Teleprompter, adds: "What we would really like is a frame grabber. You can code the frames displayed on a normal TV, so that you can identify and capture that frame, store it and then look at it as long as you wish electronically. If you wish to have hard copy of that frame, you push a button and out would come hard copy."

Most of those interviewed felt that facsimile was quite far off and that first-class mail delivery by facsimile might never come. However, Dr. Leland L. Johnson, senior staff economist at Rand Corp., sees some limited use here. "By 1980," he says, "we might very well have facsimile mail delivery from post office to post office—but from this point on, normal delivery to the home."

Just how rapidly the market can expand for any of the new services depends to a great extent on how rapidly equipment is developed to

fill broadband communications needs. Bresnan of H & B American Cablevision—the largest cable system operator at present—notes:

"All of the proposed two-way services will be great. However, few people are currently working on devices to accomplish these feats."

Feldman of Rand Corp. is even more cautious:

"My guess is that cable television will probably have a significant growth in the next decade, but probably one which is going to be very disappointing to those who think it is going to revolutionize communications. It is simply because I think that the legislative framework and the standardization that is required within the industry are just not going to take place at this time. Basically, we are just going to see a somewhat greater penetration into the city areas.

"The biggest problem is that it takes a lot of capital and it is essentially a risky market. The cable systems have to compete for the consumers dollar against a lot of other things at a time when people are finding their purchasing power eroded. They are competing against off-the-air television which for many people is seemingly adequate. In order to speed things up, they must offer something that is better or different. My own feeling is that these other services are going to take a long time to develop."

For the most part, today's cable TV equipment *is* quite primitive, compared with what aerospace

Cable TV networks envisioned via satellite

When cable systems grow to the point that more than 50% of the TV homes in the country are tied into them, it will become practical to start linking cable systems into networks. Dr. Leland J. Johnson, senior staff economist with Rand Corp., says:

"By 1980 I believe that we'll see a good deal of interconnection of cable systems."

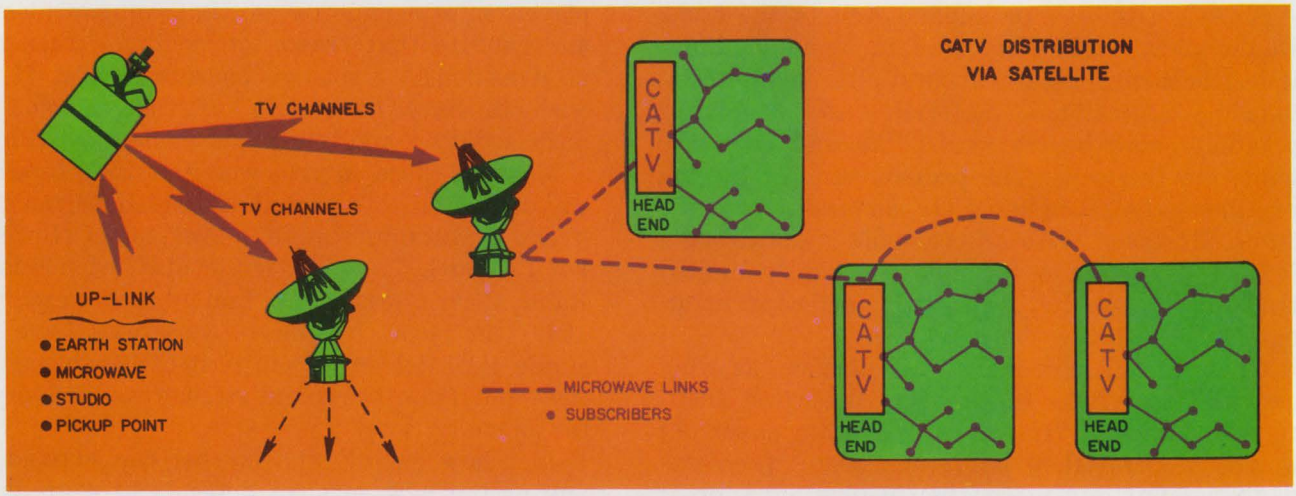
By far the cheapest and most effective scheme is to use communication satellites. According to Nathaniel E. Feldman, consultant on engineering sciences, at Rand:

"If satellite systems looked good for interconnecting 600 or so broadcast stations, what happens when you have thousands of cable head-ends? How much more inefficient must it be to do it by microwaves, waveguides, laser links or anything else, when you have to build a whole network, versus, in a sense, going from one satellite system directly down to pinpoint every head-end all at one time."

Comsat—the Communications Satellite Corp.—sees a limited number of ground stations being built to distribute signals to the cable-TV head-ends in each area. However, it doesn't preclude the possibility of signals going directly to every head-end.

According to William L. Pritchard, director of Comsat Laboratories in Washington: "Comsat has proposed a pilot program to demonstrate the operation of a distribution system in the United States. A satellite weighing about 800 kilograms, launchable by Titan II or Titan III class vehicles, would be placed in equatorial orbit south of the United States. It would use the 4000 MHz 'down' frequency band for broadcasting while receiving on the 6000 MHz 'up' band. Twelve channels of color TV could be provided over the entire United States to receiving stations using about thirty-foot antennas and costing around $75,000.

The technology for broadcasts from a communications satellite to every home has already been worked out. According to Pritchard, it could be accomplished with the use of a 3-to-9 foot-diameter antenna at every home. The receiver would need a system noise figure of between 600° and 10,000° K, and the home ter-



technology has placed within reach. There is one exception, however, if performance alone is considered: The amplifiers have low distortion. Cross-modulation is specified at −93 dB, which is respectable at any time. To keep second-order distortion effects down over relatively broad bandwidths, all new amplifiers are of the push-pull variety.

Recently thoughts have turned to the use of hybrid integrated circuits to improve the reliability and cost of the amplifiers and filters and to shrink their size. The most striking example of aerospace technology entering the industry is a joint venture of Anaconda Electronics and Hewlett-Packard Corp., Palo Alto, Calif. A result of this venture has been development of a hybrid integrated-circuit amplifier that is smaller, more repeatable, more reliable and has a broader bandwidth than any other amplifier built for cable use. The band over which the amplifier operates is 40-270 MHz at a +34 dBmV operating level. The noise figure at maximum gain is 6 dB, cross-modulation is down 93 dB across the band, and it is possible to cascade 75 of these amplifiers on a single system.

This fall, Fairchild Camera's Microwave div. in Palo Alto plans to introduce thin-film bi-directional amplifiers for the cable communications market.

But aside from these amplifiers, the picture is bleak. A source high in the ranks of the FCC says bluntly:

"The industry, right now, is guilty of very, very lax equipment performance. The equipment stinks! A lot of shortcuts are being taken to cut cost at the expense of performance."

John W. Atwood, head of the Cable TV Management Office at Hughes Aircraft Co., comments that there is room for great improvement in head-end electronics and cable electronics. "There is development required for both hardware and software for the computer which will be associated with the cable systems," he says.

Taylor of Malarkey, Taylor & Associates asserts: "I don't believe that we have the technical caliber of distribution equipment necessary to make the long systems for the major markets. Furthermore the major markets are going to require a quality of performance that we haven't been producing—and really hasn't been necessary—so far. This means that there is some technology that we don't have yet. For example, we don't know why our cable pictures are soft. They're good, but if you take a directly received off-the-air picture in a high-signal-strength area and compare it to a cable picture, the cable picture will be softer."

The mysterious black box

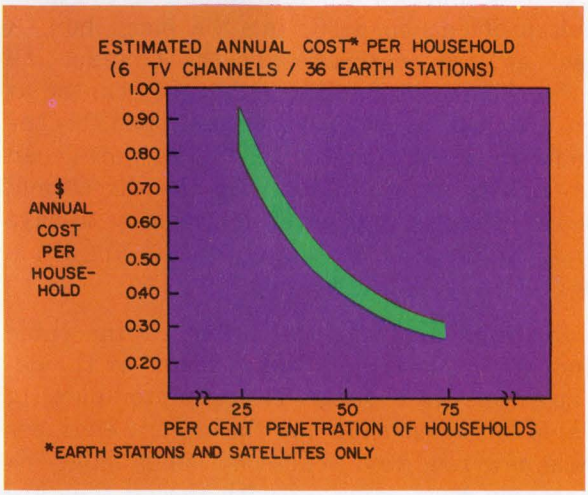
Aside from problems like these, the key to all future two-way cable TV will be the development of a black box—an interface between the cable system and the sensors in the home. The black box must convert all of the incoming channels into something that a normal set can use, and it has to provide a means for transmission back to the head-end (Fig. 4).

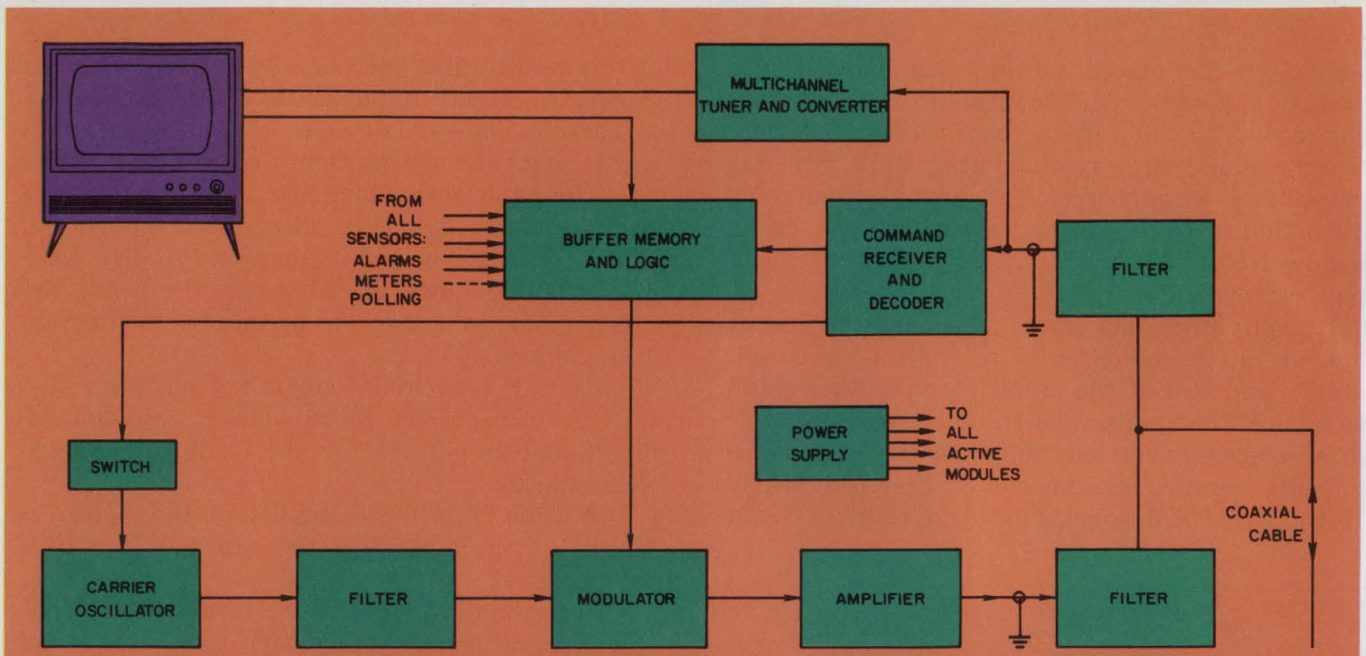
Reception of many channels is the easy part. Rodriquez of Vikoa notes the two methods now in use for 21 channel systems: "One is a simple block converter. It takes the nine midband channels, amplifies these and converts them to uhf and feeds them into the regular uhf tuner on the set. At the same time it allows the normal 12 vhf channels to get through. Therefore the block con-

minal cost would be between $100 and $300. The wide range of all of these figures reflects dependence upon how elaborate the home terminal becomes.

Direct satellite-to-home broadcasts could have international implications, however. One specialist at Rand, John Hult, points out: "There are a lot of foreign governments that are apprehensive about broadcasting from space. They don't want to be propagandized, politically, commercially, religiously or what have you, in any way. They want to be able to control reception within their jurisdiction. If we can offer them a system that permits this control of reception within their jurisdiction, then I think you would find a lot of people would go along with the idea of broadcasting from space."

Hult says that by utilizing the synchronous period of the television signal, one could incorporate digital codes that would allow a receiver on the ground to either receive or reject any transmitted signal. By incorporating coding, almost any level of signal direction can be achieved.





4. The key to future two-way cable TV will be development of a black-box—an interface between the cable system and sensors in the home—that converts incoming channels into something a normal set can use.

verter hangs on the back of the set and doesn't have to be touched by the consumer at all.

"The other type of converter sits on top of the set and converts all 21 channels to a single vhf channel, which the set is permanently tuned to. A control on this box then is used to select a channel."

For the more difficult operation—transmission back to the head-end—two techniques have been suggested. Both make use of a low-frequency carrier. Anaconda Electronics has looked into a technique that would have a carrier oscillator in each home. According to Rogeness, the company's director of engineering:

"We can serve an area of 100,000 homes using time multiplexing and frequency multiplexing. It would use the frequency range from approximately 100 kHz to 10 MHz. Each home would take approximately a 10-kHz slot. When a switch is tripped, the oscillator will turn on and a modulator will place one kind of modulation if it were a burglar alarm and another kind if it were a fire alarm. The frequency received at the central monitoring point might indicate the particular home that the signal was being transmitted from."

Others in the industry who have considered the problem feel that the best way is to use a single frequency transmitted from every home with a pulse-code identification signifying the transmitting home. Subscription Television, Inc., has developed an interesting device that it calls a "subscriber program selector." The device uses pulse-code modulation. According to Harmon:

"You have a demodulator and a modulator at every home. The subscriber loads his information into a buffer. When the interrogation code comes down the system, the information from the buffer is coded and transmitted back to a central computer. The box that sits in the home will cost between $50 and $100."

The Nielson system works basically the same way. Haselwood describes it this way:

"In the system we have installed in New York, we have a transponder at the home. It accepts digital signals from the wafer switch, codes them and also accepts digital signals sent by our central computer. The computer periodically scans the homes on the system by polling them."

The Nielson system presently uses lines leased from the telephone company.

Robert Beamon, vice president of engineering with H & B American, points to one of the most difficult problems in designing the black box. A TV set at best matches only the channel it's tuned to, Beamon says. The set's tuner can be as badly matched as a short or an open to the channels it is not tuned to. This, he notes, can cause tremendous problems with the directional couplers. "Precise and careful matching always pays. Lack of good matching results in disastrous cross-talk in the system."

In the final analysis, the future of the cable TV industry rests largely in the hands of the design engineer. As Kahn of Teleprompter puts it:

"Cable has opened up for the design engineer a whole new roadway. Where he is challenged is that he now must come up with things that are not only pretty but are economically feasible." ■■

Panel design ideas from Dialight

Many different push button cap and bezel options permit custom panel designing with standard switches and matching indicators. Designers and engineers are welcoming these low-profile, snap-in-mounting push button switches that are interchangeable with most 4-lamp and 2-lamp displays. Units available in ¾" x 1" rectangular, ¾" square, ⅝" round and ⅝" square designs. Bezels with or without barriers in black, gray, dark gray or white. Legends are positive or negative—either visible or hidden when "off." Switches are momentary or alternate action and low level to 125V at 5A, resistive.

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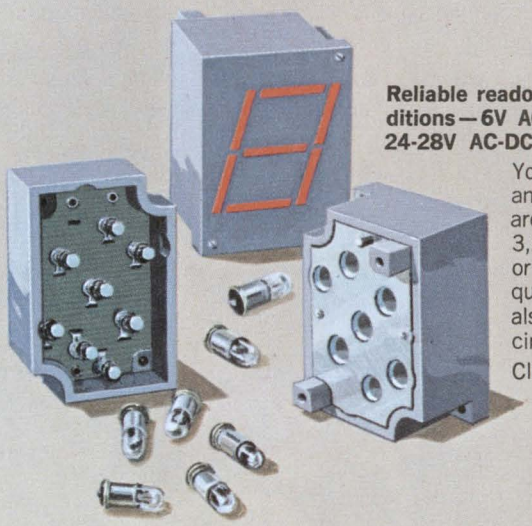

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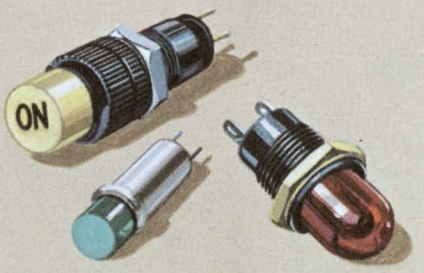

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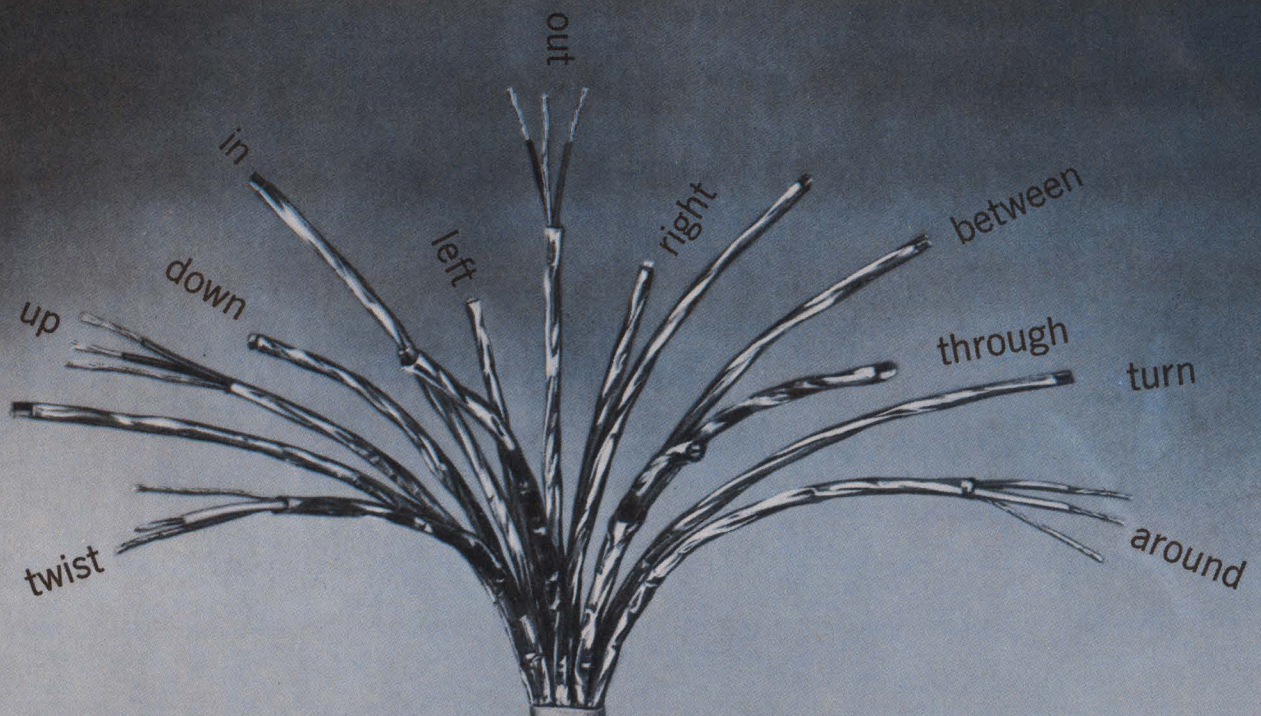

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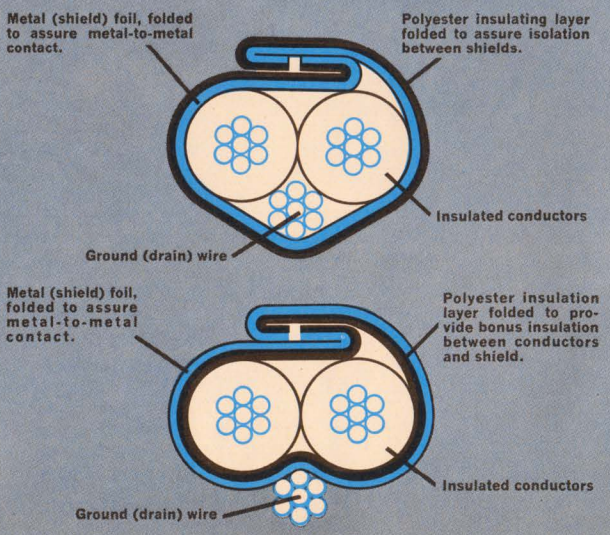


An Electronic Design practical guide for

synchro-to-digital converters

Written by: Hermann Schmid, Senior Engineer, General Electric Co., Binghamton, N. Y.

Edited by: Don Mennie, Circuits Editor

Part 3: Type III converter provides easily realizable design

There is a class of synchro/resolver-to-digital angle converters that is easily realized with readily available hardware. These converters are referred to as Type III.

The digital output, X_D, of any a/d converter is proportional to the ratio V_S/V_R, where V_S and V_R are the signal and reference input voltages. For example, connecting the outputs, V_X and V_Y, of a resolver selected for the proper octant, to the signal and reference inputs of a conventional a/d converter (so that $V_S = V_Y$ and $V_R = V_X$) produces the digital output signal X_D, where

$$X_D = V_S/V_R = V_Y/V_X = \frac{K_Y \sin\theta}{K_X \cos\theta} = K\tan\theta. \quad (53)$$

When K_X is equal to K_Y, K becomes 1, and the digital output signal is equal to the tangent of the resolver shaft angular position.

Often $X_D = \tan\theta$ can be used directly for further processing. When just the angle θ is required, an arc-tangent function generator must be employed to recover the angular information. (This is a theoretical example; practical arc-tangent function generators are not available.)

The most practical method of converting $\tan\theta$ to θ is to use a linear-segment function generator.[19,20] Less than 16 segments are needed to obtain good accuracy.

The Type III converters described here are broken down into three categories: the general, the low-speed and the high-speed. The converter's major internal subdivisions are identified in the general version. Then the low-speed system, with 1000-per-second conversion rate, and the high-speed system, with 10,000-per-second conversion rate, are detailed.

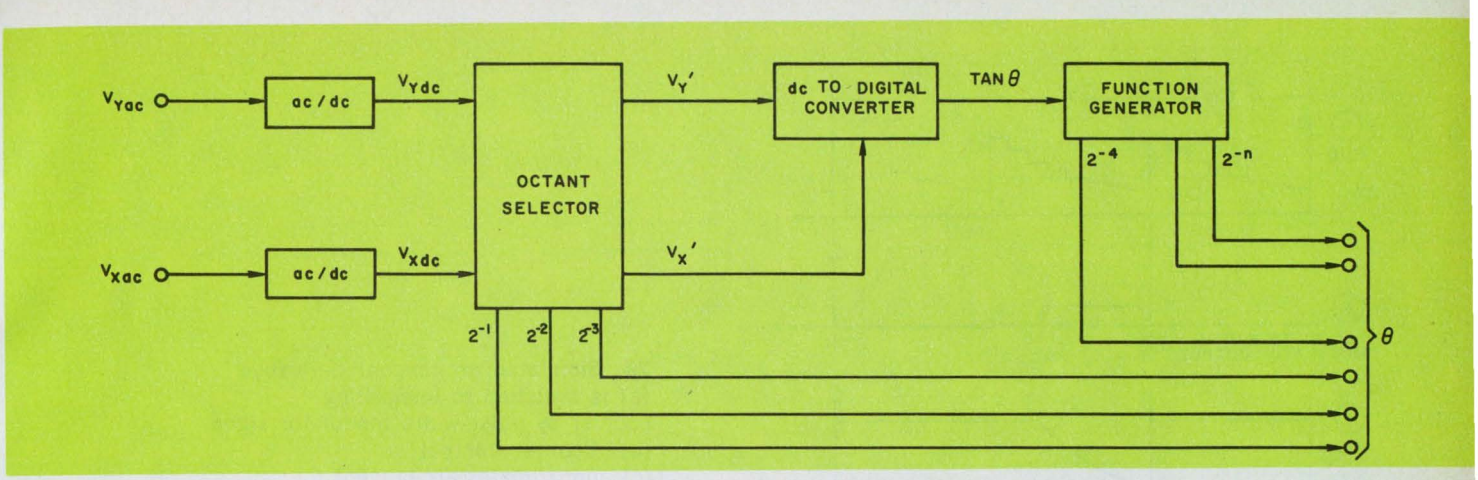
General version

The general design of Type III resolver-to-digital-angle converters consists of an octant selector, two ac-to-dc converters, a conventional dc encoder, and an arc-tangent function generator (Fig. 22). The octant selector, with two ac-to-dc converters, connects voltages between zero and +0.707 of full scale to the signal input V_Y' and voltages between −0.707 of full scale and minus full scale to the reference input V_X'. It also generates the three most significant bits of θ.

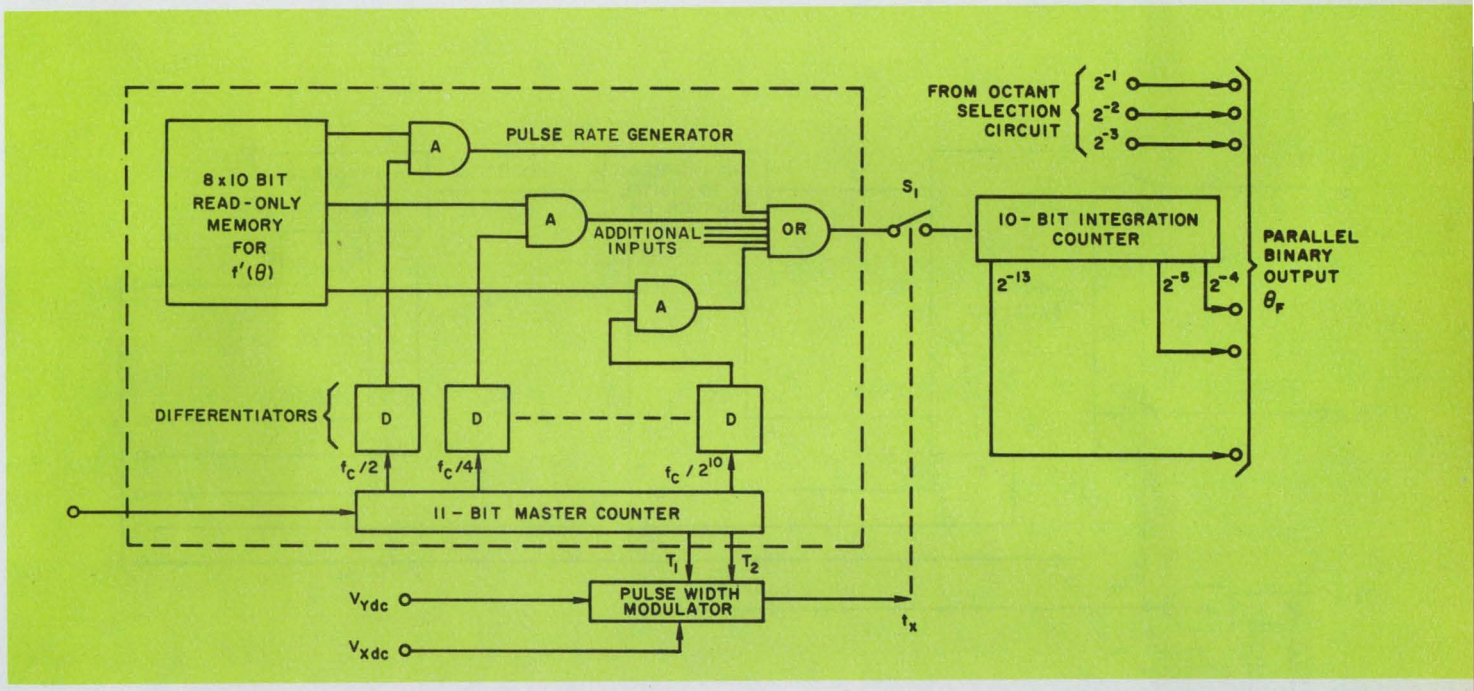
The a/d converter output (X_D) is proportional to the tangent of resolver angle θ. The linear-segment function generator converts this to an (n-3)-bit number representing θ between zero and 45 degrees. The type of function generator used depends on the a/d converter speed. The digital output signal is composed of the octant selector and the function-generator outputs.

Low-speed version

Figure 23 illustrates a Type III resolver-to-digital-angle converter circuit (ac-to-dc demodulators and octant selection are not shown) which employs an Up/Down integration pulse-width modulator and a low-speed linear-segment function generator.[19]. The pulse-width modulator output t_x operates switch S_1, which in turn connects the pulse rate, $R_i(t)$, to the integrating counter. The counter content will increase according to



22. **The Type III converter's dc-to-digital output** is proportional to the tangent of resolver angle θ.



23. **Low-speed** Type III converter has a 1000-per-second conversion rate and ±0.05% accuracy.

the magnitude of pulse rate $R_i(t)$. If the $R_i(t)$ magnitude is made to approximate the arc-tangent function derivative (Fig. 24), then the counter content increases with time like the arc tangent. At the end of pulse-width period t_x the content of the counter is

$$Z \approx \int_0^{t_x} R_i(t)\,dt = \int_0^{t_x} d[\tan^{-1}(t)]\,dt = [\tan^{-1}(t)]_0^{t_x} \quad (54)$$

and since

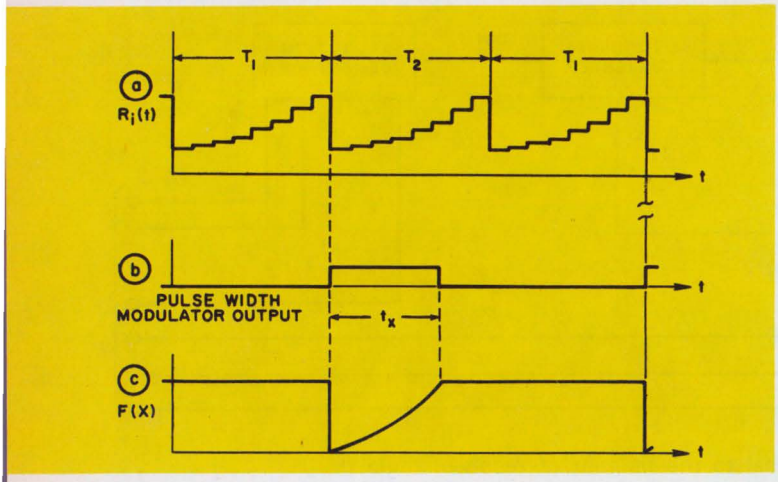
$$t_x = V_X/V_Y = K\cos\theta/K\sin\theta = \tan\theta. \quad (55)$$

The content of the counter becomes

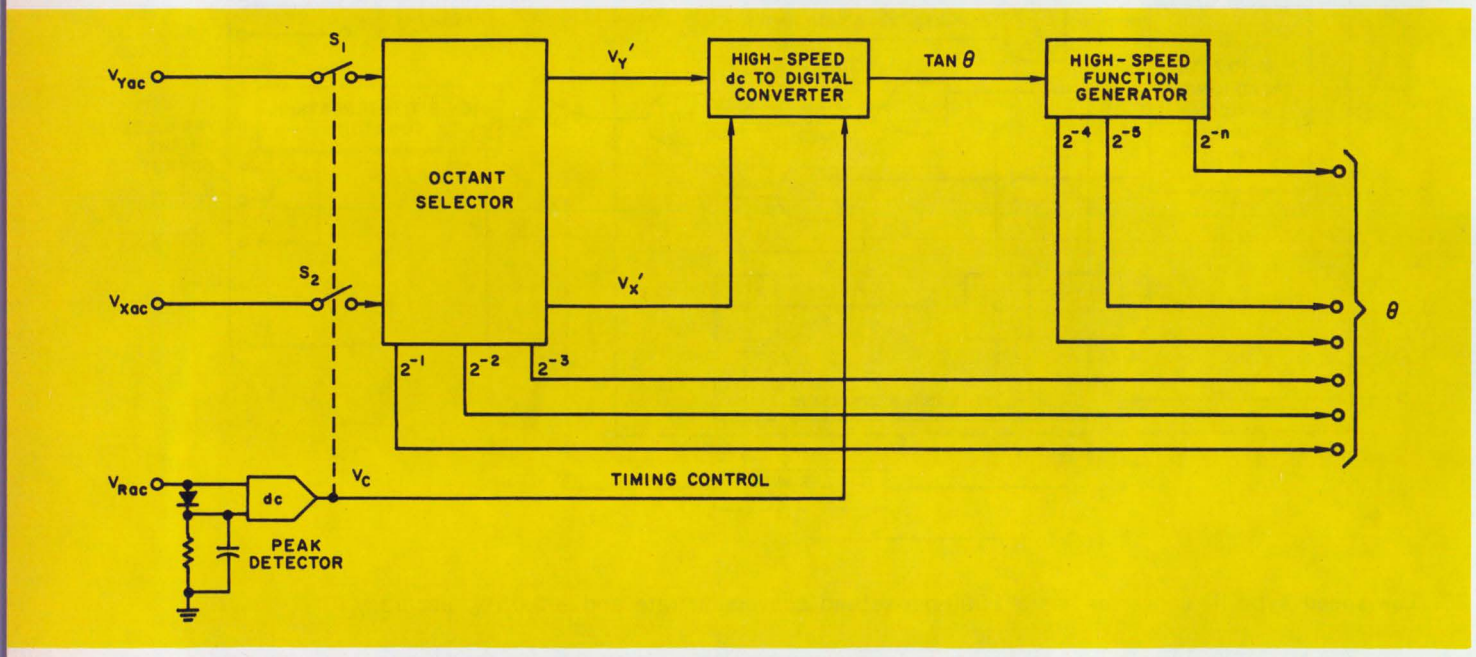
$$Z = \tan^{-1}(\tan\theta) = \theta. \quad (56)$$

The rate generator that produces $R_i(t)$ is comprised of a master counter, a Read-Only-Memory (ROM) and some gating logic. The 11-bit master counter generates the 10 fixed pulse frequencies ($f_c/2$, $f_c/4$, $f_c/8\cdots$to $f_c/2^{10}$) and the timing signals, T_1 and T_2, for the pulse-width modulator.

The three most-significant outputs of the master counter define the eight segments of the desired function and are used to select the eight 10-bit words, which represent the slope $f'(\theta)$ of one specific segment. For each ONE in $f'(\theta)$, a fixed pulse rate is connected to the OR gate by enabling the appropriate AND gate. Any desired frequency can be generated by selecting and combining the various fixed frequencies. For example, if f_c has 1024 pulses per ms, then $f_c/2$ has 512, $f_c/4$ has 256 and so on. A pulse rate of 586 pulses per ms can thus be generated by selecting 512 + 64 + 8 + 2.

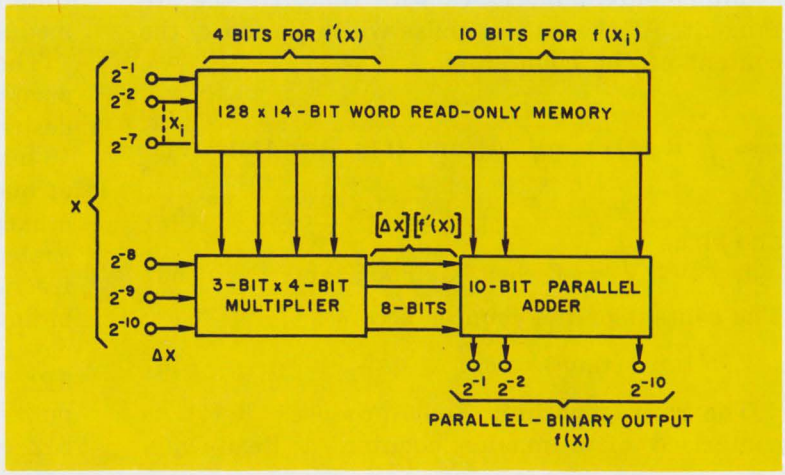


24. **Simulated** arc-tangent derivative (a) is switched to integrating counter by pulse-width modulator signal (b). Counter content (c) approximates arc-tangent function over period t_x.



25. **High-speed** Type III converter has a 10,000-per-second conversion rate and 0.025% accuracy.

26. **Nondestructive,** permanent information storage is provided by a Read-Only Memory in this high-speed linear-segment function generator.



Before gating and combining the various pulse frequencies, the master counter outputs must be differentiated by analog or digital means.

Swith S_1 can be implemented with almost any logic gate. A 10-bit unidirectional ripple counter will suffice as integrating counter, because there is plenty of time for data read-out during the period T_1 (Fig. 24). The integrating counter outputs are labeled 2^{-4}, $2^{-5}, \cdots 2^{-13}$, because they represent the 10 least-significant bits. The three most-significant bits—2^{-1}, 2^{-2}, and 2^{-3}— are generated in the octant selection circuit.

Experience with the Up/Down integration pulse width modulator and the linear-segment function generator indicates that this resolver-to-digital angle converter can have high accuracy—$\pm 0.05\%$ or better with temperature. With a 2-MHz clock frequency, a conversion rate of about 1000-per-second results. (Ten circuits each providing a 100-per-second conversion rate).

High-speed version

Using a high-speed dc-to-digital converter, this Type III resolver-to-digital-angle converter quantizes a pair of resolver output signals in a fraction of an ac signal cycle (400 Hz). The resolver output signals, V_X and V_Y, are connected to the octant selection circuit by two analog voltage switches, S_1 and S_2, which are operated by the peak detector output, V_C (Fig. 25). These switches and the peak detector are part of the octant selector (Fig. 8b, see p. 183, ED 6). They illustrate that the octant-selected signals V_X' and V_Y' are pulsed dc voltages. Therefore, V_X' can be connected directly to the signal input and V_Y' directly to the dc-to-digital converter.

For proper a/d converter operation, the V_X' magnitude should lie between zero and $+0.707$ of full scale and the V_Y' magnitude should lie between -0.707 of full scale and minus full scale. Control signal V_C synchronizes the dc-to-digital converter operation with the ac signal.

As with the single-phase encoder (Fig. 2, see p. 179, ED 6) variation in the V_X' and V_Y' amplitude will not affect the a/d converter output (Fig. 25) provided change occurs proportionally on both signals. The proposed resolver-to-digital-angle converter is also insensitive to noise appearing simultaneously and proportionally on V_X' and V_Y'.

A high-speed linear-segment function generator is required for the arc-tangent operation. An intermediate storage register should be provided at the successive-approximation a/d converter output or at the function generator input, thus giving a permanent output for the n-3 least-significant bits.

A multi-channel resolver-to-digital-angle converter (Fig. 25) without the arc-tangent function generator at the output was developed by the Gordon Engineering Co.[21] Converter accuracy is $\pm 0.025\%$ of full scale across the military temperature range with a conversion rate exceeding 10,000 per second.

A high-speed linear-segment function generator, comprised of a Read-Only-Memory, one 10-bit parallel-binary adder and a 3-bit by 4-bit multiplier are shown in Fig. 26. The function generator's input X is divided into: (a) seven most-significant bits, X_i, which, when decoded, define the 128 break points of the function, and (b) the three least-significant bits representing the increment ΔX. The seven most-significant bits (2^{-1} to 2^{-7}) select one value for $f(X_i)$ and one value for $f'(X_i)$. Selected values are permanently stored in the ROM. Both $f(X_i)$ and $f'(X_i)$ may have 128 distinct levels.

The ROM is a circuit where information is permanently and nondestructively held. Stored information can be read out as often as desired. Stored-information adjustments, when possible, require rewiring. Diodes, capacitors and rope cores have been used for ROM, but memories with those components become large and expensive when many bits are stored. Significant size and cost reduction came with MOS-FET-ROMs, now widely available.

The parallel adder sums the two parallel binary numbers at its input quickly. Carry-ripple propagation through 10 stages provides the only delay.

The 128 values of $f(X_i)$ and $f'(X_i)$ are stored in a 2048-bit ROM, where $f(X_i)$ is represented with 10-bit words and $f'(X_i)$ with 4-bit words. The 4-bit $f'(X_i)$ words are then multiplied with the 3-bit ΔX words in another ROM by selecting one of 128 (8-bit) words for the product: $[\triangle X]\,[(f'X_i)]$. The parallel adder sums the $f(X_i)$ magnitude with the $[\Delta X]\,[f'(X_i)]$ magnitude to form the output signal $f(X)$ according to Eq. 33, see p. 56, ED 7) ■■

References:

19. Schmid, H., "An Operational Hybrid Computing System Provides Analog Type Computations with Digital Elements," *IEEE Transactions on Electronic Computers*, Dec., 1963, pp. 715-732.

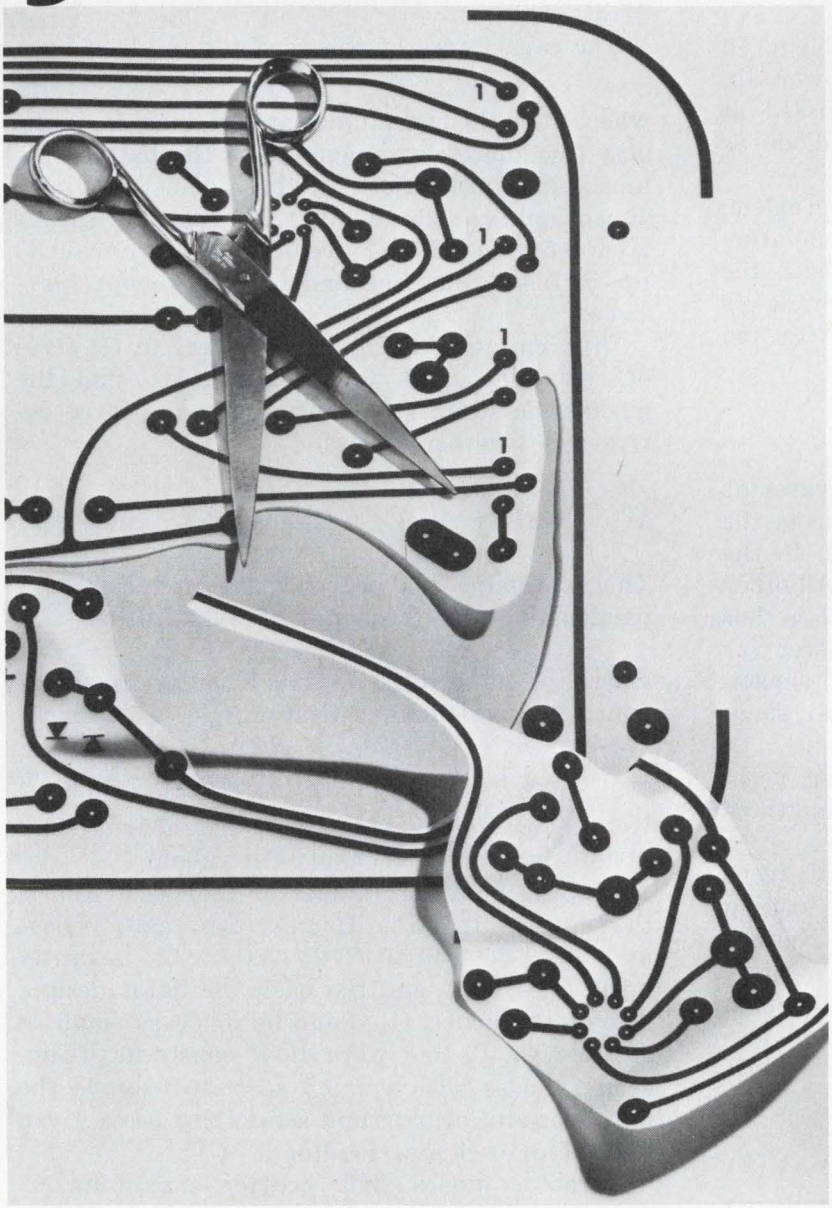
20. Kollatay, J. H., "Linearizing Sensor Signals Digitally," *Electronics*, March 4, 1968, pp. 112-121.

21. "Subsystem Test Results, ILAAS CDAU A/D Module," Gordon Engineering Co., Waltham Mass., April, 1967.

Watch for Part 4

The fourth section of this Practical Guide for Synchro-to-Digital Converters will appear in our next issue, ED 9, April 26, 1970. This portion will describe the Type IV converter, a design requiring no linear-segment generator and the Type V converter utilizing a harmonic oscillator.

Cut yourself in.



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Varactor tuning can be tricky in high-power circuits. High modulation sensitivity means reduced power and possible diode burnout. Here are the tradeoffs.

The more tightly a varactor (variable-capacitance) diode is coupled to an oscillator, the greater the oscillator's modulation sensitivity (frequency deviation per volt of modulation) will be. Tight coupling also means greater loading of the oscillator circuit by the diode.

In low-power circuits this is no problem. In high-power oscillators, however, the power absorbed by the diode may be sorely missed at the output. And it may burn out the diode as well.

There are no easy solutions to this problem, but by developing expressions for the modulation sensitivity and diode loading of the circuit, the designer can intelligently examine the tradeoffs between the two effects. Let's start with the modulation sensitivity.

Finding the modulation sensitivity

A typical tank circuit employing a varactor for frequency modulation (Fig. 1) connects the varactor, designated C_2 for convenience, to the circuit through a coupling capacitor, C_1. All other capacitances in the circuit are lumped together and represented by C_3. C_3 includes transistor (or tube) capacitance, tuning or trimmer capacitance and lead-coupling, distributed and stray capacitances.

Inductance L can be a lumped inductor, as in low frequency circuits; or it may be a length of transmission line, as at higher frequencies.

Resistor R is an isolating resistor that keeps the modulating-voltage source, V_c, from loading the circuit. C_{BP} is an rf bypass capacitor. Neither R nor C_{BP} enters the rf analysis of the circuit.

The total capacitance of the circuit—which will resonate with L to set the oscillator frequency—is given by

$$C = C_3 + C_1C_2/(C_1 + C_2). \quad (1)$$

This results in an oscillating frequency

$$f = 1/2\pi\ (LC)^{1/2}. \quad (2)$$

Norman G. Rhinehart, Senior Engineer, Microdot, Inc., South Pasadena, Calif.

The modulation sensitivity of the circuit, df/dV_c, is the product of three derivatives: df/dC, dC/dC_2 and dC_2/dV_c. Differentiating Eq. 1 with respect to C_2 gives dC/dC_2, and differentiating Eq. 2 with respect to C yields df/dC.

The capacitance of the varactor is given by

$$C_2 = C_o/[1 + (V_c/V_\theta)]^\gamma \quad (3)$$

where C_o is the capacitance at zero bias, V_c is the bias (modulating) voltage, V_θ is the barrier potential, a characteristic of the diode, and γ is a dimensionless diode constant. V_θ typically ranges from 0.5 V to 0.6 V. Typical values of γ are 0.33 for diffused junctions and 0.5 for abrupt junctions.

Differentiating Eq. 3 with respect to C_2 gives dC_2/dV_c—the final factor needed to find the modulation sensitivity. Multiplying the three derivatives together yields:

$$\frac{df}{dV_c} = \left(\frac{1}{4\pi L^{1/2}C^{3/2}}\right)\left(\frac{C_1}{C_1 + C_2}\right)^2\left(\frac{\gamma C_o}{V_\theta\,(1 + V_c/V_\theta)^{\gamma+1}}\right) \quad (4)$$

The expression can be rewritten in terms of a particular center frequency by substituting

$$L^{1/2} = 1/(2\pi f_Q C_Q^{1/2}) \quad (5)$$

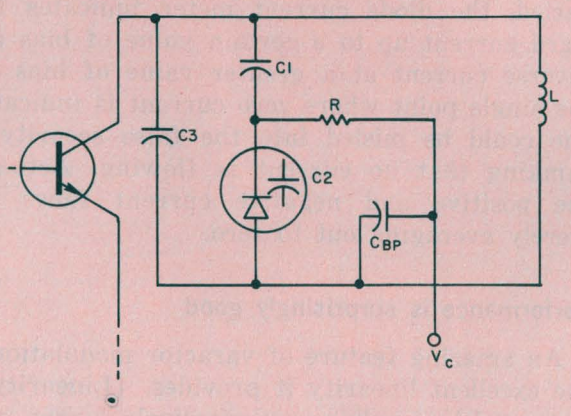
where the subscript Q denotes a center-frequency value. Making this substitution, Eq. 4 becomes

$$\frac{df}{dV_c} = \left(\frac{f_Q}{2C_Q}\right)\left(\frac{C_1}{C_1 + C_{2Q}}\right)^2\left(\frac{\gamma C_o}{V_\theta\,(1 + V_c/V_\theta)^{\gamma+1}}\right) \quad (6)$$

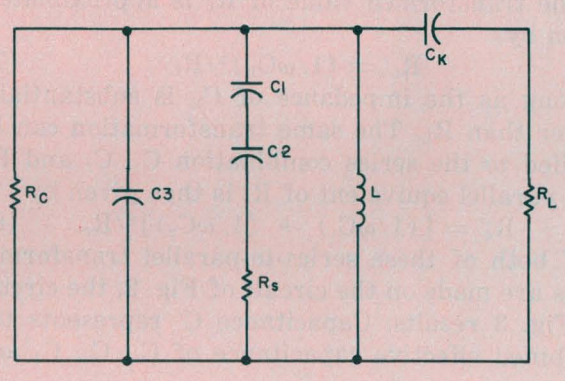
Note that Eq. 6 treats C_2 as a constant and hence is valid only for small changes in f about f_Q.

Despite the large number of factors in Eq. 6, the only one that the designer can really choose at will to determine df/dV_c is C_1. C_Q is pretty much fixed by f_Q and the basic oscillator design. At vhf and above, C_Q would be made as small as possible. C_o, V_θ and γ are diode constants. (Generally, diodes with $\gamma = 0.5$ seem to provide the best over-all linearity and sensitivity for a given amount of oscillator loading.)

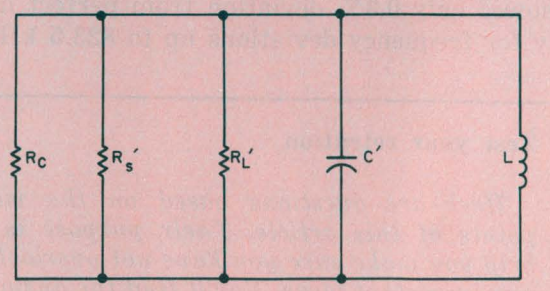
Varactor diodes that provide maximum C_2 values between about 1 and 100 pF are available. Thus, only C_1 can vary widely in design value



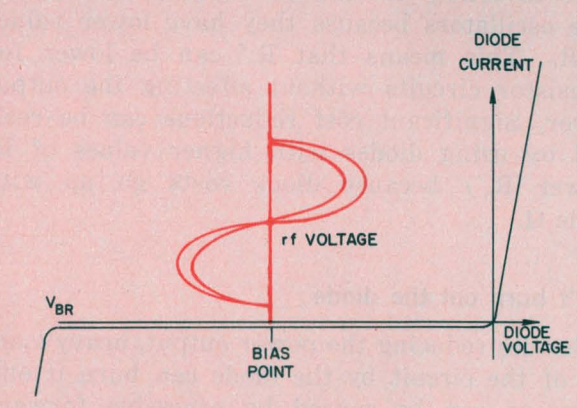
1. **The modulation sensitivity** of this fm oscillator tank circuit is most easily adjusted by changing the size of capacitor C_1. R should present an impedance many times larger than that of the varactor (C_2) if it is to be omitted from the rf analysis of the circuit.



2. **The effective series resistance, R_s,** of the diode should not be neglected when analyzing the loaded tank circuit. R_C is the effective shunt resistance of the transistor, R_L is the load and C_K couples the load to the oscillator. Only rf components are shown.



3. **Power output suffers** as R_s' is decreased. The primes indicate parallel-equivalent transformation.



4. **Both forward and reverse currents can flow** concurrently if the p-p rf voltage swing exceeds V_{BR}.

and be used for adjusting the modulation sensitivity of the circuit.

Tight coupling wastes power

As Eq. 6 shows, the way to increase modulation sensitivity is to increase C_1. But this also increases the loading of the circuit by the effective series resistance of the diode (Fig. 2).

The series combination of R_L and C_K can be represented, at a particular frequency, by a parallel equivalent: R_L' and C_K'. C_K is usually chosen so that $R_L' = R_C$, for maximum power transfer. It may also be chosen to make $R_L' >> R_C$ for high efficiency. At vhf and above, circuit losses usually make maximum efficiency coincident with maximum power into the load.

The transformed value of R_L is approximately given by

$$R_L' = (1/\omega C_K)^2/R_L \qquad (7)$$

so long as the impedance of C_K is substantially larger than R_L. The same transformation can be applied to the series combination C_1, C_2 and R_s. The parallel equivalent of R_s is then given by

$$R_s' = [(1/\omega C_1) + (1/\omega C_2)]^2/R_s. \qquad (8)$$

If both of these series-to-parallel transformations are made on the circuit of Fig. 2, the circuit of Fig. 3 results. Capacitance C′ represents the combined effective capacitance of C_1, C_2, C_3 and C_K.

It is clear from Fig. 3 that the total developed rf power is distributed between R_C, R_s' and R_L' in inverse proportion to their values. Thus increasing C_1 increases the amount of power dissipated in the diode, by decreasing R_s'. Up to the point where the diode only begins to significantly load the circuit, increased modulation sensitivity is obtained with no reduction in power. Beyond that, a tradeoff begins.

Note that transistor oscillators lend themselves more favorably to varactor modulation than do tube oscillators because they have lower values of R_C. This means that R_s' can be lower for transistor circuits without affecting the output power. Significant cost reductions can be realized by using diodes with higher values of R_s (lower R_s') because diode costs go up with diode Q.

Don't burn out the diode

Besides reducing the power output, heavy loading of the circuit by the diode can burn it out. Burn-out can be caused by excessive forward current or excessive reverse voltage, and it's not always easy to tell which was responsible in a given situation.

The instantaneous voltage across the diode is the sum of the reverse bias voltage and a portion of the rf tank voltage determined by the division ratio of C_1 and C_2. If a modulation signal is present, it must also be added in. The rf voltage across the varactor can cause the diode to go into forward conduction on one voltage peak, or into reverse breakdown on the other peak, or both.

This can be observed experimentally by varying the bias level and monitoring the diode current. If the peak-to-peak rf voltage is less than the diode's breakdown voltage, V_{BR}, the bias can be adjusted to yield zero current. The bias level can then be reduced until forward current flows, or raised until reverse current flows (Fig. 4).

Now, if the bias is set close to (1/2) V_{BR} and the rf voltage is increased to the point where its peak-to-peak value exceeds V_{BR}, then both types of current will flow concurrently. This is made evident by observing that, as the bias is varied, the diode current meter indicates forward current up to a certain value of bias and reverse current at a greater value of bias. At the single point where zero current is indicated, one could be misled into the false security of thinking that no current is flowing. Actually, the positive and negative current flows are merely averaging out to zero.

Performance is surprisingly good

An amazing feature of varactor modulation is the excellent linearity it provides. (Linearity is measured by applying progressively larger voltage swings to the varactor and measuring the peak-to-peak frequency deviation that results. Ideally, deviation is exactly proportional to the voltage.) Although the formulas describing frequency versus V_c look hopelessly nonlinear, computer calculations and experimental results indicate that excellent linearity can be obtained.

For example, an experimental 800-MHz oscillator built around a Motorola MV1864B diode, showed only 0.3% deviation from perfect linearity for frequency deviations up to 823.5 kHz. ■■

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. How are modulation sensitivity and circuit loading (by the varactor) related? Why?

2. Why are transistor oscillators more tolerant of low-Q diodes than vacuum-tube oscillators?

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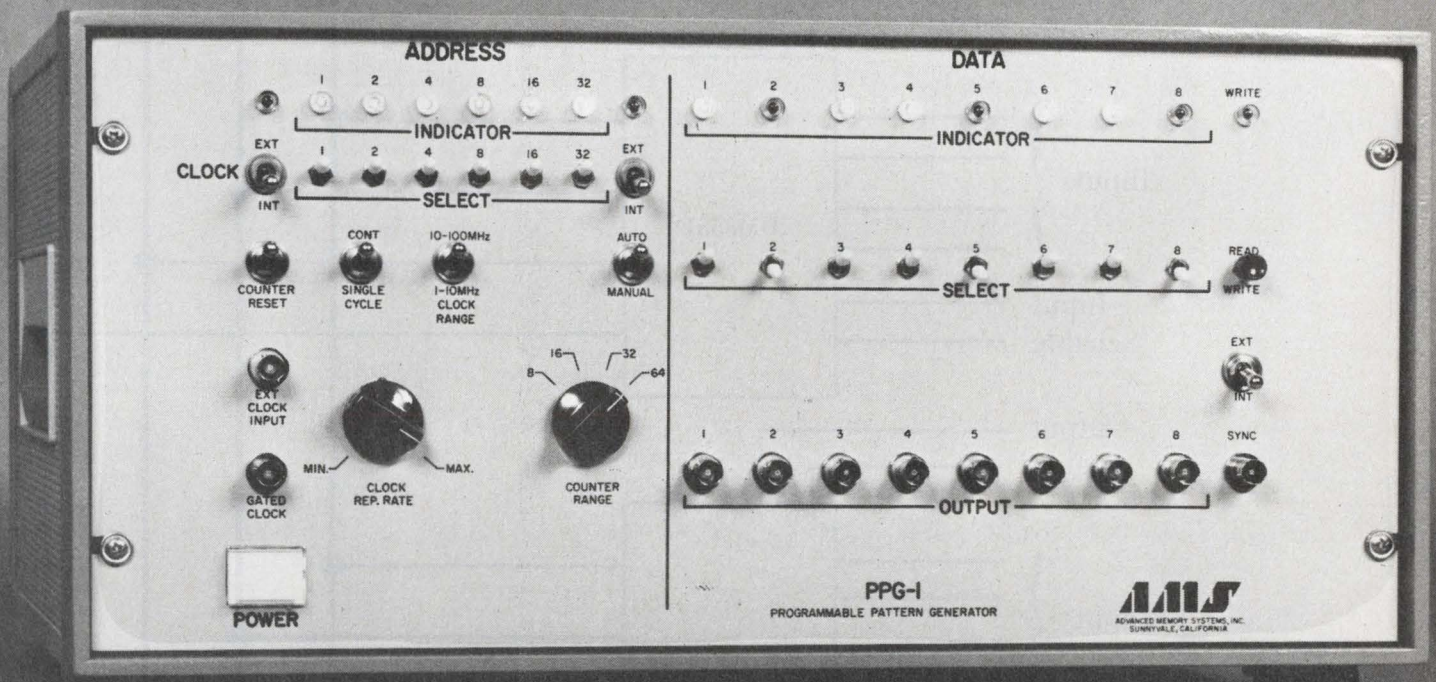

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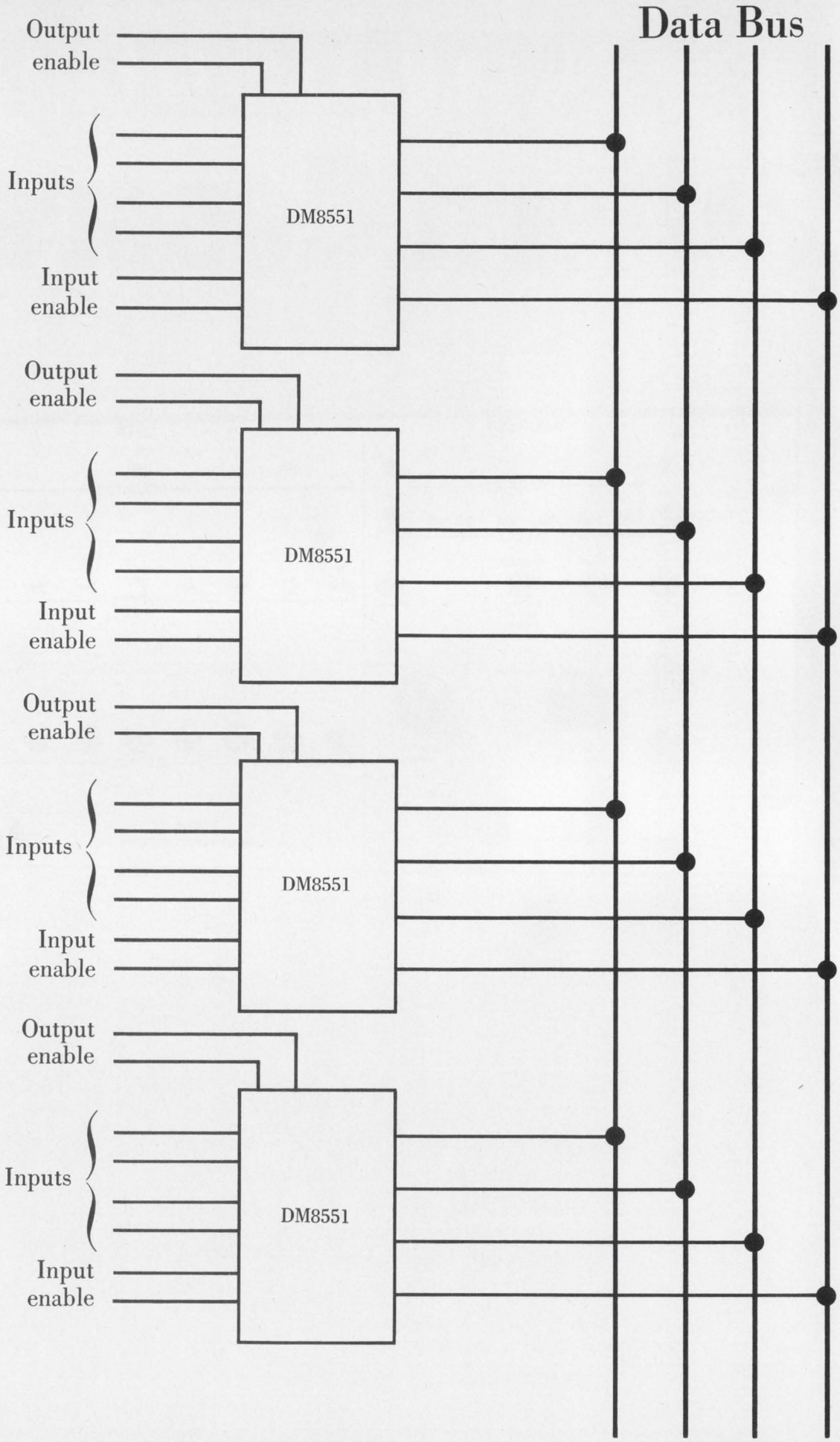
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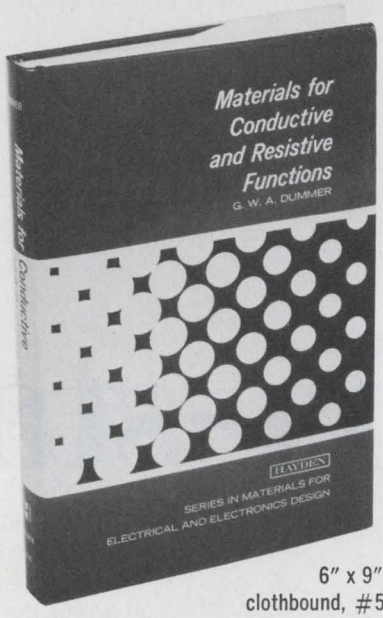

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Boost your DTL efficiency with wired-OR

You can often replace a DTL NAND gate with a simple piece of jumper wire.

Many designers make do with DTL NAND gates where they would like to have AND, OR, or NOR functions, because only NANDs are widely available. They use a pair of cascaded NAND gates, for instance, to perform the AND function, and accept the increased gate count as inevitable. But a very useful design trick can mean great savings.

Wired-OR DTL design offers a marked reduction in gate count, an opportunity to perform many simple functions in only one stage of logic, and a decreased propagation delay. And all it costs is a decreased fan-out capability.

Consider the function shown in Fig. 1a. Does it really require three logic elements? Or are only two required?

Impossible, you say, to build it with two gates: the Karnaugh Map[1] indicates three gates (Fig. 1b). You're wrong. It can be built with two gates. And the answer to the paradox lies in a concept of logic developed for the DTL 930 series IC line—the wired-OR.

Jumper wire is an OR gate

The equivalent of the circuit of Fig. 1a using the wired-OR logic is shown in Fig. 1c. The third gate has become nothing more than a "jumper wire," and all that it cost was the inversion of the inputs. The circuitry of the DTL NAND gate makes the wired-OR possible.

The circuit of the basic 930 DTL NAND gate is shown in Fig. 2a, and the wired-OR connection that performs the logic function of Fig. 1c is shown in Fig. 2b. Since each gate performs the basic NAND function, the output, f, of the circuit of Fig. 2b will be at ground potential when either $\overline{A}$ = ONE or $\overline{B} = \overline{C}$ = ONE. Thus the circuit may be described by the Boolean[1] equation

$$f = (\overline{\overline{A} + \overline{B}\overline{C}}). \qquad (1)$$

The output will be a logic ONE when neither $\overline{A}$ nor $\overline{B}\overline{C}$ is a ONE.

Equation 1 also describes the operation of the AND/NOR logic structure, a form generally unfamiliar to the logic designer. And this makes design with NAND/wired-OR very much easier.

No longer is it necessary to "cut-and-try" wired-OR circuits: To come up with a wired-OR logic implementation, all we need to do is express the function in Boolean algebra, manipulate the algebra to a form suited to AND/NOR implementation, and draw the logic diagram. Then we substitute NAND gates for the AND gates and the wired-OR connection for the NOR gate in the diagram, and we have the equivalent NAND/wired-OR circuit.

The AND/NOR logic form

To use the AND/NOR logic form we must first express the function in the minimum product[1] form, and then manipulate the expression into the proper form to be easily implemented.

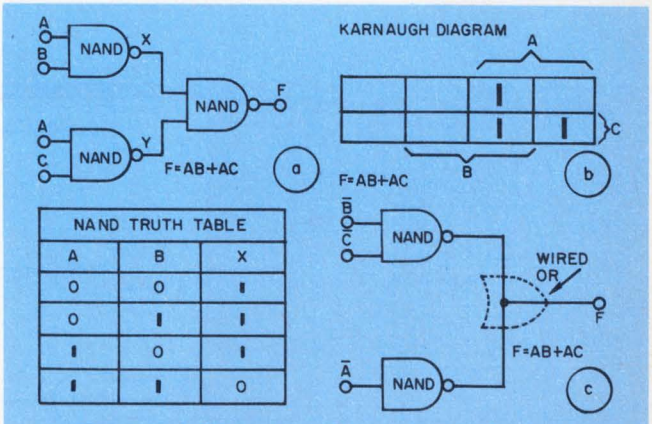
Consider the circuit for the function

$$f = AC + \overline{A}\,\overline{C} + B. \qquad (2)$$

The equivalent minimum product form of this expression is

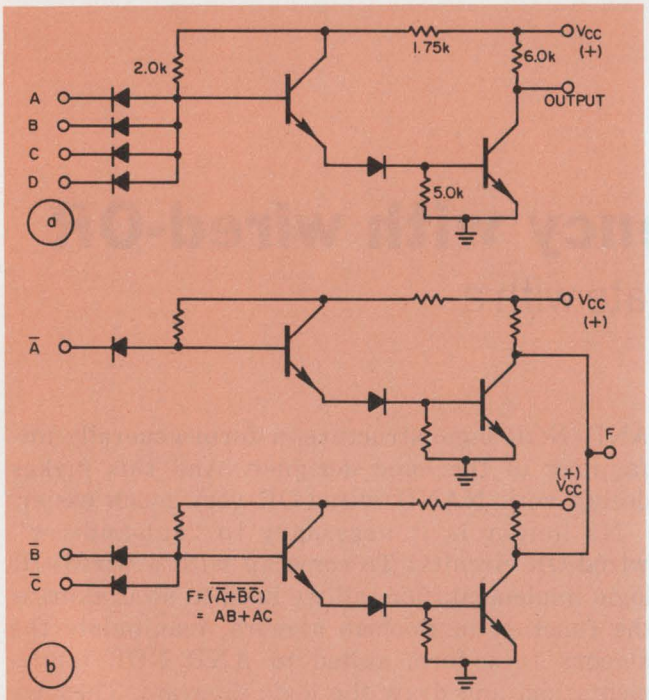
$$f = (\overline{A} + B + C)\ (A + B + \overline{C}), \qquad (3)$$

and this may then be manipulated into the

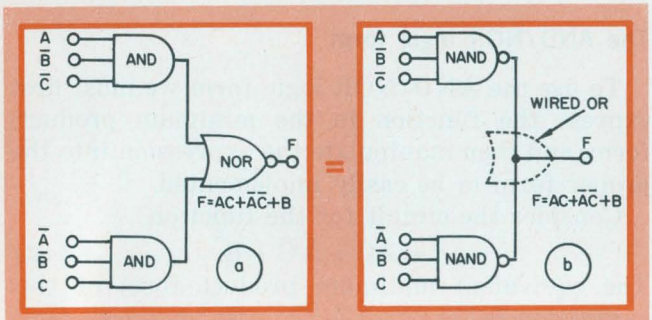


1. **The wired-OR connections can eliminate gates** in a DTL logic design. The three NAND gates (a), which perform the function f = AB + AC (b), for instance, can be replaced by two identical NAND gates with their outputs jumpered (c).

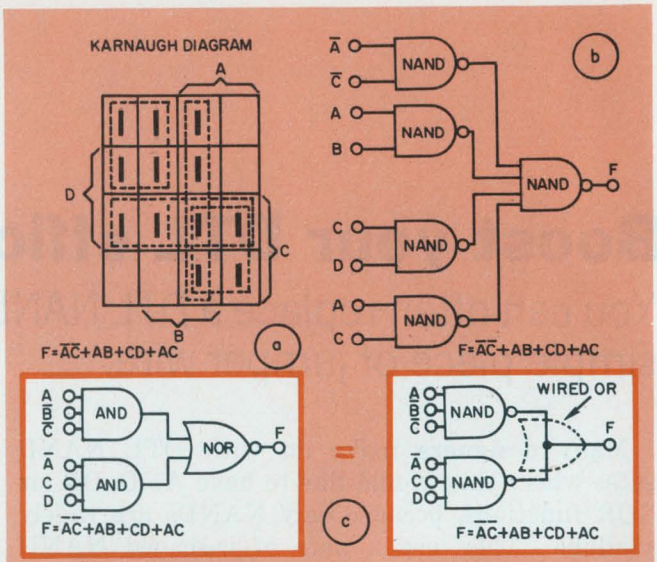
Gilbert I. Starr, Systems Analyst, QED Systems, Inc., Pleasantville, N.Y.



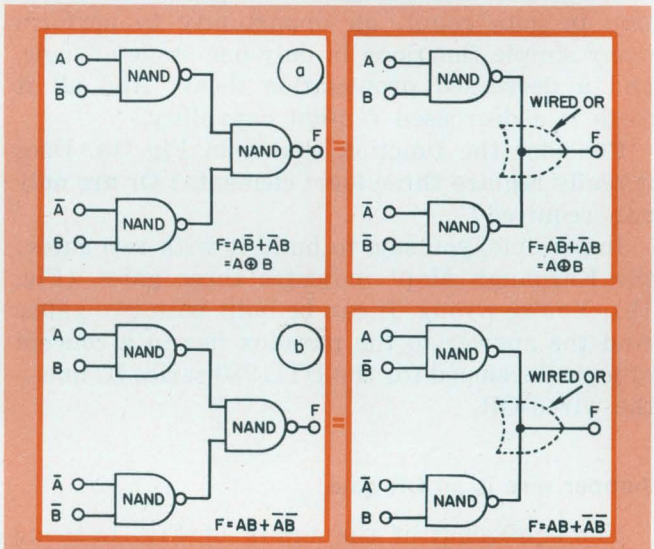
2. **The basic 930 DTL NAND gate** (a) gives a LOW output only if all inputs are HIGH. A simple connection of the output leads of two of these gates (b) results in an additional OR function; the combined outputs is LOW if either output is LOW.



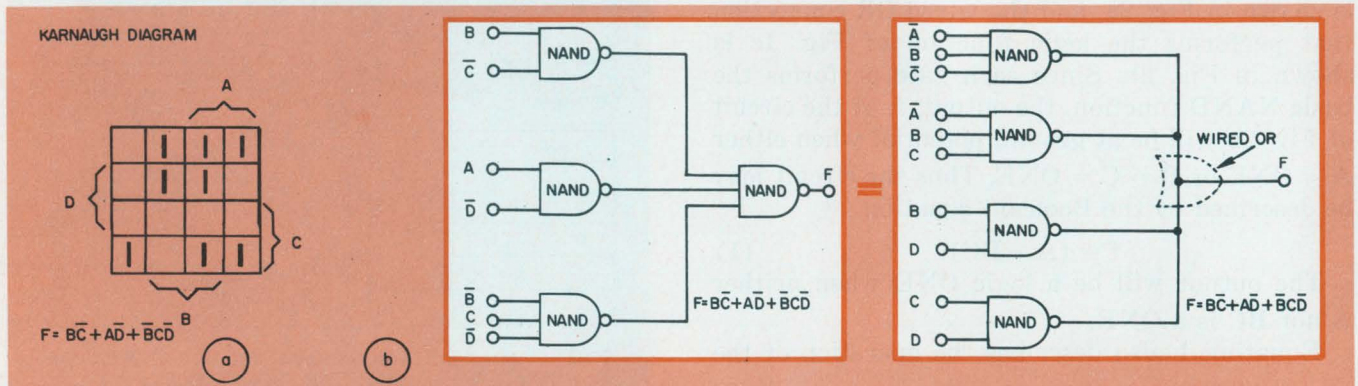
3. **AND/NOR (a) and NAND/wired-OR (b) gates perform equivalent functions** if connected in similar patterns. The designer performs Boolean calculations to minimize the gates in an AND/NOR system; then he replaces AND gates with NAND gates, NOR gates with the wired-OR connection.



4. **Significant savings in gate count result** for some logic functions (a). In this case a simple NAND circuit requires five gates (b), but a simplified AND/NOR circuit uses three gates and a NAND/wired-OR equivalent uses only two gates.



5. **An exclusive-OR function at a one-gate saving** (a), and a two-input coincidence detector, also at a one-gate saving (b), from NAND/wire-OR.



6. **NAND/wired-OR is not always best, and the designer must be cautious.** For some functions (a), the same number of gates is required after Boolean simplification (b), and for others (c) attempts at simplification result in an actual increase in the number of gates required (d).

proper form

$$f = (\bar{A} + B + C)\ (A + B + \bar{C}),$$
$$= \overline{(A\bar{B}\bar{C})}\ \overline{(\bar{A}\bar{B}C)},$$
$$= \overline{(A\bar{B}\bar{C} + \bar{A}\bar{B}C)}. \quad (4)$$

This result allows us to readily build the function with AND/NOR construction (Fig. 3a), and the AND/NOR is easily translated to the wired-OR configuration. Note that the wired-OR requires only two gates, whereas the formal Boolean realization requires three.

The possible savings in using this approach are immediately evident when we implement the function shown in the Karnaugh map of Fig. 4a. The straightforward AND/OR or NAND/NAND forms result in the following equation and structure (Fig. 4b):

$$f = \bar{A}\bar{C} + AB + CD + AC. \quad (5)$$

The equivalent, simplified AND/NOR structure and the wired-OR equivalent are shown in Fig. 4c. The equation is

$$f = (\bar{A} + B + C)\ \overline{(A + \bar{C} + \bar{D})}$$
$$= \overline{(A\bar{B}\bar{C} + \bar{A}C\bar{D})}. \quad (6)$$

The saving through simplification is three gates or 60%!

A most attractive aspect of the wired-OR logic structure is that it reduces many two-stage logic circuits to one stage. And one-stage logic is extremely attractive where high-speed operation and low propagation delays are required.

Some very common circuits suddenly take on very odd appearances when built with wired-OR logic. The common NAND element "exclusive OR" function of Fig. 5a is easily built—at a one-gate saving. The two-input coincidence detector is shown similarly in Fig. 5b—also built with wired-OR at a one-gate saving.

Any circuit implemented with NAND/NAND structure, of course, has an equivalent AND/NOR and hence wired-OR configuration.

Wired-OR not always best

A word of caution: Before the logic designer rushes to change his circuits to the wired-OR, he must first check to see that he will indeed reduce the number of elements required. This will *not* always occur.

The function illustrated in Fig. 6a results in two circuits that require the same number of gates (Fig. 6b). There is no way to predict this before working out the logic equations and the diagrams.

It should also be noted that the wired-OR decreases the fan-out capabilities of the gate used, and so a multiple wired-OR connection could conceivably decrease the circuit's fan-out to one. ■■

Reference

1. Mayley, G. and Earle, J., *The Logic Design of Transistor Digital Computers*, Prentice-Hall, Inc., 1963.

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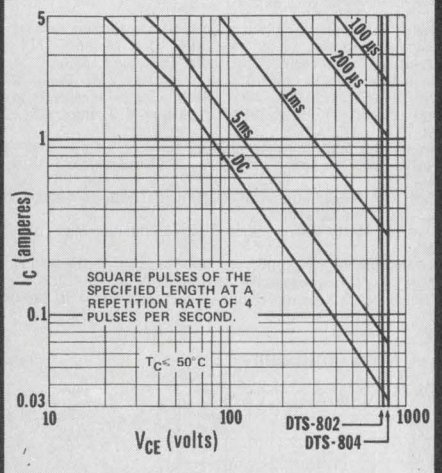

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h_{FE}, I_C = 3.5A, V_{CE} = 5V	2.2 min.	2.2 min.
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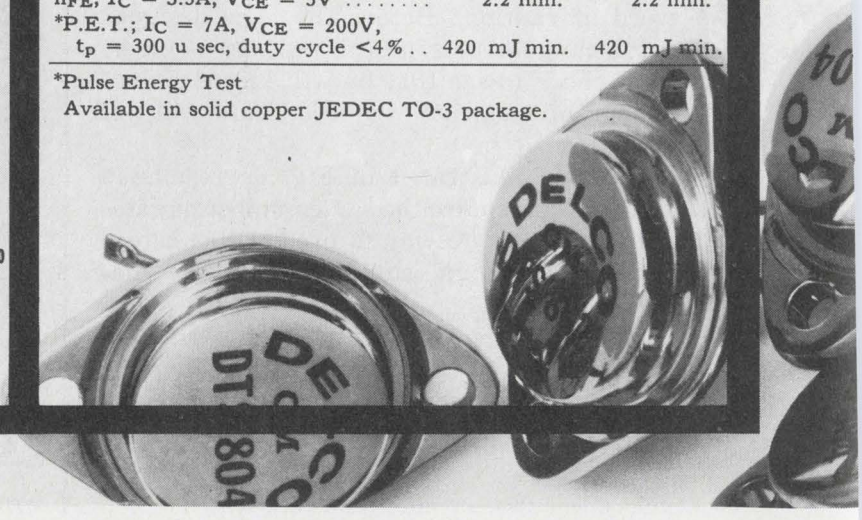

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Wired for the 'electric' generation?

Managers intent on employing top talent attend this seminar to learn how to attract and manage an anti-business youth.

Richard L. Turmail, Management Editor

Because methods of technical management change almost as often as technology itself, we believe our readership is interested in knowing about current projected managerial trends. We explore the problem in a three-part series on the management of change in technology, covering (1) changes in management style (2) managing the generation gap (3) exploring the management of technology. This article is second in the series.

Ever since the "electric" generation started hanging the establishment in effigy, conscientious recruiters of the business community have been trying to find a way to persuade top young talent to share in its company's employee stock option plan. Bridging the gap between those with mortgages and those who emblazon the scenery with contemporary graffiti such as "Stamp out virginity" and "I was curious," was the subject of a recent seminar conducted by the Bureau of Industrial Relations at the University of Michigan.

The conference, titled, "Managing the Generation Gap," was originated and chaired by Dr. Eugene Koprowski, associate dean of the University of Colorado Business School at the Denver Center, and associate professor of management and organization. Present were about 25 managers, one-third of whom represented electronics companies. They hoped to discover a way to change the opinion reportedly held by many young people that the business establishment is narrow, short-sighted, and uninspiring.

The "safety-valve" generation

What are the different generations? Why the gap? And how to manage it? These were some of the questions asked by the managers at the conference. They also asked more specifically:

- How do I attract bright, creative young people to my company?
- How do I turn them on?
- What strategies are available to accomplish these aims?

In answer to these almost desperate inquiries, Dr. Koprowski first explained why attitudes and values vary between those under and over 30.

"People," he said, "look at the world in very different ways. When you realize that someone is looking at the world unlike you, you figure that one of you must be wrong, and it can't be you."

He pointed out that most people view the world and their place in it by the criterion of a critical time in their lives—perhaps the time they got their first job. Those who are 60 years and older were first employed during a time when work was difficult to get, and so their approach to a job is that work is good for its own sake. They are conditioned by the way the world was then—which makes them part of the depression generation.

The next generation, Koprowski says, was one in which the young men were taken from the security of home and school and thrust into a mobile war. And when the war was over, their primary objective was to master a profession, marry, and establish a secure home life. These escapists from anxiety are members of the war generation.

These two older generations have basic values in common, but the younger generation has heard quite a a different drummer. For one thing, today's young people have never had to worry seriously about economic security. They could be called the "safety valve" generation because, if they get into deep water financially, their families are usually able and willing to bail them out. This financial freedom (or safety valve) has given a knowledgeable generation time to be conscious about social ills.

Value systems have changed

These young people are also aware of their market value. Koprowski cited the case of a usually well-mannered senior engineering student, who, after experiencing successful interviews with seven expectant companies, plopped his size 13's on Koprowski's desk and asked,

Seminar leaders make their point in a casual atmosphere at BIR-sponsored conferences.

"What job should I take, Gene, baby?" He is, of course, a member in good standing of the *electric generation.*

According to data compiled by Koprowski, the electric generation is further divided into three different groups of youths:

- Those who are vocal. They account for about 10% of the generation and are articulate leaders of the youth movement. They want to change the world, but not through the establishment.

The two branches of this type are the political wing (the new left), and the life-style group that does its own thing—long hair; drugs; beards; bizarre clothing.

- Those who aren't happy with the world. However, they are easily mobilized and willing to try to straighten things out via the establishment. They account for 50% to 60% of the total generation.
- Those who have been well conditioned by society. They aren't too different from those of the depression generation.

"The value systems," Koprowski said, "between the depression and war generations and the electric generation are different because of the way the world is different."

What is it that separates us?

The threadbare school of thought that says, "Once kids have to face the facts of life, they'll grow up," only helps to keep the generations separated.

In an exercise designed to wedge open our understanding of youthful attitudes, we were confronted at the seminar by a few students of the University of Michigan. One of them was an engineering major. His future plans include working in municipal government. He is interested in the marketing aspects of engineering, and he enrolled in engineering because, as he said, "It teaches me logical sequence." Then, with a smile, he added, "And perhaps because I was afraid I couldn't pass a language"—a fear, he said, that influenced quite a few of his fellow students when they decided to enroll in the college of engineering.

He explained that the generation gap is real to him because, "We have lost sight of what priorities are really important for our country. We need to change both the priorities and those who make them." He would give top priority to fighting pollution, for example.

An English Literature major put it in a different way: "A gap exists because there's little communication between the younger generation and those in power who are more interested in national security than they are in individual enterprise. We need more opportunities for personal involvement."

Another opinion came from a business economics major, who complained, "It's impossible for me to understand a government that taxes me to pay farmers not to grow food when people in this country are starving. Those with economic power have no right to use that power to control others."

And then one of the managers asked: "What is it you don't like about us?"

The students gave various reasons why companies aren't able to hire many of the top graduates. They include:

1. The business community emphasizes the importance of money, rather than purpose.

The engineer as student and job seeker

To explore the attitudes and aspirations of this year's upcoming crop of engineering graduates, ELECTRONIC DESIGN *recently interviewed Prof. John G. Young, director of engineering placement, College of Engineering, University of Michigan, and asked these questions:*

What do forthcoming engineering graduates here at Michigan look for during their job interviews with prospective employers?

Mostly, they look for the kind of research work they've done here in school. Most engineering assignments in college are research-oriented. Students don't really know too much about industrial engineering. If they're interested in an industry job, they concern themselves with the potential growth of the company and equate their own growth with that. Beyond that they seek employment in aerospace, new communications, and new devices.

What do employers look for in engineering students?

Employers in the market for research engineers, usually look for those with the best scholastic record. Employers in industry, on the other hand, usually want those with management potential—those who can take responsibility and make decisions. These employers don't care much if the student has no engineering specialty. You may find it interesting that although 80% of our students are managerially inclined, the percentage of electronics engineering students in this category is somewhat less because they are more scientifically oriented.

What is the average education for an engineering student here at Michigan?

About half of our students obtain a master's degree, and 11% of those earn a doctor's degree. These percentages may have dropped now since the students who are considering postgraduate work no longer receive a draft deferment.

(According to a nationwide survey of the 1969 graduating class just completed by the Engineering Manpower Commission, only 16% of this year's engineering graduates plan to study for a master's or doctor's degree. In the years 1965-67, about 25% of all new engineers pursued a higher education. The graduate today appears to be seeking an occupational deferment, since the graduate deferment is no longer open to him.)

Does the course of study required for a master's degree in engineering prepare the student for the responsibilities of management?

The course doesn't really broaden the engineering student's knowledge of business administration methods. Students pursue master's degrees because they know they will be more competitive in the job market having proved that they can handle master's work. To learn methods of management, a student must take courses designed specifically for that purpose.

What kind of engineering work do the senior students want?

They don't want a routine job. Grads are looking for job freedom—that is, an opportunity to innovate technically and/or managerially. They're also seeking social and environmental improvement.

Is the number of students enrolling in engineering at Michigan increasing or decreasing compared to say, five or ten years ago?

There has been a yearly increase in enrollments—at a decreasing rate. I used to think that the reason for the decrease was either that engineering was moving more from the manual to the technical, or that science instead of engineering was getting all the credit for technical accomplishments. However, what has happened, I think, is that among the students there is an increasing emphasis on individualism. They're turned off by organizational jobs.

There has been an enrollment increase in the English Literature School here because, I think, an increasing number of students believe they can find themselves in a course of study that is more subject to interpretation, that allows more freedom of expression than they think engineering does. Also, students with managerial ability are inclined to enroll in a school of business administration, instead of engineering school.

Do many engineering students at Michigan attend liberal arts classes?

Very few. To graduate at Michigan, the engineering student must accumulate a minimum of 128 credits. Of that number, only 24 are electives and many undergraduates spend those in economics courses. They could broaden themselves a little better, perhaps, if they took courses in the behavioral sciences, language, sociology, and psychology.

Officials of electronics companies have complained that they have to retrain an engineering graduate before he's capable of making a worthwhile contribution to the company. Why?

We can only school the student in the fundamentals of engineering. If we attempted to train him in depth in one field, he would be sadly lacking in others. He must learn to adapt himself to the company situation.

What is the best way to manage today's engineering student?

Brief him face to face on how the company's function depends on engineering, on him, and how the many corporate decisions are governed by technical considerations. Also give him the group concept: let him see what he can accomplish with others that he couldn't hope to accomplish by himself.

2. Some of the graduate talent, including many engineers, is spurning business in favor of government in hopes of changing social ills.

3. The narrow-mindedness of business is a real barrier to young innovators who have fresh ideas to unload.

The engineering student summed it up this way: "The member of the establishment that I respect is a 72-year-old engineering dean, who, despite the fact that he's a very conservative gentleman, has always attempted to give a new idea a chance. A company's life depends on new ideas to keep up with the times. A forward-looking image is crucial for any company hoping to place creative college graduates on its payroll.

"I must work for a company that feels its own significance; that is socially conscious; that, for example, helps the community with its pollution problem; that is open to change and is constantly updating its operating techniques."

Tapping the fountain of youth

The door had barely closed behind the last departing student before more than one manager was asking the obvious question: "How do we bridge the gap that separates us?"

Guest speaker James R. Shultz, director of personnel planning for Kaiser Aluminum listed the following ways that company has tried to reach the electric generation:

- Set up a program in Oakland, Calif., to acquaint ghetto children with the law.
- Revamped its employee selection process because tests proved it to have no correlation with job accomplishment because highly competent employees were becoming bored with their work.
- Placed talented youths in positions where they can do what they do best as quickly as possible.

Professor John G. Young

Another area where companies can look for improvement, Schultz says, is in the investigation of the company's organization chart to find out if there are any jobs that may be obsolete. Still another approach is putting youth to work on task forces that deal with problem-solving and goal-setting. "These jobs will weed out the phonies," Shultz said, "because they come to grips with the problems immediately."

Shultz said further, "A title doesn't make it with the younger set. The better management is the one with less supervision—the one with more mutual respect. For that reason, more and more people at our company report to only one supervisor."

In conclusion, Shultz said that company managers shouldn't be afraid to pay young employees what they're worth, even if it's more than older employees are making. Educated youth is the most valuable investment any company can make.

Seminar leader Koprowski then offered his own list of suggestions to managers who are interested in attracting talented young people for their companies:

1. Be prepared to take risks to keep your company young and vital.

2. Get to know your new employee on a face-to-face basis.

3. Level with him about his future and the company goals.

4. Involve him in decision-making, and give him work that has a purpose.

5. Develop a climate of trust.

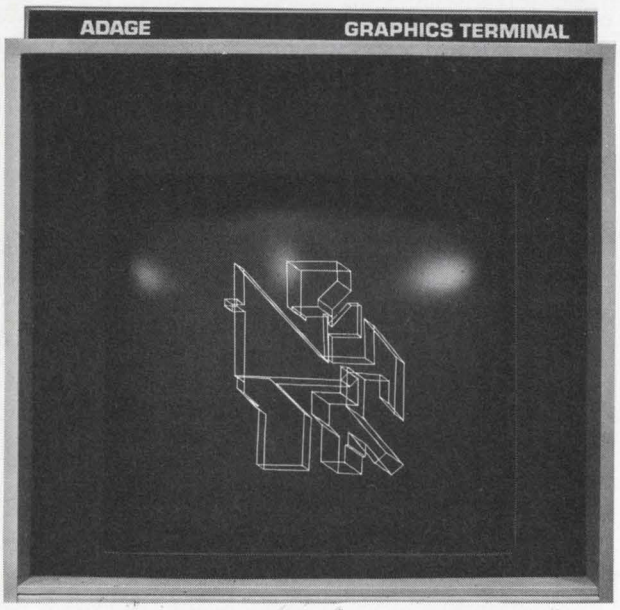
6. Help him grow at his own pace.

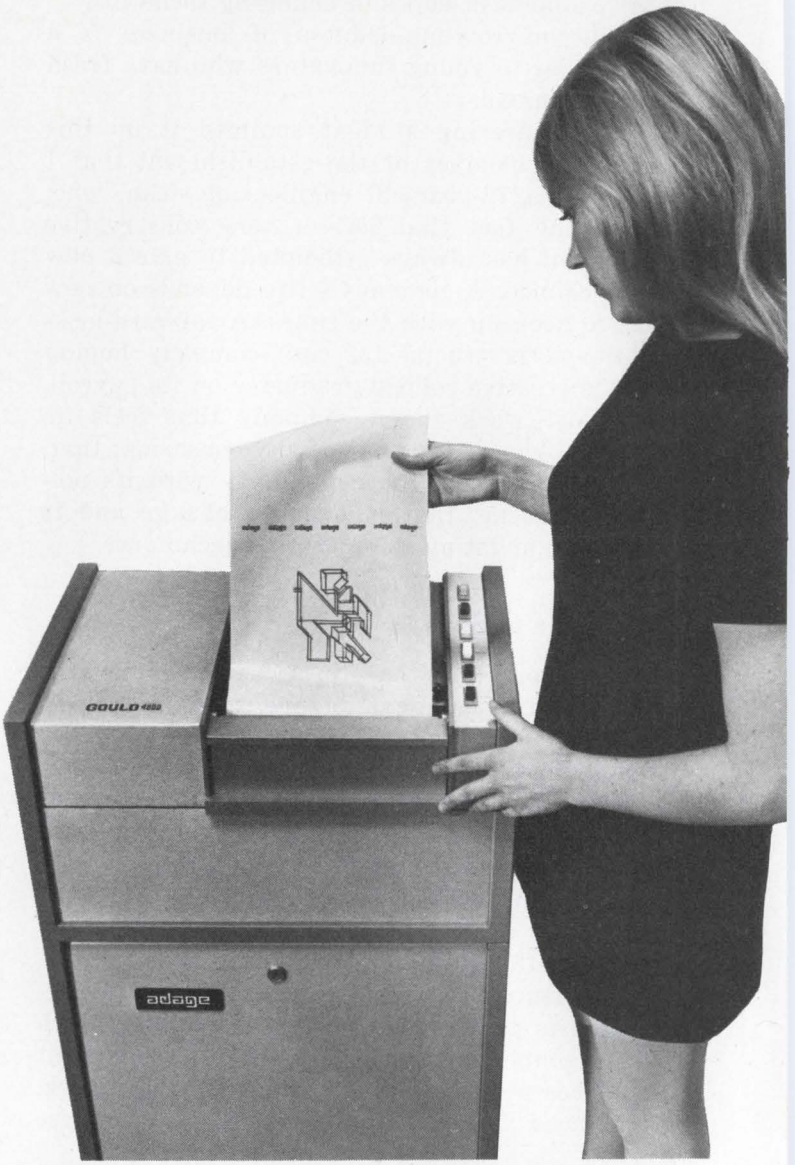
What's the real difference?

Capping the two-day conference was a dramatization designed to confront the managers with the problem of blending the young, nonconforming employee with the company image.

One participant was Mark, a brilliant engineer, long-haired, bearded, weirdly dressed—and who keeps a pet cricket in a sterling silver cage at work. He was pitted against a manager, Ken, who was a former honor student and a wing commander in the Air Force during World War II.

As the conversation between the two characters unfolded, most of us realized that because two people differ from each other, one isn't necessarily right and the other wrong. Both can be right, and management can benefit from the lesson. ■■





From CRT display to hardcopy printout. In seconds!

A plotter takes 30 minutes. A dry-silver photographic process makes muddy copies. But at Adage, Inc. the Gould 4800 Electrostatic Printer puts out clean hard copy in seconds. No wait.

No wonder the 4800 is now a catalogued item for Adage Inc.'s award-winning Graphics Terminal.

The Graphics Terminal is a CRT display computer system with infinite potential for interractive graphics applications in science and engineering. To name a few, cockpit design, mathematical equations and printed circuit cards.

Having the 4800 Electrostatic Printer on line the user can alter his design equation with a light pen and have clean hard copy of any stage within seconds.

Adage officials say their system is further enhanced by the economy of the 4800. It doubles as a printer by putting out both alphanumerics and graphics. It has fewer moving parts to maintain than conventional equipment. And Adage interfaced the 4800 in a matter of days . . . at surprisingly low cost.

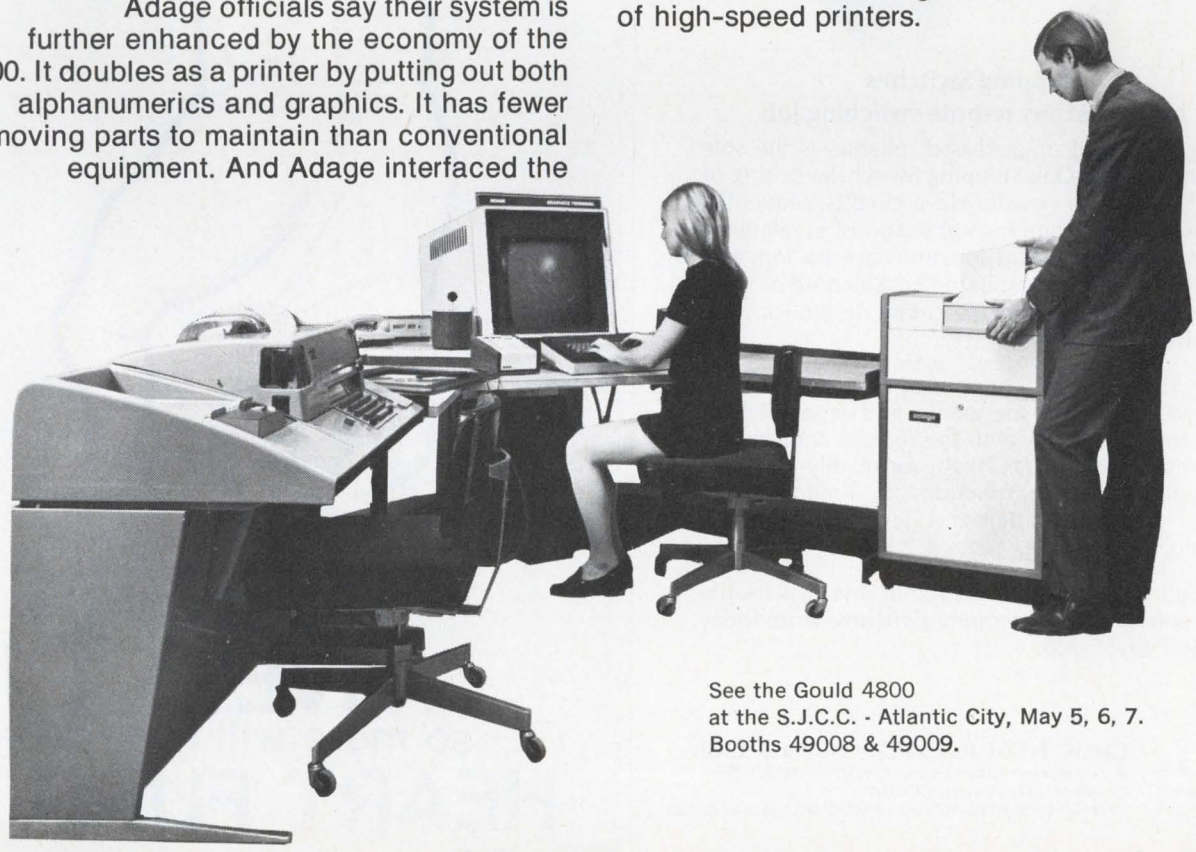
More 4800 facts:

At 412,000 characters per minute, the Gould 4800 breaks the old printout bottleneck on your computer. It reproduces signals from any source of digital input or data transmission by telemetry, radio microwave and/or land line, quickly, quietly, accurately and economically.

4800 can probably recap the same benefits for your system as it does for Adage's Graphics Terminal. Write us to see. Don't wait. Graphics Division, Gould Inc., 3631 Perkins Avenue, Cleveland, Ohio 44114.

GOULD CLEVITE

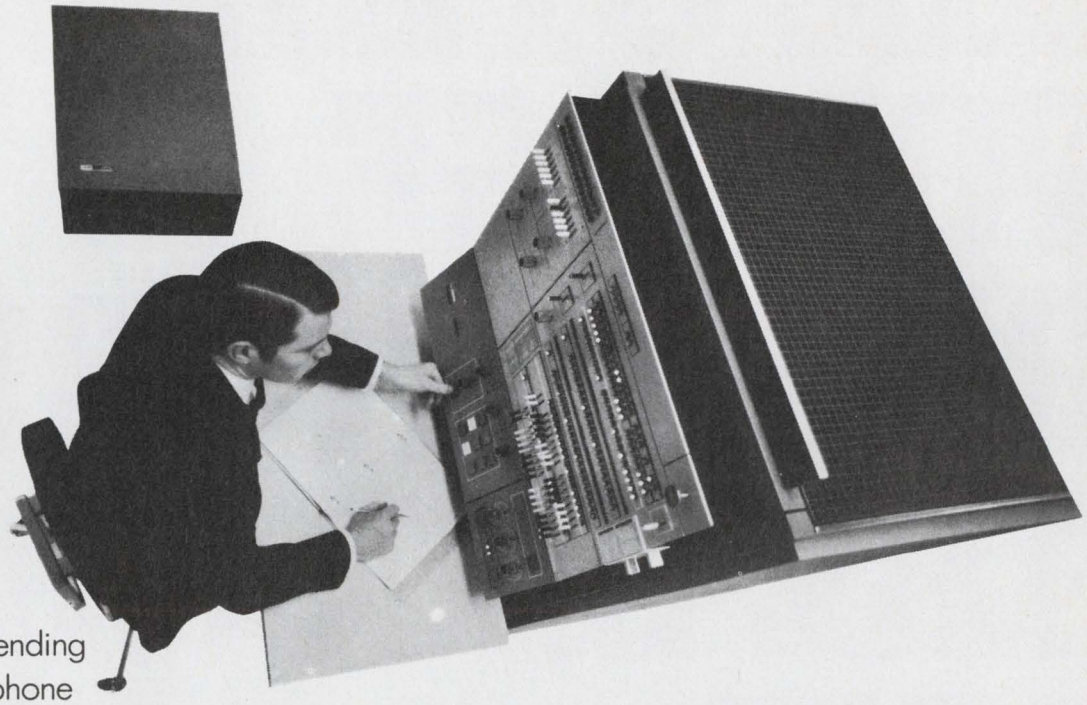
Gould 4800. The next generation of high-speed printers.



See the Gould 4800
at the S.J.C.C. - Atlantic City, May 5, 6, 7.
Booths 49008 & 49009.

INFORMATION RETRIEVAL NUMBER 71

The IBM Modem. Only the price will surprise you.



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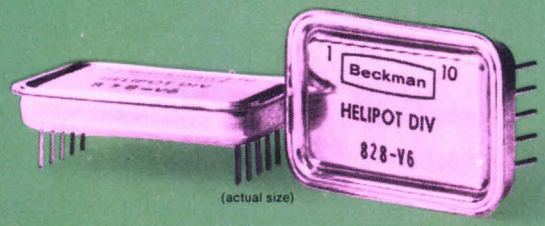

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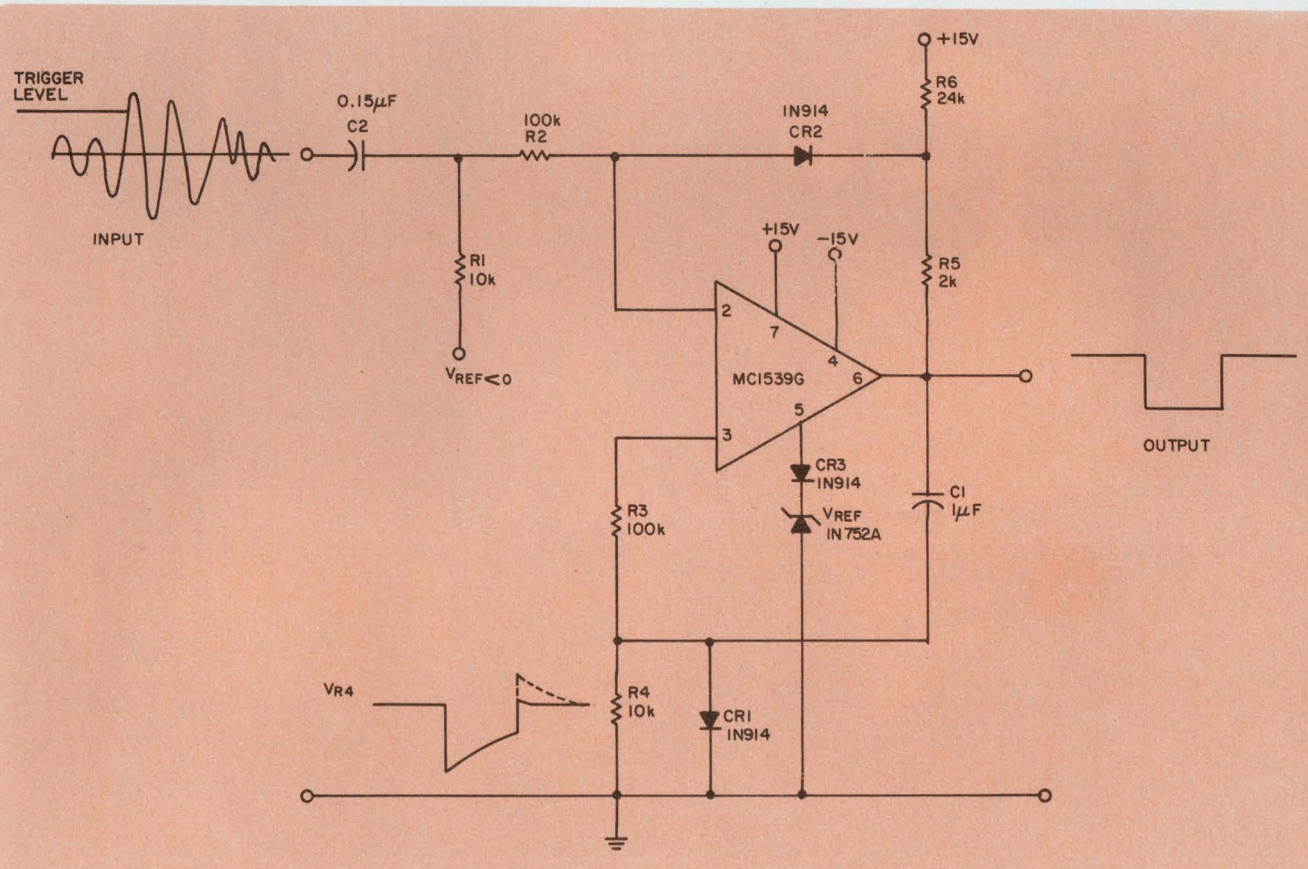
Feedback and clamping circuits improve comparator one-shot

One-shot multivibrator designs using IC comparators or operational amplifiers have several disadvantages. These are described, and improvements are suggested.

One problem is pulse width variation which results if the input signal continues after the one-shot is triggered on. Since pulse duration is controlled by the timing capacitor charging above the input voltage, variations in the input voltage cause variations in the pulse duration. The new approach uses a feedback technique to fix the input to a constant voltage while the one-shot is on.

Another problem is the long recovery time required before many one-shots can be retriggered by the proper voltage. Since turn-on occurs whenever the input signal exceeds the reference, any excess reference voltage will raise the trigger point. Normally, capacitor feedback causes the reference to increase at turn-off.

As shown in the figure, the improved circuit uses an operational amplifier with feedback and clamping features. A diode (CR_2) has been inserted to clamp the excess voltage and decrease the recovery time. The operational amplifier is normally in the positive state, one diode voltage below the zener (V_{Ref}) voltage. When triggered, the output swings to its negative state (−12 V), and C_1 causes V_{R4} to drop the same differential voltage. At the same time, CR_2 is forward-biased,



Improved circuit combines feedback and clamping to enhance the performance of a comparator one-shot.

Now...CERMOLOX® Power for VHF-TV

New economy, long life, and convenience are possible now throughout the VHF-TV band. RCA-devised techniques and up-graded CERMOLOX structures are being employed to advantage in RCA-8806 and RCA-8807—two new Beam Power Tubes designed for high performance up to 400 MHz.

8806 delivers 12.5 kW peak sync; 8807 offers 20 kW peak sync.

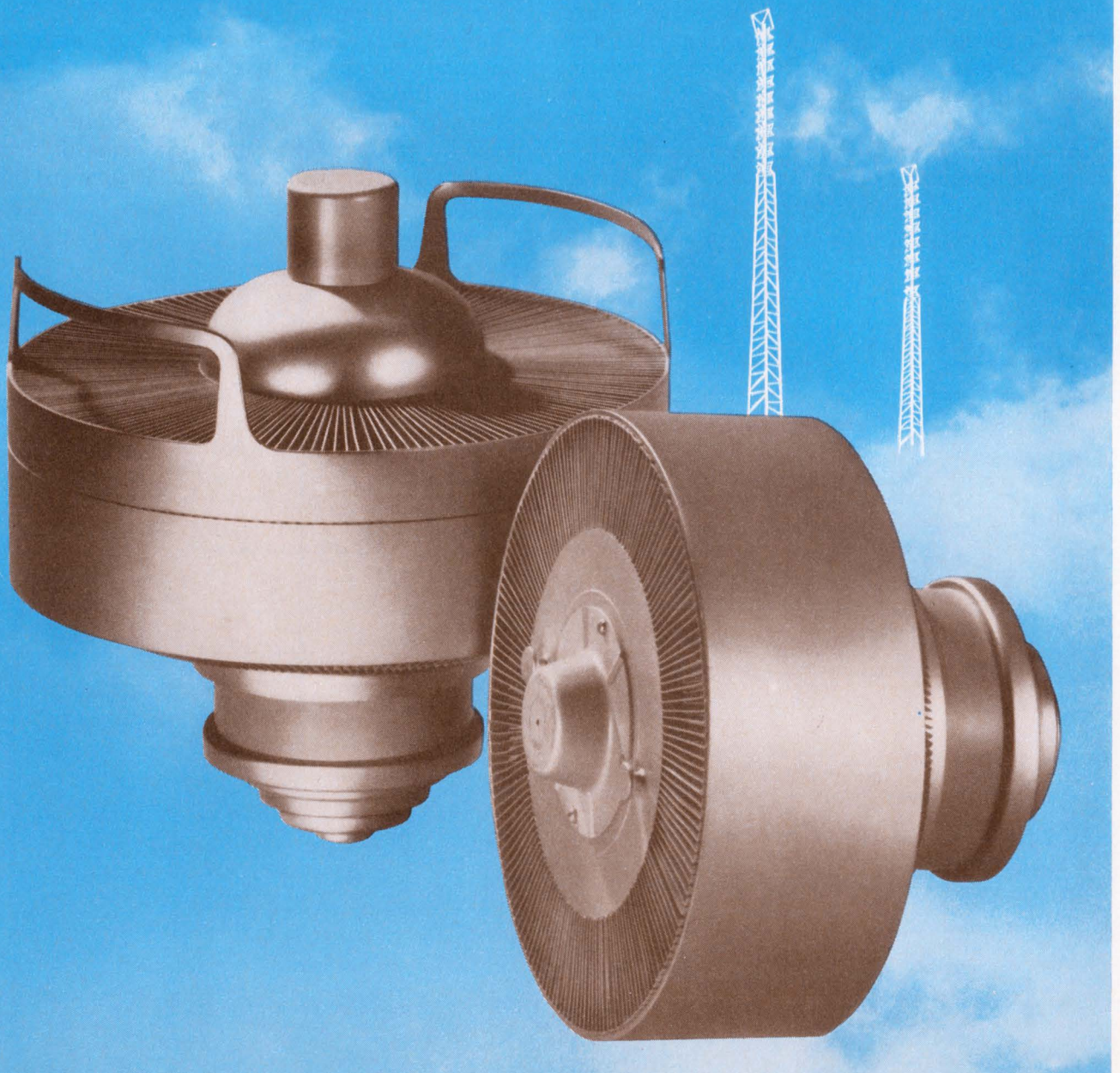
Neither tube requires screen or cathode tuning. You get stability. Both incorporate more cathode area than any equivalent tetrode on the market. You get lower operating cathode current density—and the longest life available today!

In RCA's continuing program to optimize UHF tubes for VHF-TV use, 8806 and 8807 employ precisely aligned grid and screen wires. Low screen and grid current result. Because of the amplitude linearity of the tubes, you can use simple TV modulation schemes.

What about low sync compression and differential gain? No tube on the market can match RCA's performance. In VHF-TV service, phase linearity leading to low differential gain allows development of a new level of performance for broadcast transmitters.

Ask your local RCA Representative or your RCA Industrial Tube Distributor for more information on these tubes, including their use in SSB and FM. 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



*Section D18T-1

clamping pin 2 to a constant negative voltage, thus preventing this point from following input voltage variations.

Gradually C_1 charges, and when $V_{pin\ 3}$ exceeds $V_{pin\ 2}$ the operational amplifier starts switching to the positive state. As the voltage increases at pin 6, the differential voltage is coupled to pin 3. At the same time an attenuated portion of this differential voltage appears at pin 2. This additional positive feedback assures switching to the positive state. As the output voltage completes its positive swing, CR_1 conducts and discharges the excess voltage that C_1 developed across R_4. This sets up the one-shot for another triggering signal.

Built-in diode protection prevents large input voltage swings from damaging the amplifier. However, these diodes do allow a small dc voltage to develop across R_1 and the R_4-C_1 combination. Thus the trigger voltage is:

$$V_{Trigger} = V_{Ref} + V_{R1} + V_{R4}$$

Diodes are used from pin 5 to ground to prevent a supersaturation condition in the op amp from affecting the trigger point. They also limit the output voltages and help set the pulse duration (t), which is 5 ms for this circuit. Pulse duration is primarily determined by C_1 from the equation

$$t \approx -R_4C_1 \ln (V_{pin\ 2}/\Delta V_{pin\ 6})$$

where

$V_{pin\ 2}$ = the voltage at pin 2 when the ouput is negative

$\Delta V_{pin\ 6}$ = the transition of voltage at the output.

Paul B. Weil, Member of the Technical Staff, Hughes Aircraft Co., Culver City, Calif.

VOTE FOR 311

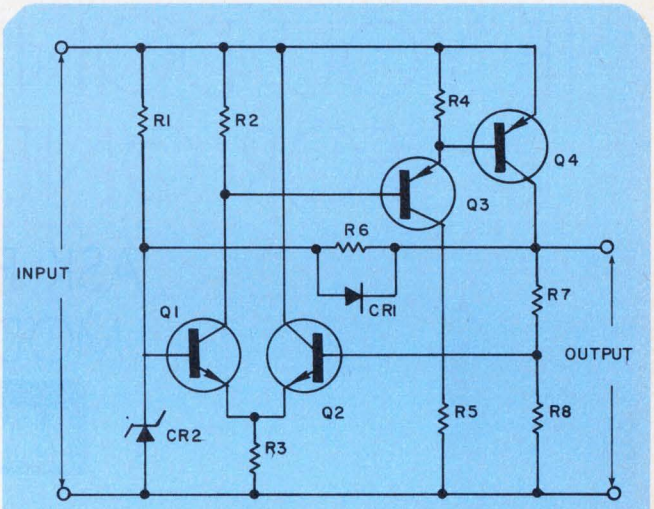
Diode protects power supply from short circuits

Power-supply protection is a perennial problem and the circuit shown offers a simple and economical solution.

Under normal conditions, CR_1 is reverse-biased by the voltage drop across R_6 and thus does not affect the operation of the stabilizer. However, when the output is shorted, CR_1 turns on, drawing current through R_1 and causing the zener diode (CR_2) reference voltage to collapse. Because CR_1 is a germanium diode, it holds Q_1 off, thus turning off Q_3 and Q_4. When the short is removed, the circuit resumes normal operation.

Damer E. O'N Waddington, Design Engineer, Mulgrave, St. Albans, Herts., England

VOTE FOR 312

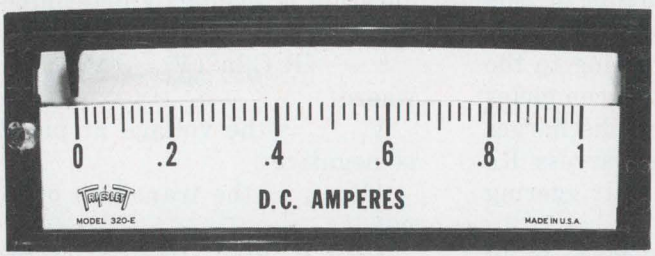


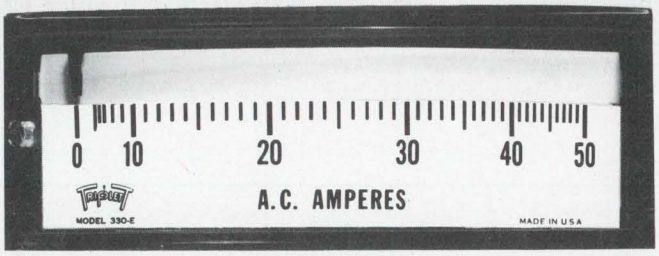
Diode CR_1 is reverse-biased unless output is shorted. Forward bias during short circuit protects power supply.

DTL circuit triggers multivibrator and insures starting

An astable multibrator circuit driving a lamp makes a simple and convenient visual warning indicator system for many applications.

The control of the multivibrator from a digital integrated logic gate poses several problems. One way in which the required function might be achieved is shown in Fig. 1. A saturating lamp transistor, Q_3, can be switched across the collector-emitter circuit of Q_1 to inhibit oscillation. For the condition where Q_3 is cut off, the multivibrator functions normally. But there is no guarantee that the multivibrator will start. Switching Q_3 off may leave both Q_1 and Q_2 simultaneously saturated and the circuit with insufficient loop





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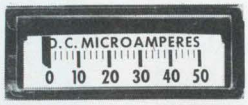

Requiring only 0.625 sq. in. of panel space (1.250" x 0.500"), Triplett's Model 0.5-E is the smallest of a line of panel meters specifically designed to fit in less than half the panel space required for a conventional meter of comparable scale length and accuracy.

Called the Triplett E-Series and available in ½, 1½, 3½ and 4½" sizes, this line includes AC, DC and RF ammeters and milliammeters, AC and DC voltmeters and DC millivoltmeters and microammeters. Counting all the sizes, types and ranges in which the E-Series meters are available, Triplett offers over 700 different edgewise meters. Accuracy of the AC iron vane, DC and RF movements is 2% . . . 3% for the AC rectifier types.

The Triplett E-Series meter line is available right now at your local Triplett distributor or sales/service/modification center. For more information, including the availability of special scales and ranges, contact one of them or your Triplett sales representative. Triplett Corporation, Bluffton, Ohio 45817.

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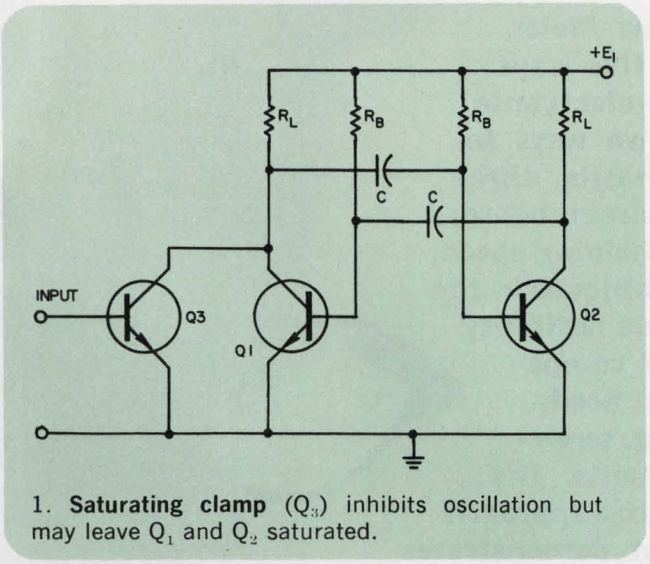
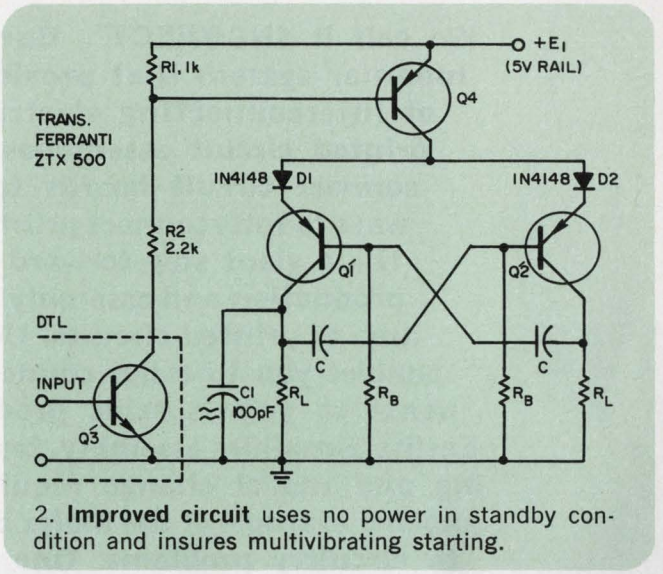


1. **Saturating clamp** (Q_3) inhibits oscillation but may leave Q_1 and Q_2 saturated.



2. **Improved circuit** uses no power in standby condition and insures multivibrating starting.

gain to commence oscillation. The multivibrator may be made self-starting, but this requires more components, plus an undesirable power dissipation during the standby condition.

These problems are overcome by the circuit shown in Fig. 2. When Q_3' (DTL output) is switched off, the current in R_1 is only a few nA and Q_4 is effectively off. R_2 is chosen so that when Q_3' saturates, Q_4 saturates and its collector voltage is approximately E_1, thus permitting the multivibrator to function. D_1 and D_2 are included to prevent base-emitter breakdown in Q_1' and Q_2' for large values of E_1. C_1 is a small capacitor (about 100 pF) included to make the collector circuits of Q_1' and Q_2' dissimilar: this ensures that the multivibrator will not block. Conventional design consideration governs the choice of C, R_L and R_B. Power dissipation is zero in the standby state.

The circuit functions just as well if R_2 is omitted and the base of Q_4 is driven from a high impedance source (for example: the collector of a current-mode switch).

B. L. Hart, West Ham College of Technology, London, England.

VOTE FOR 313

Level-shifting circuit uses analog and digital design

When dc level shifting must be compatible with both digital and analog circuits, the following design provides the required interface. The circuit shown (Fig. 1) provides three dc levels, sequenced as illustrated by the timing diagram (Fig. 2).

Upon application of a reset pulse, V_{F1} is obtained at the output. An enable pulse changes the output from V_{F1} to V_{F2}. After a fixed delay (T), the output again changes and remains set to level V_{F3} until the next reset pulse. The three output levels are related to each other by the equation

$$V_F = [R_4/(R_3+R_4)]\ E_2\ [1+(R_2/R_1)] - E_1(R_2/R_1). \quad (1)$$

The ZERO level of input NAND gates IC_A and IC_B is approximately zero volts. The ONE level voltages are all equal, and Eq. 1 reduces to

$$V_{F1} = [R_4/(R_3+R_4)]\ E\ [1+(R_2/R_1)] \quad (2)$$

$$V_{F2} = -E(R_2/R_1) \quad (3)$$

$$V_{F3} = V_{F1} - V_{F2} \quad (4)$$

where E is the ONE level input voltage of the particular NAND gate used (3.5 V to 4.0 V). The loads on IC_A and IC_B must be the same to insure that the ONE level NAND gate output voltages are equal. (Both NAND gates should be on the same chip.)

The RS (reset-set) latch ff_1 provides either A and $\overline{B}$ or B and $\overline{A}$ to the summing junctions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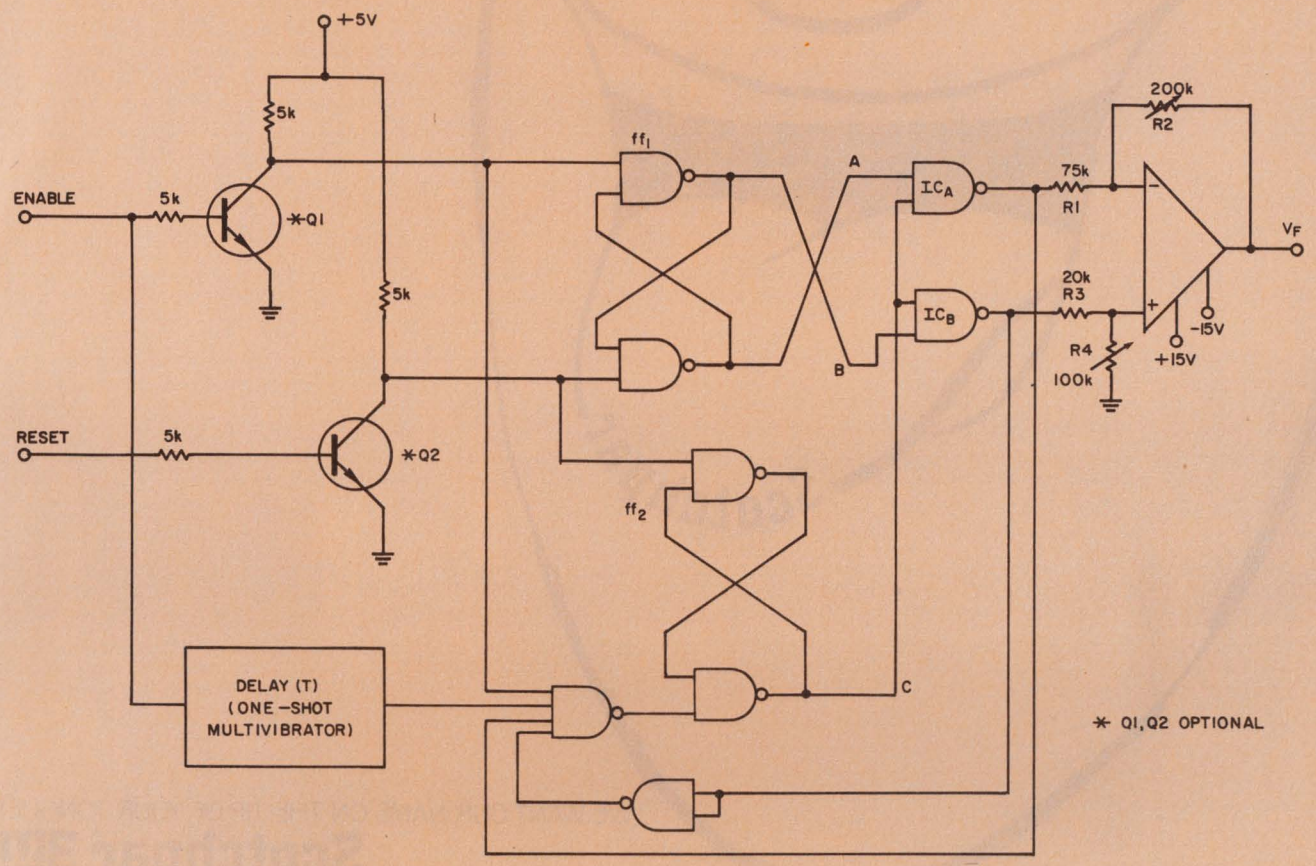
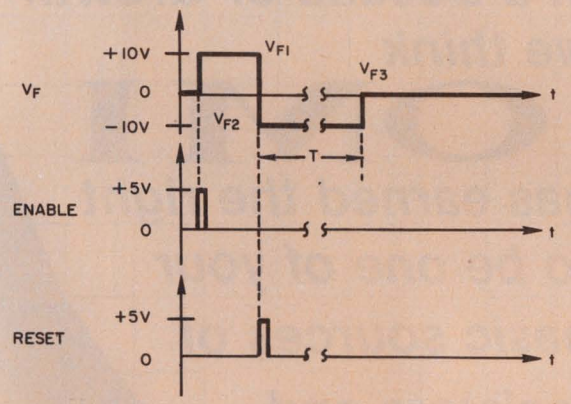


1. **Combined analog/digital circuit** provides three dc output levels.



2. **Timing diagram** illustrates the delay (T) provided by the one-shot multivibrator.

of the op-amp. Output C of RS latch ff_2 is normally high once reset has occurred. This allows the input voltages E_1 and E_2 to assume the logic level of their respective NAND gates governed by the inputs AC and BC, according to the truth table.

TRUTH TABLE

Mode	A	B	C	E_1	E_2	Output
Reset	1	0	1	0	1	V_{f1}
Enable	0	1	1	1	0	V_{f2}
Enable + Time Delay	0	1	0	1	1	V_{f3}

The delay circuit used can be any one-shot multivibrator. For the circuit shown, a discrete component one-shot was used due to the long delay required.

The response time of this circuit is equal to the longest path length through the logic, plus the op-amp slew rate. Since the gates need less than 50 ns each to operate, the circuit response time can be considered equivalent to that of the operational amplifier used. An extension of this concept is summing more than two voltages at the op-amp input. This would result in a very elaborate analog output signal. This analog signal can be generated easily, demonstrating the usefulness of combined digital and analog techniques.

Wayne T. Armstrong, Design Engineer, Hughes Aircraft Co., Canoga Park, Calif.

VOTE FOR 314

VOTE! Go through all Idea-for-Design entries, select the best, and circle the appropriate number on the Reader-Service-Card.

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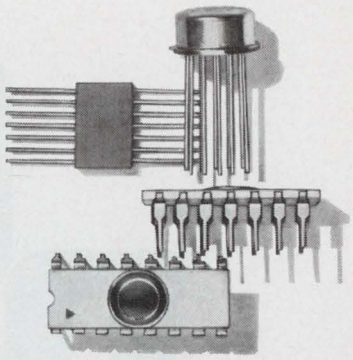
RCA's expanding COS/MOS line.



Circuit designers and component engineers, in increasing number, are taking advantage of the unique performance features of RCA COS/MOS IC's. They are attracted by the immediate availability of production quantities and the economics of these devices; and RCA's continued leadership in expanding the number of circuit types in this exciting line. Today, there are COS/MOS IC's to satisfy most of your commercial, industrial, aerospace and military logic-system design requirements.

Look at these COS/MOS IC advantages:

- ☐ Extremely low quiescent power dissipation
  gates—P_T=10 nW/pkg (typ) @ V_{DD}=10 V
  MSI circuits—P_T=5 μW (typ) @ V_{DD}=10 V
- ☐ Speed
  gates—propagation delay (t_{pd})=50 ns (typ) @ V_{DD}=10 V, C_L=15 pF
  MSI circuits—clock pulse frequency (f_{CL})=2.5 MHz (typ) @ V_{DD}=10 V
- ☐ Excellent dc and dynamic noise immunity—4.5 V (typ) @ V_{DD}=10 V
- ☐ High dc fanout (e.g. > 50)
- ☐ Simple circuit and subsystem design
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- ☐ Operation from one unregulated power supply—6 to 15 V
- ☐ Full military operating-temperature range—−55°C to +125°C
- ☐ Stable performance over wide ranges of supply voltage and temperature

They all add up to a big plus for circuit engineers: lower system design and production costs.

For further information on COS/MOS integrated circuits, see your local RCA Representative or RCA Distributor. Ask for the following COS/MOS application information: "Counters and Registers", ST 4166; "Noise Immunity", ICAN 6176; "Astable and Monostable Oscillator Designs", ICAN 6267; "COS/MOS Reliability", RIC 101. Or write: RCA Electronic Components, Commercial Engineering, Sec. ICG4-2/CD34, Harrison, N. J. 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

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CD4007	CD4007D	Dual complementary pair plus inverter	4.00	3.00
CD4011	**CD4011D**	**Quad 2-input NAND**	**5.75**	**4.75**
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CD4004	— *CD4004T	7-stage ripple counter/freq. divider	11.00	— 10.00
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—	**CD4008D**	**4-bit full adder with parallel carry out**	—	**16.00**

*TO-5 package
(COS/MOS IC's listed in bold-face type are recent additions to the line.)

RCA Integrated Circuits

INFORMATION RETRIEVAL NUMBER 82

The Great Debate:

Custom Power Supplies vs. Standard

Custom power supplies offer you precise performance, precise interface and high efficiency. Added up, that means total guaranteed *system* reliability with discs, drums, logic, displays, etc. for computers, printers, data terminals and all the other peripherals we've designed supplies for. It can also mean special size, weight and integrated shape, to fit within the available space.

Custom supplies mean a lower price, too, compared to off-the-shelf modular units, and you can have features like automatic sequencing, AC failure sensing, reverse temperature compensation, and under and over-voltage sensing, among others, that are not available with the "standard" supplies.

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The irrefutable evidence leads to an "aye" vote for Hi-G Custom Power Supplies. But on the other hand: when the demand is widespread for Hi-G Custom Power Supplies, they become "the standard." All those in favor... return the attached card.

Hi G

Hi-G Incorporated
Electronic Products Division
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Windsor Locks, Conn. 06096

INFORMATION RETRIEVAL NUMBER 83


CUSTOM
POWER
SUPPLIES

Product Source Directory

AC Power Supplies and Special Purpose DC Power Supplies

This Product Source Directory covers AC Power Supplies and Special Purpose DC Power Supplies. Special purpose power supplies are in two categories, Voltage Reference and Klystron. It contains products frequently purchased by design engineers.

For each table, the instruments are listed in ascending order of one major parameter. The column containing this parameter is color-coded white. An index of models by manufacturer is included at the end of each table. Manufacturers are identified by abbreviation. The complete name of each manufacturer can be found in the Master Cross Index below.

An Addendum to dc power supplies is located on p. 131.

AC Power Supplies

Abbrev.	Company	Reader Service No.
Behl-Invar	Behlman Division California Instrument Corp. 3511 Midway Dr. San Diego, Calif. 92110 (714) 224-3241	439
CML	CML Inc. Sub. Tenney Engineering 350 Leland Ave. Plainfield, N.J. 07062 (201) 754-5502	440
EDC	Electronic Development Corp. 11 Hamlin St. Boston, Mass. 02127 (617) 268-9696	441
Elgar	Elgar Corp. 8159 Engineer Rd. San Diego, Calif. 92111 (714) 279-0800	442
ERA	Electronic Research Associates 67 Sand Park Rd. Cedar Grove, N.J. 07009 (201) 239-3000	443
GE	General Electric Co. Specialty Transformer Dept. Fort Wayne, Ind. (219) 743-7431	444
Ind Test	Industrial Test Equipment Co. 20 Beechwood Ave. Port Washington, N.Y. 11050 (516) 767-5253	445
Lambda	Lambda Electronics 515 Broad Hollow Rd. Melville, N.Y. 11746 (516) MY 4-4200	446
NJE	NJE Corp. 20 Boright Ave. Kenilworth, N.J. 07033 (201) 272-6000	447
North Hills	North Hills Electronics Alexander Pl. Glen Cove, N.Y. 11542 (516) 671-5700	448
Princeton	Princeton Applied Research Corp. P.O. Box 565 Princeton, N.J. 08549 (609) 924-6835	449
RFL	RFL Industries, Inc. Communications Div. Powerville Rd. Boonton, N.J. 07005 (201) 334-3100	450
Sola	Sola Electric Div. Sola Basic Industries 1717 Busse Rd. Elk Grove Village, Ill. 60007 (312) HE 9-2800	451
Sorensen	Sorensen Operation Raytheon Co. Richards Ave. Norwalk, Conn. 06856 (203) 838-6571	452
Superior	Superior Electric Co. 383 Middle St. Bristol, Conn. 06010 (203) 582-9561	453
Tel-Inst	Tel-Instrument Electronics Group 728 Garden St. Carlstadt, N.J. 07072 (201) 933-1600	454

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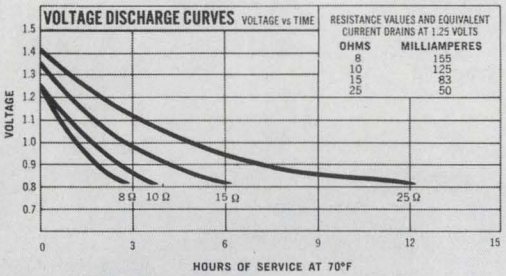

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Abbrev.	Company	Reader Service No.
EDC	Electronic Development Corp. 11 Hamlin St. Boston, Mass. 02127 (617) 268-9696	455
ERA	Electronic Research Assoc. 67 Sand Park Rd. Cedar Grove, N.J. (201) 239-3000	456
EPSCO	EPSCO Inc. 411 Providence Highway Westwood, Mass. 02090 (617) 329-1500	457
Fluke	John Fluke Mfg. Co. Box 7428 Seattle, Wash. 98133 (206) 774-2211	458
H-P	Hewlett Packard Co. 110 Locust Ave. Berkeley Heights, N.J. 07922 (201) 464-1234	459
Keithley	Keithley Instrument Corp. 28775 Aurora Rd. Cleveland, Ohio 44139 (216) 248-0400	460
Micro-Power	Micro-Power Inc. 25-14 Broadway Long Island City, N.Y. 11106 (212) 726-4060	461
Narda	Narda Microwave Corp. Commercial St. Plainview, N.Y. 11803 (516) 433-9000	462
North Hills	North Hills Electronics Alexander Pl. Glen Cove, N.Y. 11542 (516) 671-5700	463
PDP	Power Designs Pacific Miranda Ave. Palo Alto, Calif. (415) 321-6111	464
PRD	PRD Electronics, Inc. 6801 Jericho Tpke. Syosset, N.Y. 11791 (516) 364-0400	465
Power Des	Power Design 1700 Shames Dr. Westbury, N.Y. 11590 (516) 333-6200	466
RFL	RFL Industries Inc. Communications Div. Powerville Rd. Boonton, N.J. 07005 (201) 334-3100	467
Singer	The Singer Co. Ballantine Operation Box 97 Boonton, N.J. 07005 (201) 334-1432	468
Sorensen	Sorensen Operation Raytheon Co. Richards Ave. Norwalk, Conn. 06856 (203) 838-6571	469
Weston-Lex	Weston-Lexington Div. of Daystrom Inc. 17 Hartwell Ave. Lexington, Mass. 02173 (617) 861-9000	470

AC Power Supplies (Frequency Regulated, Fixed Frequency) 67

			FREQUENCY				OUTPUT								
										REGULATION					
	Manufacturer	Model	Min. Hz	Max. Hz	Accuracy %	Stability %	Min. Volts	Max. Volts	Power VA	Line %	Load %	Distortion %	Response Time	Misc Features	Price $
FF1	CML	NS570-1A	50	50	ina	±0.25	0	125	70	±0.5	±0.5	3	50 µs		reg
	CML	NS120-1A	50	50	ina	±0.25	0	125	120	±0.5	±0.5	3	50 µs		reg
	CML	T150A/SG-31A	50	50	ina	±0.25	0	217	150	±0.5	±0.5	3	50 µs		reg
	CML	NS175-1A	50	50	ina	±0.25	0	125	175	±0.5	±0.5	3	50 µs		reg
	CML	T300B/SG-31A	50	50	ina	±0.25	0	217	300	±0.5	±0.5	3	50 µs		reg
	CML	NS350-1A	50	50	ina	±0.25	0	125	350	±0.5	±0.5	3	50 µs		reg
	CML	T500B/SG-31A	50	50	ina	±0.25	0	217	500	±0.5	±0.5	3	50 µs		reg
	CML	N500A/SG-11A	50	50	ina	±0.25	0	125	500	±0.5	±0.5	3	50 µs		reg
	CML	T750A/SG-31A	50	50	ina	±0.25	0	217	750	±0.5	±0.5	3	50 µs		reg
	CML	N750B/SG-11A	50	50	ina	±0.25	0	125	750	±0.5	±0.5	3	50 µs		reg
FF2	CML	N750A/SG-11A	50	50	ina	±0.25	0	125	750	±0.5	±0.5	3	50 µs		reg
	CML	N1000A/SG-11A	50	50	ina	±0.25	0	125	1000	±0.5	±0.5	3	50 µs		reg
	CML	T1200A/SG-31A	50	50	ina	±0.25	0	217	1200	±0.5	±0.5	3	50 µs		reg
	CML	N1500A/SG-11A	50	50	ina	±0.25	0	125	1500	±0.5	±0.5	3	50 µs		reg
	CML	T1750A/SG-31A	50	50	ina	±0.25	0	217	1750	±0.5	±0.5	3	50 µs		reg
	CML	N2000A/SG-11A	50	50	ina	±0.25	0	125	2000	±0.5	±0.5	3	50 µs		reg
	CML	T2500A/SG-31A	50	50	ina	±0.25	0	217	2500	±0.5	±0.5	3	50 µs		reg
	CML	N5000A/SG-11A	50	50	ina	±0.25	0	125	5000	±0.5	±0.5	3	50 µs		reg
	CML	T5000A/SG-31A	50	50	ina	±0.25	0	217	5000	±0.5	±0.5	3	50 µs		reg
	CML	NS70-2A	60	60	ina	±0.25	0	125	70	±0.5	±0.5	3	50 µs		reg
FF3	Ind Test	80S-1-B	60	60	0.1	0.1	0	260	80	0.1	0.5	0.3	50 µs	v	reg
	CML	NS120-2A	60	60	ina	±0.25	0	125	120	±0.5	±0.5	3	50 µs		reg
	CML	T150A/SG-32A	60	60	ina	±0.25	0	217	150	±0.5	±0.5	3	50 µs		reg
	CML	NS175-2A	60	60	ina	±0.25	0	125	175	±0.5	±0.5	3	50 µs		reg
	Ind Test	250S-1-B	60	60	0.1	0.1	0	260	250	0.1	0.5	0.2	50 µs	v	reg
	CML	T300B/SG-32A	60	60	ina	±0.25	0	217	300	±0.5	±0.5	3	50 µs		reg
	CML	NS350-2A	60	60	ina	±0.25	0	125	350	±0.5	±0.5	3	50 µs		reg
	CML	T500B/SG-32A	60	60	ina	±0.25	0	217	500	±0.5	±0.5	3	50 µs		reg
	CML	N500A/SG-12A	60	60	ina	±0.25	0	125	500	±0.5	±0.5	3	50 µs		reg
	CML	T750A/SG-32A	60	60	ina	±0.25	0	217	750	±0.5	±0.5	3	50 µs		reg
FF4	CML	N750A/SG-12A	60	60	ina	±0.25	0	125	750	±0.5	±0.5	3	50 µs		reg
	CML	N750B/SG-12A	60	60	ina	±0.25	0	125	750	±0.5	±0.5	3	50 µs		reg
	Ind Test	1000S-1-B	60	60	0.1	0.1	0	300	1000	0.1	0.5	0.4	50 µs	v	reg
	CML	N1000A/SG-12A	60	60	ina	±0.25	0	125	1000	±0.5	±0.5	3	50 µs		reg
	CML	T1200A/SG-32A	60	60	ina	±0.25	0	217	1200	±0.5	±0.5	3	50 µs		reg
	Ind Test	1500S-1-B	60	60	0.1	0.1	0	300	1500	0.1	0.5	0.4	50 µs	v	reg
	CML	N1500A/SG-12A	60	60	ina	±0.25	0	125	1500	±0.5	±0.5	3	50 µs		reg
	CML	T1750A/SG-32A	60	60	ina	±0.25	0	217	1750	±0.5	±0.5	3	50 µs		reg
	CML	N2000A/SG-12A	60	60	ina	±0.25	0	125	2000	±0.5	±0.5	3	50 µs		reg
	CML	T2500A/SG-32A	60	60	ina	±0.25	0	217	2500	±0.5	±0.5	3	50 µs		reg
FF5	CML	T5000A/SG-32A	60	60	ina	±0.25	0	217	5000	±0.5	±0.5	3	50 µs		reg
	CML	N5000A/SG-12A	60	60	ina	±0.25	0	125	5000	±0.5	±0.5	3	50 µs		reg
	ERA	IT256RS	57	62	1	1	105	135	50	±1	±1	6	50 µs	b	235
	ERA	IT2106RS	57	62	1	1	105	135	100	±1	±1	6	50 µs	b	260
	ERA	IT2256RS	57	62	1	1	105	135	250	±1	±1	6	50 µs	b	340
	CML	LRS-250A	57	63	ina	±0.5	105	125	250	±0.5	±0.5	3	ina		reg
	CML	LRS-500A	57	63	ina	±0.5	105	125	500	±0.5	±0.5	3	ina		reg
	CML	LRS-1000A	57	63	ina	±0.5	105	125	1000	±0.5	±0.5	3	ina		reg
	Behl-Invar	1503T	45	400	0.1	0.001	0	130	120	±0.5	1	1	ina	a	reg
	Behl-Invar	123A	45	400	0.1	0.001	0	130	120	±0.5	1	1	ina	a	reg
FF6	Behl-Invar	161A	45	400	0.1	0.001	0	130	120	±0.5	1	1	ina	a	reg
	Behl-Invar	753T	45	400	0.1	0.001	0	130	120	±0.5	1	1	ina	a	reg
	Behl-Invar	251T	45	400	0.1	0.001	0	130	250	±0.05	1	1	ina	a	reg
	Behl-Invar	503A	45	400	0.1	0.001	0	130	500	±0.5	1	1	ina	a	reg
	Behl-Invar	351A	45	400	0.1	0.001	0	130	500	±0.5	1	1	ina	a	reg
	Behl-Invar	501T	45	400	0.1	0.001	0	130	500	±0.05	1	1	ina	a	reg
	Behl-Invar	751A	45	400	0.1	0.001	0	130	750	±0.5	1	1	ina	a	reg
	Behl-Invar	1501A	45	400	0.0	0.001	0	130	1500	±0.5	1	1	ina	a	reg
	Behl-Invar	2253B	45	400	0.1	0.001	0	130	2250	±0.5	1	1	ina	a	reg
	Behl-Invar	5001A	45	400	0.1	0.001	0	1300	5000	±0.5	1	1	ina	a	reg
FF7	CML	NS70-4A	400	400	ina	±0.25	0	125	70	±0.5	±0.5	1	50 µs		reg
	Ind Test	80S-1-A	400	400	0.1	0.1	0	260	80	0.1	0.5	0.3	50 µs	v	reg
	CML	NS120-4A	400	400	ina	±0.25	0	125	120	±0.5	±0.5	1	50 µs		reg
	CML	T150A/SG-34A	400	400	ina	±0.25	0	217	150	±0.5	±0.5	1	50 µs		reg
	CML	NS175-4A	400	400	ina	±0.25	0	125	175	±0.5	±0.5	1	50 µs		reg
	Ind Test	250S-1-A	400	400	0.1	0.1	0	260	250	0.1	0.5	0.2	50 µs	v	reg
	CML	T300B/SG-34A	400	400	ina	±0.25	0	217	300	±0.5	±0.5	1	50 µs		reg
	CML	NS350-4A	400	400	ina	±0.25	0	125	350	±0.5	±0.5	1	50 µs		reg
	CML	T500B/SG-34A	400	400	ina	±0.25	0	217	500	±0.5	±0.5	1	50 µs		reg
	CML	N500A/SG-14A	400	400	ina	±0.25	0	125	500	±0.5	±0.5	1	50 µs		reg
FF8	CML	T750A/SG-34A	400	400	ina	±0.25	0	217	750	±0.5	±0.5	1	50 µs		reg
	CML	N750A/SG-14A	400	400	ina	±0.25	0	125	750	±0.5	±0.5	1	50 µs		reg
	CML	N750B/SG-14A	400	400	ina	±0.25	0	125	750	±0.5	±0.5	1	50 µs		reg
	Ind Test	1000S-1-A	400	400	0.1	0.1	0	300	1000	0.1	0.5	0.4	50 µs	v	reg

AC Power Supplies (Frequency Regulated, Fixed Frequency) 68

			FREQUENCY				OUTPUT								
										REGULATION					
	Manufacturer	Model	Min. Hz	Max. Hz	Accuracy %	Stability %	Min. Volts	Max. Volts	Power VA	Line %	Load %	Distortion %	Response Time	Misc Features	Price $
F F 9	CML	N1000A/SG-14A	400	400	ina	±0.25	0	125	1000	±0.5	±0.5	1	50 µs		reg
	CML	T1200A/SG-34A	400	400	ina	±0.25	0	217	1200	±0.5	±0.5	1	50 µs		reg
	Ind Test	1500S-1-A	400	400	0.1	0.1	0	300	1500	0.1	0.5	0.4	50 µs	v	reg
	CML	N1500A/SG-14A	400	400	ina	±0.25	0	125	1500	±0.5	±0.5	1	50 µs		reg
	CML	T1750A/SG-34A	400	400	ina	±0.25	0	217	1750	±0.5	±0.5	1	50 µs		reg
	CML	N2000A/SG-14A	400	400	ina	±0.25	0	125	2000	±0.5	±0.5	1	50 µs		reg
	CML	T2500A/SG-34A	400	400	ina	±0.25	0	217	2500	±0.5	±0.5	1	50 µs		reg
	CML	T5000A/SG-34A	400	400	ina	±0.25	0	217	5000	±0.5	±0.5	1	50 µs		reg
	CML	N5000A/SG-14A	400	400	ina	±0.25	0	125	5000	±0.5	±0.5	1	50 µs		reg
	CML	T15000A/SG-34A	400	400	ina	±0.25	0	217	15K	±0.5	±0.5	1	50 µs		reg
F F 10	CML	N15000A/SG-14A	400	400	ina	±0.25	0	125	15K	±0.5	±0.5	1	50 µs		reg
	CML	T20000A/SG-34A	400	400	ina	±0.25	0	217	20K	±0.5	±0.5	1	50 µs		reg
	CML	CRS-50A	380	420	ina	±0.5	105	125	50	±0.5	±0.5	1	ina		reg
	ERA	IT259RS	380	420	1	1	105	135	50	±1	±1	6	50 µs	b	240
	CML	CRS-100A	380	420	ina	±0.5	105	125	100	±0.5	±0.5	1	ina		reg
	ERA	IT2104RS	380	420	1	1	105	135	100	±1	±1	6	50 µs	b	275
	CML	CRS-150A	380	420	ina	±0.5	105	125	150	±0.5	±0.5	1	ina		reg
	ERA	IT2254RS	380	420	1	1	105	135	250	±1	±1	6	50 µs	b	365
	CML	CRS-250A	380	420	ina	±0.5	105	125	250	±0.5	±0.5	1	ina		reg
	CML	CRS-500A	380	420	ina	±0.5	105	125	500	±0.5	±0.5	1	ina		reg
F F 11	CML	CRS-1000A	380	420	ina	±0.5	105	125	1000	±0.5	±0.5	1	ina		reg
	CML	CRS-2000A	380	420	ina	±0.5	105	125	2000	±0.5	±0.5	1	ina		reg
	CML	NS70-8A	800	800	ina	±0.25	0	125	70	±0.5	±0.5	1	50 µs		reg
	CML	NS120-8A	800	800	ina	±0.25	0	125	120	±0.5	±0.5	1	50 µs		reg
	CML	T150A/SG-38A	800	800	ina	±0.25	0	217	150	±0.5	±0.5	1	50 µs		reg
	CML	NS175-8A	800	800	ina	±0.25	0	125	175	±0.5	±0.5	1	50 µs		reg
	CML	T300B/SG-38A	800	800	ina	±0.25	0	217	300	±0.5	±0.5	1	50 µs		reg
	CML	NS350-8A	800	800	ina	±0.25	0	125	350	±0.5	±0.5	1	50 µs		reg
	CML	T500B/SG-38A	800	800	ina	±0.25	0	217	500	±0.5	±0.5	1	50 µs		reg
	CML	N500A/SG-18A	800	800	ina	±0.25	0	125	500	±0.5	±0.5	1	50 µs		reg
F F 12	CML	T750A/SG-38A	800	800	ina	±0.25	0	217	750	±0.5	±0.5	1	50 µs		reg
	CML	N750A/SG-18A	800	800	ina	±0.25	0	125	750	±0.5	±0.5	1	50 µs		reg
	CML	N750B/SG-18A	800	800	ina	±0.25	0	125	750	±0.5	±0.5	1	50 µs		reg
	CML	N1000A/SG-18A	800	800	ina	±0.25	0	125	1000	±0.5	±0.5	1	50 µs		reg
	CML	T1200A/SG-38A	800	800	ina	±0.25	0	217	1200	±0.5	±0.5	1	50 µs		reg
	CML	N1500A/SG-18A	800	800	ina	±0.25	0	125	1500	±0.5	±0.5	1	50 µs		reg
	CML	T1750A/SG-38A	800	800	ina	±0.25	0	217	1750	±0.5	±0.5	1	50 µs		reg
	CML	N2000A/SG-18A	800	800	ina	±0.25	0	125	2000	±0.5	±0.5	1	50 µs		reg
	CML	T2500A/SG-38A	800	800	ina	±0.25	0	217	2500	±0.5	±0.5	1	50 µs		reg
	CML	T5000A/SG-38A	800	800	ina	±0.25	0	217	5000	±0.5	±0.5	1	50 µs		reg
F F 13	CML	N5000A/SG-18A	800	800	ina	±0.25	0	125	5000	±0.5	±0.5	1	50 µs		reg
	CML	N15000A/SG-18A	800	800	ina	±0.25	0	125	15K	±0.5	±0.5	1	50 µs		reg
	RFL	829G	50	1000	5	1	0	1000	30W	0.05	n/a	0.04	n/a		3100
	Tel-Inst	4030A-3	50	4000	0.001	0.001	90	130	100	0.5	0.1	1	ina	awx	reg
	Tel-Inst	4025B-1	50	4000	0.001	0.001	90	130	250	0.5	0.1	1	ina	awx	reg
	Tel-Inst	4050-1	50	4000	0.001	0.001	90	130	500	0.5	0.1	1	ina	awx	reg
	Tel-Inst	4100-1	50	4000	0.001	0.001	90	130	1000	0.5	0.1	1	ina	awx	reg
	Tel-Inst	4250-1	50	4000	0.001	0.001	90	130	2500	0.5	0.1	1	ina	awx	reg
	Tel-Inst	4500-1	50	4000	0.001	0.001	90	130	5000	0.5	0.1	1	ina	awx	reg
	Elgar	600-3	45	5000	0.1	0.025	0	260	200	0.25	0.25	0.5	50 µs	a	1820
F F 14	Elgar	400-1	45	5000	0.1	0.025	0	520	400	0.25	0.25	0.5	50 µs	ar	1205
	Elgar	1503	45	5000	0.1	0.025	0	130	500	0.25	0.25	0.5	50 µs	a	3050
	Elgar	501	45	5000	0.1	0.025	0	260	500	0.25	0.25	0.5	50 µs	a	1380
	Elgar	1500-3	45	5000	0.1	0.025	0	260	500	0.25	0.25	0.5	50 µs	a	4190
	Elgar	751	45	5000	0.1	0.025	0	260	750	0.25	0.25	0.5	50 µs	a	1800
	Elgar	2250-3	45	5000	0.1	0.025	0	260	750	0.25	0.25	0.5	50 µs	a	5450
	Elgar	1000-1	45	5000	0.1	0.025	0	520	1000	0.25	0.25	0.5	50 µs	ar	2875
	Elgar	1001	45	5000	0.1	0.025	0	260	1000	0.25	0.25	0.5	50 µs	a	2250
	Elgar	3000-3	45	5000	0.1	0.025	0	260	1000	0.25	0.25	0.5	50 µs	a	6800
	Elgar	1500-1	45	5000	0.1	0.025	0	520	1500	0.25	0.25	0.5	50 µs	ar	3625
F F 15	Elgar	1501	45	5000	0.1	0.025	0	260	1500	0.25	0.25	0.5	50 µs	a	3050
	Elgar	4500-3	45	5000	0.1	0.025	0	260	1500	0.25	0.25	0.5	50 µs	a	8975
	Elgar	2000-1	45	5000	0.1	0.025	0	520	2000	0.25	0.25	0.5	50 µs	ar	4525
	Elgar	6000-3	45	5000	0.1	0.025	0	260	2000	0.25	0.25	0.5	50 µs	a	13600
	Elgar	9000-3	45	5000	0.1	0.025	0	260	3000	0.25	0.25	0.5	50 µs	a	16625
	Elgar	3000-1	45	5000	0.1	0.025	0	520	3000	0.25	0.25	0.5	50 µs	ar	6125
	Elgar	153	350	10K	0.1	0.025	0	520	150	0.25	0.25	0.5	50 µs	ar	1050
	Elgar	201	45	10K	0.1	0.025	0	260	200	0.25	0.25	0.5	50 µs	a	590
	Ind Test	80S-1-C	10	20K	0.1	0.1	0	260	80	0.1	0.5	0.3	50 µs	av	reg
	Ind Test	80S-1-D	10	20K	0.01	0.001	0	260	80	0.1	0.5	0.3	50 µs	av	reg
F F 16	Ind Test	80S-1-E	10	20K	0.001	0.0001	0	260	80	0.1	0.5	0.3	50 µs	av	reg
	Ind Test	250S-1-E	10	20K	0.001	0.0001	0	260	250	0.1	0.5	0.2	50 µs	av	reg
	Ind Test	250S-1-D	10	20K	0.01	0.001	0	260	250	0.1	0.5	0.2	50 µs	av	reg
F F 17	Ind Test	250S-1-C	10	20K	0.1	0.1	0	260	250	0.1	0.5	0.2	50 µs	av	reg
	Ind Test	1000S-1-E	10	20K	0.001	0.0001	0	300	1000	0.1	0.5	0.4	50 µs	av	reg
	Ind Test	1000S-1-D	10	20K	0.01	0.001	0	300	1000	0.1	0.5	0.4	50 µs	av	reg
	Ind Test	1000S-1-C	10	20K	0.1	0.1	0	300	1000	0.1	0.5	0.4	50 µs	av	reg
	Ind Test	1500S-1-D	10	20K	0.01	0.001	0	300	1500	0.1	0.5	0.5	50 µs	av	reg
	Ind Test	1500S-1-C	10	20K	0.1	0.1	0	300	1500	0.1	0.5	0.4	50 µs	av	reg
	Ind Test	1500S-1-E	10	20K	0.001	0.0001	0	300	1500	0.1	0.5	0.4	50 µs	av	reg

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			FREQUENCY				OUTPUT								
										REGULATION					
	Manufacturer	Model	Min. Hz	Max. Hz	Accuracy %	Stability %	Min. Volts	Max. Volts	Power VA	Line %	Load %	Distortion %	Response Time	Misc Features	Price $
AF1	Behl-Invar	123A	45	60	0.1	0.05	0	130	120	±0.5	1	1	ina		reg
	Behl-Invar	161A	45	60	0.1	0.05	0	130	120	±0.5	1	1	ina		reg
	Behl-Invar	351A	45	60	0.1	0.05	0	130	350	±0.5	1	1	ina		reg
	Behl-Invar	503A	45	60	0.1	0.05	0	130	500	±0.5	1	1	ina		reg
	Behl-Invar	751A	45	60	0.1	0.05	0	130	750	±0.5	1	1	ina		reg
	Behl-Invar	1501A	45	60	0.1	0.05	0	130	1500	±0.5	1	1	ina		reg
	Behl-Invar	2253B	45	60	0.1	0.05	0	130	2250	±0.5	1	1	ina		reg
	Behl-Invar	5001A	45	60	0.1	0.05	0	1300	5000	±0.5	1	1	ina		reg
	Behl-Invar	251T	45	65	0.1	0.05	0	130	250	±0.05	1	1	ina		reg
	Behl-Invar	501T	45	65	0.1	0.05	0	130	500	±0.05	1	1	ina		reg
AF2	CML	T500B/SG-33A	47	65	ina	±0.25	0	217	500	±0.5	±0.5	3	50 µs		reg
	Behl-Invar	753T	45	65	0.1	0.05	0	130	750	0.05	1	1	ina		reg
	Behl-Invar	1503T	45	65	0.1	0.05	0	130	1500	0.05	1	1	ina		reg
	CML	NS70-3A	45	70	ina	±0.25	0	125	70	±0.5	±0.5	3	50 µs		reg
	CML	NS120-3A	45	70	ina	±0.25	0	125	120	±0.5	±0.5	3	50 µs		reg
	CML	T150A/SG-33A	45	70	ina	±0.25	0	217	150	±0.5	±0.5	3	50 µs		reg
	CML	NS175-3A	45	70	ina	±0.25	0	125	175	±0.5	±0.5	3	50 µs		reg
	CML	T300B/SG-33A	45	70	ina	±0.25	0	217	300	±0.5	±0.5	3	50 µs		reg
	CML	NS350-3A	45	70	ina	±0.25	0	125	350	±0.5	±0.5	3	50 µs		reg
	CML	N500A/SG-13A	45	70	ina	±0.25	0	125	500	±0.5	±0.5	3	50 µs		reg
AF3	CML	T750A/SG-33A	45	70	ina	±0.25	0	217	750	±0.5	±0.5	3	50 µs		reg
	CML	N750B/SG-13A	45	70	ina	±0.25	0	125	750	±0.5	±0.5	3	50 µs		reg
	CML	N750A/SG-13A	45	70	ina	±0.25	0	125	750	±0.5	±0.5	3	50 µs		reg
	CML	N1000A/SG-13A	45	70	ina	±0.25	0	125	1000	±0.5	±0.5	3	50 µs		reg
	CML	T1200A/SG-33A	45	70	ina	±0.25	0	217	1200	±0.5	±0.5	3	50 µs		reg
	CML	N1500A/SG-13A	45	70	ina	±0.25	0	125	1500	±0.5	±0.5	3	50 µs		reg
	CML	T1750A/SG-33A	45	70	ina	±0.25	0	217	1750	±0.5	±0.5	3	50 µs		reg
	CML	N2000A/SG-13A	45	70	ina	±0.25	0	125	2000	±0.5	±0.5	3	50 µs		reg
	CML	T2500A/SG-33A	45	70	ina	±0.25	0	217	2500	±0.5	±0.5	3	50 µs		reg
	CML	T5000A/SG-33A	45	70	ina	±0.25	0	217	5000	±0.5	±0.5	3	50 µs		reg
AF4	CML	N5000A/SG-13A	45	70	ina	±0.25	0	125	5000	±0.5	±0.5	3	50 µs		reg
	Ind Test	80S-1-L	10	100	1	0.2	0	260	80	0.1	0.5	0.3	50 µs	v	reg
	Ind Test	250S-1-L	10	100	1	0.2	0	260	250	0.1	0.5	0.3	50 µs	v	reg
	Ind Test	1000S-1-L	10	100	1	0.2	0	300	1000	0.1	0.5	0.5	50 µs	v	reg
	Ind Test	1500S-1-L	10	100	1	0.2	0	300	1500	0.1	0.5	0.5	50 µs	v	reg
	Behl-Invar	1503T	45	400	0.1	±0.05	0	130	120	±0.5	1	1	ina		reg
	Behl-Invar	753T	45	400	0.1	±0.05	0	130	120	±0.5	1	1	ina		reg
	Behl-Invar	161A	45	400	0.1	0.05	0	130	120	±0.5	1	1	ina		reg
	Behl-Invar	123A	45	400	0.1	0.05	0	130	120	±0.5	1	1	ina		reg
	Behl-Invar	251T	45	400	0.1	0.05	0	130	250	±0.05	1	1	ina		reg
AF5	Behl-Invar	351A	45	400	0.1	0.05	0	130	500	±0.5	1	1	ina		reg
	Behl-Invar	503A	45	400	0.1	0.05	0	130	500	±0.5	1	1	ina		reg
	Behl-Invar	501T	45	400	0.1	0.05	0	130	500	±0.05	1	1	ina		reg
	Behl-Invar	751A	45	400	0.1	0.05	0	130	750	±0.5	1	1	ina		reg
	Behl-Invar	1501A	45	400	0.1	0.05	0	130	1500	±0.5	1	1	ina		reg
	Behl-Invar	2253B	45	400	0.1	0.05	0	130	2250	±0.5	1	1	ina		reg
	Behl-Invar	5001A	45	400	0.1	0.05	0	1300	5000	±0.5	1	1	ina		reg
	NJE	TFC-26-100	380	420	±0.5	0.2	24	30	100	±0.5	±4	5	30 ms		420
	NJE	TFC-115-100	380	420	±0.5	0.2	105	130	100	±0.5	±1	5	30 ms		410
	NJE	TFC-26-200	380	420	±0.5	0.2	24	30	200	±0.5	±4	5	30 ms		640
AF6	NJE	TFC-115-200	380	420	±0.5	0.2	105	130	200	±0.5	±1	5	30 ms		630
	NJE	FC-26-500	380	420	±0.25	0.2	24	30	500	±0.5	±4	5	100 ms		1180
	NJE	FC-115-500	380	420	±0.25	0.2	95	135	500	±0.5	±1	5	100 ms		1120
	NJE	FC-115-1000	380	420	±0.25	0.2	95	135	1000	±0.5	±1	5	100 ms		1920
	CML	NS70-5A	350	450	ina	±0.25	0	125	70	±0.5	±0.5	1	50 µs		reg
	Ind Test	80S-1-N	350	450	0.25	0.1	0	260	80	0.1	0.5	0.1	50 µs	v	reg
	CML	NS120-5A	350	450	ina	±0.25	0	125	120	±0.5	±0.5	1	50 µs		reg
	CML	T150A/SG-35A	350	450	ina	±0.25	0	217	150	±0.5	±0.5	1	50 µs		reg
	CML	NS175-5A	350	450	ina	±0.25	0	125	175	±0.5	±0.5	1	50 µs		reg
	Ind Test	250S-1-N	350	450	0.25	0.1	0	260	250	0.1	0.5	0.2	50 µs	v	reg
AF7	CML	T300B/SG-35A	350	450	ina	±0.25	0	217	300	±0.5	±0.5	1	50 µs		reg
	CML	NS350-5A	350	450	ina	±0.25	0	125	350	±0.5	±0.5	1	50 µs		reg
	CML	T500B/SG-35A	350	450	ina	±0.25	0	217	500	±0.5	±0.5	1	50 µs		reg
	CML	N500A/SG-15A	350	450	ina	±0.25	0	125	500	±0.5	±0.5	1	50 µs		reg
	CML	N750B/SG-15A	350	450	ina	±0.25	0	125	750	±0.5	±0.5	1	50 µs		reg
	CML	T750A/SG-35A	350	450	ina	±0.25	0	217	750	±0.5	±0.5	1	50 µs		reg
	CML	N750A/SG-15A	350	450	ina	±0.25	0	125	750	±0.5	±0.5	1	50 µs		reg
	Ind Test	1000S-1-N	350	450	0.25	0.1	0	300	1000	0.1	0.5	0.4	50 µs	v	reg
	CML	N1000A/SG-15A	350	450	ina	±0.25	0	125	1000	±0.5	±0.5	1	50 µs		reg
	CML	T1200A/SG-35A	350	450	ina	±0.25	0	217	1200	±0.5	±0.5	1	50 µs		reg
AF8	Ind Test	1500S-1-N	350	450	0.25	0.1	0	300	1500	0.1	0.5	0.4	50 µs	v	reg
	CML	N1500A/SG-15A	350	450	ina	±0.25	0	125	1500	±0.5	±0.5	1	50 µs		reg
	CML	T1750A/SG-35A	350	450	ina	±0.25	0	217	1750	±0.5	±0.5	1	50 µs		reg

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			FREQUENCY				OUTPUT								
										REGULATION					
	Manufacturer	Model	Min. Hz	Max. Hz	Accuracy %	Stability %	Min. Volts	Max. Volts	Power VA	Line %	Load %	Distortion %	Response Time	Misc Features	Price $
AF9	CML	N2000A/SG-15A	350	450	ina	±0.25	0	125	2000	±0.5	±0.5	1	50 µs		reg
	CML	T2500A/SG-35A	350	450	ina	±0.25	0	217	2500	±0.5	±0.5	1	50 µs		reg
	CML	T5000A/SG-35A	350	450	ina	±0.25	0	217	5000	±0.5	±0.5	1	50 µs		reg
	CML	N5000A/SG-15A	350	450	ina	±0.25	0	125	5000	±0.5	±0.5	1	50 µs		reg
	CML	T15000A/SG-35A	350	450	ina	±0.25	0	217	15K	±0.5	±0.5	1	50 µs		reg
	CML	N15000A/SG-15A	350	450	ina	±0.25	0	125	15K	±0.5	±0.5	1	50 µs		reg
	CML	T20000A/SG-35A	350	450	ina	±0.25	0	217	20K	±0.5	±0.5	1	50 µs		reg
	Ind Test	80S-1-P	300	500	0.25	0.1	0	260	80	0.1	0.5	0.1	50 µs	v	reg
	Ind Test	250S-1-P	300	500	0.25	0.1	0	260	250	0.1	0.5	0.2	50 µs	v	reg
	Ind Test	1000S-1-P	300	500	0.25	0.1	0	300	1000	0.1	0.5	0.4	50 µs	v	reg
AF10	Ind Test	1500S-1-P	300	500	0.25	0.1	0	300	1500	0.1	0.5	0.4	50 µs	v	reg
	RFL	829G	50	1000	5	1	0	1000	30W	0.05	n/a	0.04	n/a		3100
	Ind Test	80S-1-M	100	1000	1	0.2	0	260	80	0.1	0.5	0.3	50 µs	v	reg
	Ind Test	250S-1-M	100	1000	1	0.2	0	260	250	0.1	0.5	0.3	50 µs	v	reg
	Ind Test	1000S-1-M	100	1000	1	0.2	0	300	1000	0.1	0.5	0.5	50 µs	v	reg
	Ind Test	1500S-1-M	100	1000	1	0.2	0	300	1500	0.1	0.5	0.5	50 µs	v	reg
	CML	NS70-6A	300	2000	ina	±0.25	0	125	70	±0.5	±0.5	2	50 µs		reg
	CML	NS120-6A	300	2000	ina	±0.25	0	125	120	±0.5	±0.5	2	50 µs		reg
	CML	T150A/SG-36A	300	2000	ina	±0.25	0	217	150	±0.5	±0.5	2	50 µs		reg
	CML	NS175-6A	300	2000	ina	±0.25	0	125	175	±0.5	±0.5	2	50 µs		reg
	CML	T300B/SG-36A	300	2000	ina	±0.25	0	217	300	±0.5	±0.5	2	50 µs		reg
AF11	CML	NS350-6A	300	2000	ina	±0.25	0	125	350	±0.5	±0.5	2	50 µs		reg
	CML	N500A/SG-16A	300	2000	ina	±0.25	0	125	500	±0.5	±0.5	2	50 µs		reg
	CML	T500B/SG-36A	300	2000	ina	±0.25	0	217	500	±0.5	±0.5	1	50 µs		reg
	CML	N750A/SG-16A	300	2000	ina	±0.25	0	125	750	±0.5	±0.5	2	50 µs		reg
	CML	N750B/SG-16A	300	2000	ina	±0.25	0	125	750	±0.5	±0.5	2	50 µs		reg
	CML	T750A/SG-36A	300	2000	ina	±0.25	0	217	750	±0.5	±0.5	2	50 µs		reg
	CML	N1000A/SG-16A	300	2000	ina	±0.25	ina	125	1000	±0.5	±0.5	2	50 µs		reg
	CML	T1200A/SG-36A	300	2000	ina	±0.25	0	217	1200	±0.5	±0.5	2	50 µs		reg
	CML	N1500A/SG-16A	300	2000	ina	±0.25	0	125	1500	±0.5	±0.5	2	50 µs		reg
	CML	T1750A/SG-36A	300	2000	ina	±0.25	0	217	1750	±0.5	±0.5	2	50 µs		reg
AF12	CML	N2000A/SG-16A	300	2000	ina	±0.25	0	125	2000	±0.5	±0.5	2	50 µs		reg
	CML	T2500A/SG-36A	300	2000	ina	±0.25	0	217	2500	±0.5	±0.5	2	50 µs		reg
	CML	N5000A/SG-16A	300	2000	ina	±0.25	0	125	5000	±0.5	±0.5	2	50 µs		reg
	CML	T5000A/SG-36A	300	2000	ina	±0.25	0	217	5000	±0.5	±0.5	2	50 µs		reg
	CML	N15000A/SG-16A	300	2000	ina	±0.25	0	125	15K	±0.5	±0.5	2	50 µs		reg
	Tel-Inst	4010A-1	50	4000	1	1	90	130	100	0.5	0.1	1	ina	wx	reg
	Tel-Inst	4025B-1	50	4000	1	1	90	130	250	0.5	0.1	1	ina	wx	reg
	Tel-Inst	4050-1	50	4000	1	1	90	130	500	0.5	0.1	1	ina	wx	reg
	Tel-Inst	4100-1	50	4000	1	1	90	130	1000	0.5	0.1	1	ina	wx	reg
	Tel-Inst	4250-1	50	4000	1	1	90	130	2500	0.5	0.1	1	ina	wx	reg
AF13	Tel-Inst	4500-1	50	4000	1	1	90	130	5000	0.5	0.1	1	ina	wx	reg
	EDC	AC-1000	45	5000	1	0.05	10 µV	1000	50	0.005	0.0025	0.5	0.1s	c+r meter	2965
	Elgar	201	45	5000	1	0.025	0	260	200	0.25	1	1	50 µs	m	590
	Elgar	600-3	45	5000	1	0.025	0	230	200	0.25	1	1	50 µs	ms	1820
	Elgar	400-1	45	5000	1	0.025	0	520	400	0.25	1	1	50 µs	m	1205
	Elgar	1503	45	5000	1	0.025	0	130	500	0.25	1	1	50 µs	ms	3150
	Elgar	1500-3	45	5000	1	0.025	0	230	500	0.25	1	1	50 µs	ms	4190
	Elgar	501	45	5000	1	0.025	0	260	500	0.25	1	1	50 µs	m	1380
	Elgar	2250-3	45	5000	1	0.025	0	260	750	0.25	1	1	50 µs	ms	5450
	Elgar	751	45	5000	1	0.025	0	260	750	0.25	1	1	50 µs	m	1800
AF14	Elgar	3000-3	45	5000	1	0.025	0	260	1000	0.25	1	1	50 µs	ms	6800
	Elgar	1001	45	5000	1	0.025	0	260	1000	0.25	1	1	50 µs	m	2250
	Elgar	1000-1	45	5000	1	0.025	0	520	1000	0.25	1	1	50 µs	mr	2785
	Elgar	4500-3	45	5000	1	0.025	0	260	1500	0.25	1	1	50 µs	ms	8975
	Elgar	1501	45	5000	1	0.025	0	260	1500	0.25	1	1	50 µs	m	3050
	Elgar	1500-1	45	5000	1	0.025	0	520	1500	0.25	1	1	50 µs	mr	3625
	Elgar	6000-3	45	5000	1	0.025	0	260	2000	0.25	1	1	50 µs	ms	13600
	Elgar	2000-1	45	5000	1	0.025	0	520	2000	0.25	1	1	50 µs	mr	4525
	Elgar	9000-3	45	5000	1	0.025	0	260	3000	0.25	1	1	50 µs	ms	16625
	Elgar	3000-1	45	5000	1	0.025	0	520	3000	0.25	1	1	50 µs	mr	6125
AF15	CML	NS70-7A	45	6000	ina	±0.25	0	125	70	±0.5	±0.5	3	50 µs		reg
	CML	NS120-7A	45	6000	ina	±0.25	0	125	120	±0.5	±0.5	3	50 µs		reg
	CML	T150A/SG-37A	45	6000	ina	±0.25	0	217	150	±0.5	±0.5	3	50 µs		reg
	CML	NS175-7A	45	6000	ina	±0.25	0	125	175	±0.5	±0.5	3	50 µs		reg
	CML	T300B/SG-37A	45	6000	ina	±0.25	0	217	300	±0.5	±0.5	3	50 µs		reg
	CML	NS350-7A	45	6000	ina	±0.25	0	125	350	±0.5	±0.5	3	50 µs		reg
	CML	N500A/SG-17A	45	6000	ina	±0.25	0	125	500	±0.5	±0.5	3	50 µs		reg
	CML	T500B/SG-37A	45	6000	ina	±0.25	0	217	500	±0.5	±0.5	3	50 µs		reg
	CML	N750B/SG-17A	45	6000	ina	±0.25	0	125	750	±0.5	±0.5	3	50 µs		reg
	CML	N750A/SG-17A	45	6000	ina	±0.25	0	125	750	±0.5	±0.5	3	50 µs		reg
	CML	T750A/SG-37A	45	6000	ina	±0.25	0	217	750	±0.5	±0.5	3	50 µs		reg
AF16	CML	N1000A/SG-17A	45	6000	ina	±0.25	0	125	1000	±0.5	±0.5	3	50 µs		reg
	CML	T1200A/SG-37A	45	6000	ina	±0.25	0	217	1200	±0.5	±0.5	3	50 µs		reg
	CML	N1500A/SG-17A	45	6000	ina	±0.25	0	125	1500	±0.5	±0.5	3	50 µs		reg

AC Power Supplies (Freq. Regulated, Adjustable Frequency) 71

	Manufacturer	Model	FREQUENCY				OUTPUT							Misc Features	Price $
										REGULATION					
			Min. Hz	Max. Hz	Accuracy %	Stability %	Min. Volts	Max. Volts	Power VA	Line %	Load %	Distortion %	Response Time		
AF17	CML	T1750A/SG-37A	45	6000	ina	±0.25	0	217	1750	±0.5	±0.5	3	50 μs		reg
	CML	N2000A/SG-17A	45	6000	ina	±0.25	0	125	2000	±0.5	±0.5	3	50 μs		reg
	CML	T2500A/SG-37A	45	6000	ina	±0.25	0	217	2500	±0.5	±0.5	3	50 μs		reg
	CML	N5000A/SG-17A	45	6000	ina	±0.25	0	125	5000	±0.5	±0.5	3	50 μs		reg
	CML	T5000A/SG-37A	45	6000	ina	±0.25	0	217	5000	±0.5	±0.5	3	50 μs		reg
	CML	N15000A/SA-2	200	6000	ina	±0.25	0	125	15K	±0.5	±0.5	3	50 μs		reg
	Ind Test	80S-1-K	10	10K	1	0.2	0	260	80	0.1	0.5	0.3	50 μs	v	reg
	Ind Test	250S-1-K	10	10K	1	0.2	0	260	250	0.1	0.5	0.3	50 μs	v	reg
	Ind Test	1000S-1-K	10	10K	1	0.2	0	300	1000	0.1	0.5	0.5	50 μs	v	reg
	Ind Test	1500S-1-K	10	10K	1	0.2	0	300	1500	0.1	0.5	0.5	50 μs	v	reg
AF18	Elgar	153	350	10K	1	0.025	0	520	150	0.25	1	1	50 μs	mr	1050
	EDC	AC-200	45	20K	1	0.05	10 μV	200	25	0.005	0.0025	0.5	0.1s		2765

AC Power Supplies (Amplitude Regulated) 72

	Manufacturer	Model	OUTPUT				INPUT		REGULATION			Misc Features	Price $
			Min. Volts	Max. Volts	Max. Amps	Power kVA	Min. Volts	Max. Volts	Line %	Load %	Response Time		
AR1	Princeton	214	-20	+20	1	0.02	ina	ina	0.2	0.2	0.2 μs	p	825
	Princeton	200	±12	±24	1,2	0.096	ina	ina	0.05	0.05	100 μs		reg
	Princeton	281	-24	+24	1	0.024	ina	ina	0.005	0.005	50 μs		390
	North Hills	VS78	1	50	0.5	0.025	105	125	0.1	0.1	ina		2995
	North Hills	VS66	5	50	0.6	0.025	105	125	0.1	0.1	ina		2995
	Sorensen	FR1016A	115	115	8.7	1	95	135	0.025	0.025	50 ms		1500
	Sorensen	FR1014A	115	115	8.7	1	95	135	0.025	0.025	50 ms		1650
	GE	9T92A100	115	115	7.5	0.86	95	135	±1	ina	f	cdf	reg
	Sorensen	FR2516A	115	115	21.74	2.5	95	135	0.025	0.025	50 ms		3425
	Sorensen	FR5015A	115	115	43.48	5	95	135	0.025	0.025	50 ms		6800
AR2	GE	9T92A101	115	115	10	1.15	95	135	±1	ina	f	cdf	reg
	Sorensen	VR6110	115	115	0.13	0.015	95	130	±0.5	±5	25 ms		25
	Sorensen	VR6113	115	115	1.04	1.2	95	130	±0.5	±5	25 ms		43
	GE	9T92A102	115	115	14.8	1.7	95	135	±1	ina	f	cdfg	reg
	Sorensen	FR1015A	115	115	8.7	1	95	135	0.025	0.025	50 ms		1500
	Sorensen	VR6114	115	115	2.17	2.5	95	130	±0.5	±5	25 ms		76
	Sorensen	VR6111	115	115	26	0.03	95	130	±0.5	±5	25 ms		30
	GE	9T92A103	115	115	20	2.3	95	135	±1	ina	f	cdfg	reg
	Sorensen	FR2515A	115	115	21.74	2.5	95	135	0.025	0.025	50 ms		3425
	GE	9T92A134	115	115	150	17.2	95	135	±1	ina	i	cdi	reg
AR3	Sorensen	VR6112	115	115	0.52	0.06	95	130	±0.5	±5	25 ms		36
	Sorensen	VR6115	115	115	4.35	5	95	130	±0.5	±5	25 ms		100
	GE	9T92A132	115	115	50	5.75	95	135	±1	ina	i	cdi	reg
	Sorensen	FR5016A	115	115	43.48	5	95	135	0.025	0.025	50 ms		6800
	Sorensen	FR2514A	115	115	21.74	2.5	95	135	0.025	0.025	50 ms		3525
	Sorensen	FR516A	115	115	4.35	0.5	95	135	0.05	0.05	50 ms		925
	GE	9T92A133	115	115	100	11.5	95	135	±1	ina	i	cdi	reg
	GE	9T91Y4070	118	118	ina	0.015	95	130	±1	ina	5 Hz	c	reg
	GE	9T91Y4090	118	118	ina	0.03	95	130	±1	ina	5 Hz	c	reg
AR4	GE	9T91Y4110	118	118	ina	0.06	95	130	±1	ina	5 Hz	c	reg
	GE	9T91Y4130	118	118	ina	0.12	95	130	±1	ina	5 Hz	c	reg
	GE	9T91Y4140	118	118	ina	0.25	95	130	±1	ina	5 Hz	c	reg
	GE	9T91Y4150	118	118	ina	0.5	95	130	±1	ina	5 Hz	c	reg
	GE	9T91Y3021	118	118	ina	0.5	95	130	±1	ina	8 Hz	de	reg
	GE	9T91Y4170	118	118	ina	1	95	130	±1	ina	5 Hz	c	reg
	GE	9T91Y3022	118	118	ina	1	95	130	±1	ina	8 Hz	cdg	reg
	GE	9T91Y4183	118	118	ina	2	95	130	±1	ina	5 Hz	ch	reg
	GE	9T91Y3023	118	118	ina	2	95	130	±1	ina	8 Hz	cd	reg
	GE	9T91Y4193	118	118	ina	3	95	130	±1	ina	5 Hz	cg	reg
AR5	GE	9T91Y4203	118	118	ina	5	95	130	±1	ina	5 Hz	cg	reg
	GE	9T91Y3027	118	118	ina	5	95	130	±1	ina	8 Hz	cg	reg
	GE	9T91Y4213	118	118	ina	7.5	95	130	±1	ina	5 Hz	cg	reg
	Superior	IES91005	110	120	4.4	0.5	95	135	100 mV	100 mV	30 ms		reg
	Sorensen	ACR2000	110	120	18.18	2	95	130	±0.1	±0.1	30 ms		475
	Sorensen	ACR7500	110	120	68.18	7.5	95	130	±0.15	±0.15	30 ms		875
	Sorensen	ACR15,000	110	120	136.36	15	95	130	±0.15	±0.15	30 ms		1575
	Superior	IES9106	110	120	52.2	6	95	135	100 mV	100 mV	30 ms		reg
	Sorensen	ACR3000	110	120	27.27	3	95	130	±0.1	±0.1	30 ms		575
	Sorensen	ACR500	110	120	4.55	0.5	95	130	±0.1	±0.1	30 ms		330

AC Power Supplies (Amplitude Regulated)

			OUTPUT				INPUT		REGULATION				
	Manufacturer	Model	Min. Volts	Max. Volts	Max. Amps	Power kVA	Min. Volts	Max. Volts	Line %	Load %	Response Time	Misc Features	Price $
AR6	Sorensen	ACR5000	110	120	45.45	5	95	130	±0.15	±0.15	30 ms		765
	Sorensen	ACR1000	110	120	9.09	1	95	130	±0.1	±0.1	30 ms		375
	Superior	IES9103	110	120	26.1	3	95	135	100 mV	100 mV	30 ms		reg
	Sorensen	ACR10,000	110	120	90.9	10	95	130	±0.15	±0.15	30 ms		1270
	Superior	IES9110	110	120	87	10	95	135	100 mV	100 mV	30 ms		reg
	Superior	IES9115	110	120	130	15	95	135	100 mV	100 mV	30 ms		reg
	Superior	EMT4102B	110	120	20	2.3	95	135	±0.75	±0.75	0.075	q	reg
	Superior	EMT4104B	110	120	35	4.2	108	137	±0.75	±0.75	0.1	q	reg
	Superior	EMT4106C	110	120	57	6.6	95	135	±0.75	±0.75	0.075	q	reg
	Superior	IES9101	110	120	8.7	1	95	135	100 mV	100 mV	30 ms		reg
AR7	Lambda	LD-801	110	120	ina	0.25	100	132	1	1	50 ms	bjk	140
	Lambda	LD-811	110	120	ina	0.5	100	132	1	1	50 ms	bjk	150
	Lambda	LD-831	110	120	ina	1	100	132	1	1	50 ms	bjk	230
	Superior	EMT4112B	110	120	114	13	105	125	±0.75	±0.75	0.15	q	reg
	Superior	EMT4115B	110	120	144	13	105	125	±0.75	±0.75	0.125	q	reg
	Elgar	1503	0	130	8	0.5	210	250	0.25	1	50 µs	mst	3150
	ERA	RT250	105	130	ina	0.25	105	130	±0.1	0.2	16 ms	b	130
	ERA	RT500	105	130	ina	0.5	105	130	±0.1	0.2	16 ms	b	175
	ERA	RT1000	105	130	ina	1	105	130	±0.1	0.2	16 ms	b	235
	Lambda	LD-802	100	132	ina	0.225	100	132	1	1	50 ms	bjkm	200
AR8	Lambda	LD-812	100	132	ina	0.45	100	132	1	1	50 ms	bjkm	225
	Lambda	LD-832	100	132	ina	0.9	100	132	1	1	50 ms	bjkm	275
	Sola	33-16-150	108	132	4.6	0.5	120	120	0.5	1	150 ms	y	reg
	Sola	39-09-315	108	132	ina	15	120/208	120/208	0.5	1	150 ms	o	reg
AR9	EDC	AC-200	10 µV	200	1	0.025	115	115	0.005	0.0025	0.1 s		2765
	Lambda	LD-803	200	220	ina	0.2	180	235	1	1	50 ms	bjn	200
	Lambda	LD-813	200	220	ina	0.4	180	235	1	1	50 ms	bjn	225
	Lambda	LD-833	200	220	ina	0.8	180	235	1	1	50 ms	bjn	275
	Elgar	1501	0	230	55	1.5	210	250	0.25	1	50 µs	mt	3050
	Sorensen	FR5025A	230	230	21.74	5	190	270	0.025	0.025	50 ms		7025
	Sorensen	FR1025A	230	230	4.35	1	190	270	0.025	0.025	50 ms		1650
	Sorensen	FR5026A	230	230	43.48	5	190	270	0.025	0.025	50 ms		7025
	Sorensen	FR2525A	230	230	10.87	2.5	190	270	0.025	0.025	50 ms		3650
	Sorensen	FR1026A	230	230	4.35	1	190	270	0.025	0.025	50 ms		1650
AR10	Sorensen	FR2526A	230	230	10.87	2.5	190	270	0.025	0.025	50 ms		3650
	Superior	IES9215	220	240	65	15	195	255	100 mV	100 mV	30 ms		reg
	Superior	IES9210	220	240	43.5	10	195	255	100 mV	100 mV	30 ms		reg
	Superior	IES9206	220	240	26.1	6	195	255	100 mV	100 mV	30 ms		reg
	Superior	IES9203	220	240	13	3	195	255	100 mV	100 mV	30 ms		reg
	Superior	EMT6210YB	220	240	33	13.1	195	255	±0.75	±0.75	0.083	q	reg
	Superior	EMT6215YB	220	240	48	19.1	195	255	±0.75	±0.75	0.083	q	reg
	Superior	EMT6220YB	220	240	63	25.1	195	255	±0.75	±0.75	0.083	q	reg
	Superior	EMT6245YB	220	240	145	57.8	195	255	±0.75	±0.75	0.25	q	reg
	Superior	EMT6270DB	220	240	188	74.9	195	255	±0.75	±0.75	0.25	q	reg
AR11	Superior	EMT4207B	220	240	36	8.3	195	235	±0.75	±0.75	0.083	q	reg
	Superior	EMT4220	220	240	93	21.4	195	255	±0.75	±0.75	0.083	q	reg
	Superior	EMT4228C	220	240	130	29.9	205	250	±0.75	±0.75	0.111	q	reg
	Sola	39-09-313	188	228	69	13	208	208	0.5	1	150 ms	z	reg
	Superior	EMT4104B	220	240	35	8.4	228	256	±0.75	±0.75	0.1	q	reg
	Lambda	LD-803V	220	240	ina	0.2	200	265	1	1	50 ms	bjn	200
	Lambda	LD-813V	220	240	ina	0.4	200	265	1	1	50 ms	bjn	225
	Lambda	LD-833-V	220	240	ina	0.8	200	265	1	1	50 ms	bjn	275
	Elgar	4500-3	0	260	55	1.5	210	250	0.25	1	50 µs	mst	8975
	Elgar	3000-3	0	260	37	1	105	125	0.25	1	50 µs	mst	6800
AR12	Elgar	2250-3	0	260	28	0.75	105	125	0.25	1	50 µs	mst	5450
	Elgar	1500-3	0	260	18.5	0.5	105	125	0.25	1	50 µs	mst	4190
	Elgar	600-3	0	260	7.4	0.2	105	125	0.25	1	50 µs	mst	1820
	Elgar	1001	0	260	37	1	105	125	0.25	1	50 µs	mt	2250
	Elgar	751	0	260	28	0.75	105	125	0.25	1	50 µs	mt	1800
	Elgar	501	0	260	18.5	0.5	105	125	0.25	1	50 µs	mt	1380
	Elgar	201	0	260	7.4	0.2	105	125	0.25	1	50 µs	mt	590
	Superior	EMT4418B	440	480	45	20.7	400	520	±0.75	±0.75	0.041	q	reg
	Superior	EMT4407B	440	480	45	9.2	400	520	±0.75	±0.75	0.041	q	reg
	Superior	EMT6450YB	440	480	75	59.8	400	520	±0.75	±0.75	0.125	q	reg
AR13	Superior	EMT6425YB	440	480	35	27.9	400	520	±0.75	±0.75	0.041	q	reg
	Superior	EMT6417YB	440	480	24	19.1	400	520	±0.75	±0.75	0.041	q	reg
	Superior	EMT6412YB	440	480	18	14.3	400	520	±0.75	±0.75	0.041	q	reg
	Superior	EMT64100YB	440	480	148	118	420	500	±0.75	±0.75	0.188	q	reg
	Elgar	153	0	520	2.8	0.15	105	125	0.25	1	50 µs	mrt	1050
	Elgar	400-1	0	520	3.6	0.4	105	125	0.25	1	1	mrt	1205
	Elgar	1000-1	0	520	9	1	105	125	0.25	1	50 µs	mrt	2785
	Elgar	1500-1	0	520	13.5	1.5	105	125	0.25	1	50 µs	mrt	3625
	Elgar	2000-1	0	520	18	2	105	125	0.25	1	50 µs	mrt	4525
	Elgar	3000-1	0	520	27	3	210	250	0.25	1	50 µs	mrt	6125
AR14	Elgar	6000-3	0	520	18	2	210	250	0.25	1	50 µs	mst	13600
	Elgar	9000-3	0	520	27	3	210	250	0.25	1	50 µs	mst	16625
	RFL	829G	0	1000	10	30W	110	130	0.05	n/a	n/a		3100
	EDC	AC-1000	10 µV	1000	2	0.05	115	115	0.005	0.0025	0.1s		2965
	Princeton	280	-200	-2000	0.005	0.01	0	10	0.001	0.001	50 µs	m	525

a. Any one fixed frequency in this range.
b. Modular.
c. Input voltage available, 190/260V, 380/520V single phase; 200/260V, three phase, specify.
d. Output voltage is adjustable ±4%.
e. Input voltage 95/130V and 110/260V.
f. Correction rate 8V/second for maximum input voltage excursion.
g. Unit may be adjusted by user to an input range 75% of that shown with a 20% increase in load current and 50% of response time (note f).
h. Output voltage 118/236V.
i. Correction rate 10.4V/second for maximum input voltage excursion.
j. Output power varies with ambient temperature, check with manufacturer.
k. Input voltage models LD801, 802, 811, 812, 831, 832, resistive load 100-132Vac, inductive load 105-132Vac, 57-63 Hz.
m. Remote programming.
n. Input voltage models LD803, 813, 833, 180-235Vac, 57-63 Hz; 200-265Vac, 47-53 Hz resistive load; 190-235Vac, 57-63Vac, 210-265Vac, 47-53Vac inductive load.
o. This model is typical of a family of units ranging from 1.5-500 kVA in Wye connected three phase. Input voltage is -20% to +10% of figure shown.
p. Also wideband amplifier to 1 MHz.
q. Response time in seconds/volt.
r. Provides full power at 1, 2 or 3 phase output.
s. Three phase output, specifications are per phase.
t. All prices are less oscillator.
v. Two and three phase outputs available, check with manufacturer.
w. Accuracy and stability available to 0.001%.
x. Single phase output. Three phase outputs available.
y. This model is typical of a family of units ranging from 0.5-150 kVA in single phase. Input voltage is -20% to +10% of figure shown.
z. This model is typical of a family of units ranging from 1.7-65 kVA in delta three phase. Input voltage is -20% to +10% of figure shown.

Index by Model Number (AC)

Name	Model	Code
	T150A/SG-31A	FF1
	T150A/SG-32A	FF3
	T150A/SG-33A	AF2
	T150A/SG-34A	FF7
	T150A/SG-35A	AF6
	T150A/SG-36A	AF10
	T150A/SG-37A	AF15
	T150A/SG-38A	FF11
	T300B/SG-31A	FF1
	T300B/SG-32A	FF3
	T300B/SG-33A	AF2
	T300B/SG-34A	FF7
	T300B/SG-35A	AF7
	T300B/SG-36A	AF10
	T300B/SG-37A	AF15
	T300B/SG-38A	FF11
	T500B/SG-31A	FF1
	T500B/SG-32A	FF3
	T500B/SG-33A	AF2
	T500B/SG-34A	FF7
	T500B/SG-35A	AF7
	T500B/SG-36A	AF11
	T500B/SG-37A	AF15
	T500B/SG-38A	FF11
	T750A/SG-31A	FF1
	T750A/SG-32A	FF3
	T750A/SG-33A	AF3
	T750A/SG-34A	FF8
	T750A/SG-35A	AF7
	T750A/SG-36A	AF11
	T750A/SG-37A	AF15
	T750A/SG-38A	FF12
	T1200A/SG-31A	FF2
	T1200A/SG-32A	FF4
	T1200A/SG-33A	AF3
	T1200A/SG-34A	FF9
	T1200A/SG-35A	AF7
	T1200A/SG-36A	AF11
	T1200A/SG-37A	AF16
	T1200A/SG-38A	FF12
	T1750A/SG-31A	FF2
	T1750A/SG-32A	FF4
	T1750A/SG-33A	AF3
	T1750A/SG-34A	FF9
	T1750A/SG-35A	AF8
	T1750A/SG-36A	AF11
	T1750A/SG-37A	AF17
	T1750A/SG-38A	FF12
	T2500A/SG-31A	FF2
	T2500A/SG-32A	FF4
	T2500A/SG-33A	AF3
	T2500A/SG-34A	FF9
	T2500A/SG-35A	AF9
	T2500A/SG-36A	AF12
	T2500A/SG-37A	AF17
	T2500A/SG-38A	FF12
	T5000A/SG-31A	FF2
	T5000A/SG-32A	FF5
	T5000A/SG-33A	AF3
	T5000A/SG-34A	FF9
	T5000A/SG-35A	AF9
	T5000A/SG-36A	AF12
	T5000A/SG-37A	AF17
	T5000A/SG-38A	FF12
	T15000A/SG-34A	FF9
	T15000A/SG-35A	AF9
	T20000A/SG-34A	FF10
	T20000A/SG-35A	AF9
EDC Electronic Development Corp.	AC-200	AF18, AR9
	AC-1000	AF13, AR14
ERA Electronic	IT256RS	FF5
	IT259RS	FF10
Research Assoc.	IT2104RS	FF10
	IT2106RS	FF5
	IT2254RS	FF10
	IT2256RS	FF5
	RT250	AR7
	RT500	AR7
	RT1000	AR7
Elgar Elgar Corp.	153	FF15, AF18, AR13
	201	FF15 AF13, AR12
	400-1	FF14, AF13, AR13
	501	FF14, AF13, AR12
	600-3	FF13, AF13, AR12
	751	FF14, AF13, AR12
	1000-1	FF14, AF14, AR13
	1001	FF14, AF14, AR12
	1500-1	FF14, AF14, AR13
	1500-3	FF14, AF13, AR12
	1501	FF15, AF14, AR9
	1503	FF14, AF13, AR7
	2000-1	FF15, AF14, AR13
	3000-1	FF15, AF14, AR13
	3000-3	FF14, AF14, AR11
	4500-3	FF15, AF14, AR11
	6000-3	FF15, AF14, AR14
	9000-3	FF15, AF14, AR14
GE General Electric Co.	9T91Y3021	AR4
	9T91Y3022	AR4
	9T91Y3023	AR4
	9T91Y3027	AR5
	9T91Y4070	AR3
	9T91Y4090	AR3
	9T91Y4110	AR4
	9T91Y4130	AR4
	9T91Y4140	AR4
	9T91Y4150	AR4
	9T91Y4170	AR4
	9T91Y4183	AR4
	9T91Y4193	AR4
	9T91Y4203	AR5
	9T91Y4213	AR5
	9T92A100	AR1

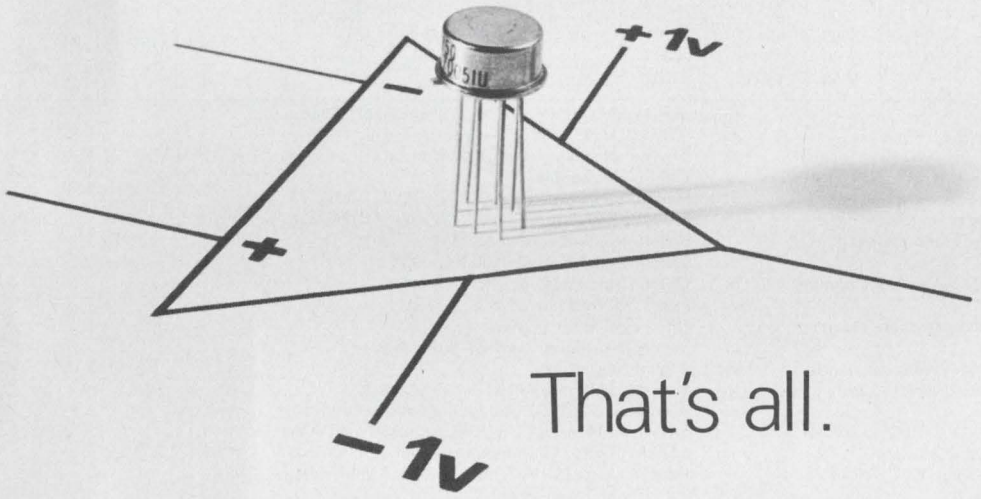
Name	Model	Code
	9T92A101	AR2
	9T92A102	AR2
	9T92A103	AR2
	9T92A132	AR3
	9T92A133	AR3
	9T92A134	AR2
Ind Test	80S-1-A	FF7
Industrial	80S-1-B	FF3
Test	80S-1-C	FF15
Equipment	80S-1-D	FF15
Co,	80S-1-E	FF16
	80S-1-K	AF17
	80S-1-L	AF4
	80S-1-M	AF10
	80S-1-N	AF6
	80S-1-P	AF9
	250S-1-A	FF7
	250S-1-B	FF3
	250S-1-C	FF17
	250S-1-D	FF16
	250S-1-E	FF16
	250S-1-K	AF17
	250S-1-L	AF4
	250S-1-M	AF10
	250S-1-N	AF6
	250S-1-P	AF9
	1000S-1-A	FF8
	1000S-1-B	FF4
	1000S-1-C	FF17
	1000S-1-D	FF17
	1000S-1-E	FF17
	1000S-1-K	AF17
	1000S-1-L	AF4
	1000S-1-M	AF10
	1000S-1-N	AF7
	1000S-1-P	AF9
	1500S-1-A	FF9
	1500S-1-B	FF4
	1500S-1-C	FF17
	1500S-1-D	FF17
	1500S-1-E	FF17
	1500S-1-K	AF17
	1500S-1-L	AF4
	1500S-1-M	AF10
	1500S-1-N	AF8
	1500S-1-P	AF10
Lambda	LD-801	AR7
Lambda	LD-802	AR7
Electronics	LD-803	AR9
	LD-803V	AR11
	LD-811	AR7
	LD-812	AR8
	LD-813	AR9
	LD-813V	AR11
	LD-831	AR7
	LD-832	AR8
	LD-833	AR9
	LD-833V	AR11
NJE	FC-26-500	AF6
NJE Corp,	FC-115-500	AF6
	FC-115-1000	AF6
	TFC-26-100	AF5
	TFC-26-200	AF5
	TFC-115-100	AF5
	TFC-115-200	AF6
North Hills	VS66	AR1
North Hills	VS78	AR1
Electronics		
Princeton	200	AR1
Princeton	214	AR1
Applied	280	AR14
Research	281	AR1
Corp,		
RFL	829G	FF13,
RFL		AF10,
Industries		AR14
Inc.		

Name	Model	Code
Sola	33-16-150	AR8
Sola	39-09-313	AR11
Electric	39-09-315	AR8
Sorensen	ACR500	AR5
Sorensen	ACR1000	AR6
Operation,	ACR2000	AR5
Raytheon	ACR3000	AR5
Co.	ACR5000	AR6
	ACR7500	AR5
	ACR10,000	AR6
	ACR15,000	AR5
	FR516A	AR3
	FR1014A	AR1
	FR1015A	AR2
	FR1016A	AR1
	FR1025A	AR9
	FR1026A	AR9
	FR2514A	AR3
	FR2515A	AR2
	FR2516A	AR1
	FR2525A	AR9
	FR2526A	AR10
	FR5015A	AR1
	FR5016A	AR3
	FR5025A	AR9
	FR5026A	AR9
	VR6110	AR2
	VR6111	AR2
	VR6112	AR3
	VR6113	AR2
	VR6114	AR2
	VR6115	AR3
Superior	EMT4102B	AR6
Superior	EMT4104B	AR6,
Electric		AR11
	EMT4106C	AR6
	EMT4112B	AR7
	EMT4115B	AR7
	EMT4207B	AR11
	EMT4220	AR11
	EMT4228C	AR11
	EMT4407B	AR12
	EMT4418B	AR12
	EMT6210YB	AR10
	EMT6215YB	AR10
	EMT6220YB	AR10
	EMT6245YB	AR10
	EMT6270DB	AR10
	EMT6412YB	AR13
	EMT6417YB	AR13
	EMT6425YB	AR13
	EMT6450YB	AR12
	EMT64100YB	AR13
	IES9101	AR6
	IES9103	AR6
	IES9106	AR5
	IES9110	AR6
	IES9115	AR6
	IES9203	AR10
	IES9206	AR10
	IES9210	AR10
	IES9215	AR10
	IES91005	AR5
Tel-Inst	4010A-1	AF12
Tel-Instrument	4025B-1	FF13,
Electronics		AF12,
	4030A-3	FF13,
	4050-1	FF13,
		AF12
	4100-1	FF13,
		AF12
	4250-1	FF13,
		AF12
	4500-1	FF13,
		AF13

Voltage Reference DC Power Supplies

	Manufacturer	Model	OUTPUT					CALIBRATION			Stability Short Term	Misc Features	Price $
			Min. Volts	Max. Volts	Current mA	Impedance Ω dc	Impedance Ω ac	Volts	Accuracy %	Resolution			
VF1	Keithley	261	10^{-10}	1.11	ina	ina	ina	ina	0.5	t	0.5%	t	565
	H-P	6113A	0	10	2000	0.002	0.002	ina	0.1	20 μV	100 ppm	r	375
	Singer	420	0.001	10	ina	450-4500	0.2-13	10	0.5	0.01%	0.05%	a	460
	EDC	VS11	0	11	50	0.02	n/a	ina	0.005	100 μV	0.001%		670
	EDC	MV106	0	11	50	0.02	n/a	ina	0.005	10 μV	0.001%	f	950
	EDC	MV105	0	11	50	0.02	n/a	ina	0.005	100 μV	0.001%	e	775
	EDC	MV100	0	11	50	0.02	n/a	ina	0.005	100 μV	0.001%	d	770
	EPSCO	VRS611	0	11.112	100	50 mΩ	n/a	250 μV	0.025	ina	ina		reg
	Sorensen	QHS20-1.0	0	20	1000	0.006	ina	20	0.1	11 μV	0.001%	w	345
	Sorensen	QHS20-1.0L	0	20	1000	0.006	ina	20	n/a	500 μV	0.005%		265
VF2	H-P	6111A	0	20	1000	0.002	0.002	ina	0.1	200 μV	100 ppm	r	375
	North Hills	VS36	0.0001	21.1	1000	ina	ina	ina	0.01	100 μV	25 ppm	u	1450
	Sorensen	QHS40-.5	0	40	500	0.027	ina	40	0.1	11 μV	0.001%	w	345
	Sorensen	QHS40-.5L	0	40	500	0.027	ina	40	n/a	500 μV	0.005%		265
	H-P	6112A	0	40	500	0.002	0.002	ina	0.1	200 μV	100 ppm	r	375
	Fluke	382A	0	50	0.002	0.005	n/a	ina	±0.01	10 μV	±0.005%		1595
	EDC	2900	0	100	100	0.03	n/a	ina	0.003	100 μV	0.0001%	g	1190
	Sorensen	QHS100-.2	0	100	200	0.025	ina	100	0.1	11 μV	0.001%	w	345
	Sorensen	QHS100-.2L	0	100	200	0.025	ina	100	n/a	500 μV	0.005%		265
	H-P	6116A	0	100	200	0.002	0.002	ina	0.1	200 μV	100 ppm	r	375
VF3	EDC	VS111/B	0	111	50	0.1	n/a	ina	0.005	100 μV	0.001%		870
	Singer	421A	0.0001	111	ina	0.2-1000	0.4-1000	110	0.1	0.01%	0.01%	b	775
	North Hills	VS35	0.0001	111.1	100	0.025	ina	ina	0.01	100 μV	25 ppm	u	1250
	EPSCO	VR607	0	111.112	15	6 mΩ	n/a	500 μV	±0.01	ina	ina		reg
	EPSCO	VRS617	1 mV	111.112	50	100 mΩ	n/a	150 μV	0.015	ina	ina		reg
	Singer	421B	0.0001	300	ina	0.22-1000	0.4-1000	110	0.1	0.01%	0.01%	bc	1225
	Fluke	407D	0	555	300	0.5	n/a	555	0.5	0.2 mV	0.05%		450
	Keithley	241	0	1000	20	ina	ina	ina	0.05	100 μV	0.005%	s	930
	Weston	166	1 μV	1000	20	ina	ina	n/a	0.075	ina	ina		4195
	Weston	166S	1 μV	1000	20	ina	ina	n/a	0.03	ina	ina		4720
VF4	RFL	829G	ina	1000	500	n/a	n/a	ina	0.05	0.01%	ina	v	3100
	H-P	6920B	0.01	1000	0.01-5A	0.0005	0.001	ina	0.2+1 dig	ina	ina	p	695
	EDC	VS1000	0	1111	10	0.1	n/a	ina	0.007	1 mV	0.001%		1250
	Fluke	341A	0	1111.110	25	ina	ina	1000	±0.01	1 ppm	±0.003	i	1195
	Fluke	343A	0	1111.111	25	ina	ina	1000	±0.003	0.1 ppm	±0.0015%	j	1795
	Fluke	332B	0	1111.111	50	0.0005	n/a	1000	±0.002	0.1 ppm	0.001%	h	2445
	Fluke	3330A	0	1111.111	100	ina	ina	10-1000	0.005	ina	5 ppm	k	2995
	Keithley	240A	0	1200	10	ina	ina	ina	1	5 mV	0.02%		360
	Power Des	2K10	1	2012	10	ina	ina	2012	±0.25	10 mV	0.005%		299
	Power Des	1565	1	2012	15	ina	ina	2012	0.15	10 mV	0.005%		415
VF5	Keithley	245	0	2100	10	ina	ina	ina	1	50 mV	0.01%		425
	Fluke	412B	0	2100	30	ina	ina	2100	±0.25	5 mV	0.005%		410
	H-P	6110A	0	3000	6	ina	q	ina	0.1	20 mV	100 ppm	q	495
	Fluke	423A	0	3000	10	ina	ina	ina	0.25	100 mV	0.01%	m	460
	Power Des	1544	1	3012	20	ina	ina	3012	0.25	10 mV	0.005%		520
	Power Des	1547	1	3012	40	ina	ina	3012	0.25	10 mV	0.005%		575
	Keithley	246	0	3100	10	ina	ina	ina	1	50 mV	0.01%		475
	Fluke	415B	0	3100	30	ina	ina	3100	±0.25	5 mV	0.002%		575
	Fluke	4150A	0	3400	50	ina	ina	ina	±0.25	100 mV	±0.02%	n	2495
	Fluke	408B	0	6000	20	ina	ina	6000	±0.25	5 mV	0.005%		700
VF6	Power Des	1556A	10	6021	20	ina	ina	6021	±0.25	10 mV	0.005%		625
	Fluke	410B	0	10000	10	ina	ina	10000	±0.25	5 mV	0.005%		975
							LATE ARRIVALS						
VF7	PDP	AEC-315A	±50	±3000	0-10	ina	ina	ina	0.25	25 mV	0.01%	y	460
	PDP	3K10	±50	±3000	0-10	ina	ina	ina	0.25	25 mV	0.01%		390
	PDP	1584R	±1 kV	±20 kV	0-3	ina	ina	ina	±0.25	500 mV	0.01%		2200
	PDP	1584M2	-1 kV	-20 kV	0-5	ina	ina	ina	±0.25	500 mV	0.01%		2350
	PDP	1584PM3	1 kV	20 kV	0-5	ina	ina	ina	±0.25	500 mV	0.01%		2860
	PDP	1584	1 kV	20 kV	0-3	ina	ina	ina	±0.25	500 mV	0.01%		1875
	PDP	1579	10 kV	30 kV	0-1				±0.25	500 mV	0.01%		2250
	PDP	1579R	±10 kV	±30 kV	0-1	ina	ina	ina	0.25	500 mV	0.01%		2575

Our new micropower op amp runs off ±1v with 20 μW power consumption.



That's all.

Solitron's UC4250 micropower op amp uses so little power that its batteries will last as long as their shelf life. It needs so little voltage that only two single cells are needed. (Although it can handle up to ±18v.)

The other specifications aren't so bad either. 3 nanoamps input bias current with temperature drift of zero nanoamps per degree C. 100 db gain into a 10K load. And it's available now. From (who else?) Solitron.

Solitron Devices, Inc., P.O. Box 1416,
San Diego, California 92112.
Telephone 714/278-8780.
TWX 910-335-1221.

Solitron DEVICES, INC.

INFORMATION RETRIEVAL NUMBER 91

Klystron Power Supplies

	Manufacturer	Model	OUTPUT Supply	Min. Volts	Max. Volts	Current mA	REGULATION Line %	Load %	Ripple mV	MODULATION Square Hz	Other Hz	External	HEATERS Volts	Amps	Misc Features	Price $
KS1	Micro-Power	EM	Beam	0	400	0-60	0.002	20 mV	1	ina	ina	ina				375
		CS	Refl	50	1000	0-15	20 mV	50 mV	10							570
		FD	Fila										6.3	0-2		305
	H-P	715A	Beam	250	400	50	1	1	7				6.3	1.5		400
			Refl	0	900	.01	1	ina	ina	1000	line freq	yes				
	Micro-Power	DX12	Beam	400	600	0-100	10 mV	25 mV	1	n/a	n/a	n/a				490
		CV	Refl	50	1000	0-15	20 mV	50 mV	1							570
		FD	Fila										6.3	2		305
	PRD	809-A	Beam	250	600	65	ina	±1	5	400-	sawtooth	yes	6.3	2		570
			Refl	0	-900	0.05	ina	±0.1	1	2000	60					
	Micro-Power	DX34	Beam	600	800	0-100	14 mV	35 mV	1	n/a	n/a	n/a				490
		CV	Refl	50	1000	0-15	20 mV	50 mV	1							570
		FD	Fila										6.3	2		305
	H-P	716B	Beam	250	800	100	0.1	0.05	1							
			Refl	0	800	ina	0.05	ina	0.0005	yes	sawtooth	yes				925
			Grid	5	9	2000	1	ina	2				6.3	0.15		
	Micro-Power	BV	Beam	75	1500	0-50	30 mV	75 mV	1.5	ina	ina					875
		CV	Refl	50	1000	0-15	20 mV	50 mV	1							570
		EM	Grid	0	400	0-60	0.002	20 mV	1			yes				375
		FD	Fila										6.3	2.0		305
	Micro-Power	BW	Beam	500	1700	0-50	34 mV	85 mV	1.7	ina	ina					875
		CS	Refl	50	1000	0-15	20 mV	50 mV	10							570
		EM	Grid	0	400	0-60	0.002	20 mV	1			yes				375
		FD	Fila										6.3	0.2		305
	Micro-Power	AV	Beam	125	2500	0-25	50 mV	.125 V	2.5	ina	ina					860
		CV	Refl	50	1000	0-15	20 mV	50 mV	1							570
		EM	Grid	0	400	0-60	0.002	20 mV	1			yes				375
		FD	Fila										6.3	0.2		305
	PRD	819-A	Beam	200	3600	100	±0.01	0.05	20	200	sawtooth	yes	2.4-	2		2795
			Refl	0	1000	0.5	ina	0.005	20	to			7.2			
			Grid +	0	+150	5	ina	0.005	30	2000						
			Grid -	0	-300	1	ina	0.005	30		40-400					
KS2	Narda	62A1A	Beam	-200	-4000	0-150	0.01	ina	3	200-	Sine	any	6.3	4	x	1995
			Refl	0	-1000	ina	0.01	ina	3	2000	60 Hz					
			Grid 1	0	+150	5	0.01	ina	5		saw					
			Grid 2	0	+300	5	0.01	ina	5		200-2000					
	ERA	HV15	Beam	0	5000	15	0.01	0.01	5	n/a	n/a	n/a	n/a	n/a		435
	KM		Refl	0	5000	15	0.01	0.01	5							
			Grid	0	5000	15	0.01	0.01	5							

a. Outputs available, p-p, rms.
b. Outputs available, 0.0001-1100 Vac, p-p & rms. Rms and p-p can be either 400 Hz or 1000 Hz. Dc can be either positive or negative.
c. Unit incorporates built-in error computer which can determine the absolute error of dc or ac responding device under test or tracking error in the presence of range error.
d. Also 0-111 mV output at 20Ω impedance, 1 μV resolution.
e. Also 0-111 mV output at 2Ω impedance, 1 μV resolution.
f. Also 0-111 mV output at 10Ω, 1 μV resolution, 0-11 mV output at 10Ω, 0.01% accuracy, 0.1 μV resolution.
g. Also 0-10V, 10 μV resolution, 0-1V at 10Ω; 1 μV resolution, 0-0.1V at 10Ω, 100 mV resolution.
h. Calibration: 10V, ±0.002%, +10 μV; 100V, ±0.002% +20 μV; 1000V, ±0.002% +40 μV.
i. Settling time within 50 ppm of final output, 5 seconds.
j. Settling time within 25 ppm of final output, 5 seconds.
k. DTL-TTL logic compatible program inputs.
m. External programming available.
n. Fully programmable.
p. Four outputs available 0.01-1V, 5A; 0.1-10V, 1A; 1-100V, 100 mA; 10-1000V, 10 mA. AC/DC calibrator, constant current capable.
q. Output impedance, 0-1000 Hz, 50Ω.
r. Output impedance, dc-100 Hz.
s. Floats 500V off ground.
t. Three significant figures.
u. Six decimal digital readout, solid state.
v. Digital readout.
w. Five decade thumb-wheel switch plus pot.
x. Also available 62D1 dual klystron adapter at $250, drives two klystrons simultaneously when used with 62A1A. The 62A2 filament supply at $375 extends the 62A1A capability with a variable heater voltage 2.5-10V at 2A regulated.

Index by Model Number (Special Purpose)

Modular Power Supplies Addendum 60a

	Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
M1	Trio	SP607	3	20	0.3	0.3	10	b	400
	CP	PM444	3.6	0.25	±0.05	±0.05	0.5	a	47
	Trio	SP608	4	20	0.3	0.3	10	b	400
	CP	PM429	5	0.25	±0.05	±0.05	0.5	a	47
	Datel	UPM-5/300	5	0.3	±0.05	±0.05	2		59
	Datel	UPM-5/1A	5	1	±0.05	±0.05	2		reg
	Trio	SP601	5	20	0.3	0.3	10	b	400
	CP	PM422	6	0.2	±0.05	±0.05	0.5	a	47
	Trio	SP602	6	17	0.3	0.3	10	b	400
	Trio	SP611	±7	7.5	0.3	0.3	10	b	400
M2	Trio	SP609	7	15	0.3	0.3	10	b	400
	CP	PM487	10	0.12	±0.02	±0.02	0.5	a	40
	Trio	SP612	±10	5	0.3	0.3	10	b	400
	Trio	SP603	10	10	0.3	0.3	10	b	400
	CP	PM463	12	0.1	±0.02	±0.02	0.5	a	40
	Trio	SP615	±12	4.5	0.3	0.3	10	b	400
	Trio	SP610	12	9	0.3	0.3	10	b	400
	Datel	BPM-15/50	±15	±0.05	±0.05	±0.05	1		reg
	Datel	BPM-15/150	±15	±0.15	±0.05	±0.05	1		reg
	CP	PM476	15	0.1	±0.02	±0.02	0.5	a	38
	Trio	SP613	±15	3.5	0.3	0.3	10	b	400
	Trio	SP604	15	7	0.3	0.3	10	b	400
	CP	PM460	18	0.065	±0.02	±0.02	1	a	40
	CP	PM474	20	0.06	±0.02	±0.02	1	a	40
	Trio	SP614	±22	2.5	0.3	0.3	10	b	400
	Trio	SP605	22	5	0.3	0.3	10	b	400
	CP	PM485	24	0.05	±0.02	±0.02	1	a	40
	CP	PM462	28	0.04	±0.02	±0.02	1	a	40
	Trio	SP606	30	4	0.03	0.3	10	b	400
	CP	PM419	170	0.01	±1	±1	15	a	50
	CP	PM420	180	0.01	±1	±1	15	a	50

High Voltage Power Supplies Addendum 46a

	Mfr	Model	OUTPUT Range Volts	OUTPUT Max Amps	REGULATION Line %	REGULATION Load %	REGULATION Ripple mV	Notes	Price $
HV1	Velonex	150	500-2500	0.01	0.001	0.001	5	c	480
	Velonex	NIMPAC103	500-3000	0.01	0.001	0.001	10		455

a. Available in different sizes, bench type, PM4 series; PC mount type, PM5 series; octal base type, PM6 series. Dual op-amp supplies available. Operating temperature 0-70°C.

b. Unit incorporates switching regulators. Remote sensing provided. All output voltages are adjustable ±10%. Dual output supplies available. Operating temperature -20°C to +71°C, no derating or heat sink required.

c. Output voltage selected by four front panel controls, 500-2500V, 0-400V, 0-80V, 0-25V (continuously adjustable).

DC Power Supply Addendum

Abbrev.	Company	Reader Service No.
CP	Computer Products 2709 N. Dixie Highway P.O. Box 23849 Ft. Lauderdale, Fla. 33307 (305) 565-9565	471
Datel	Datel Corp. 943 Turnpike St. Canton, Mass. 02021 (617) 828-1890	472
Trio	Trio Labs 80 DuPont St. Plainview, N.Y. 11803 (516) 681-0400	473
Velonex	Velonex Division Pulse Engineering Inc. 560 Robert Ave. Santa Clara, Calif. 95050 (408) 244-7370	474

Name	Model	Code
Inc.	BW	KS1
	CS	KS1
	CV	KS1
	DX12	KS1
	DX34	KS1
	EM	KS1
	FD	KS1
Narda	62A1A	KS2
Narda Microwave Corp.		
North Hills	VS35	VF3
North Hills Electronics	VS36	VF2
PDP	3K10	VF7
Power Designs	1579	VF7
Pacific Inc.	1579R	VF7
	1584	VF7
	1584M2	VF7
	1584PM3	VF7
	1584R	VF7
	AEC-315A	VF7
PRD	809-A	KS1
PRD Electronics Inc.	819-A	KS1
Power Des	2K10	VF4
Power Designs Inc.	1544	VF5
	1547	VF5
	1556A	VF6
	1565	VF4
RFL	829G	VF4
RFL Industries		
Singer	420	VF1
Singer Co., Ballantine Operation	421A	VF3
	421B	VF3
Sorensen	QHS20-1.0	VF1
Sorensen Operation, Raytheon Co.	QHS20-1.0L	VF1
	QHS40-.5	VF2
	QHS40-.5L	VF2
	QHS100-.2	VF2
	QHS100-.2L	VF2
Weston	166	VF3
Weston-Lexington	166S	VF3

New Products

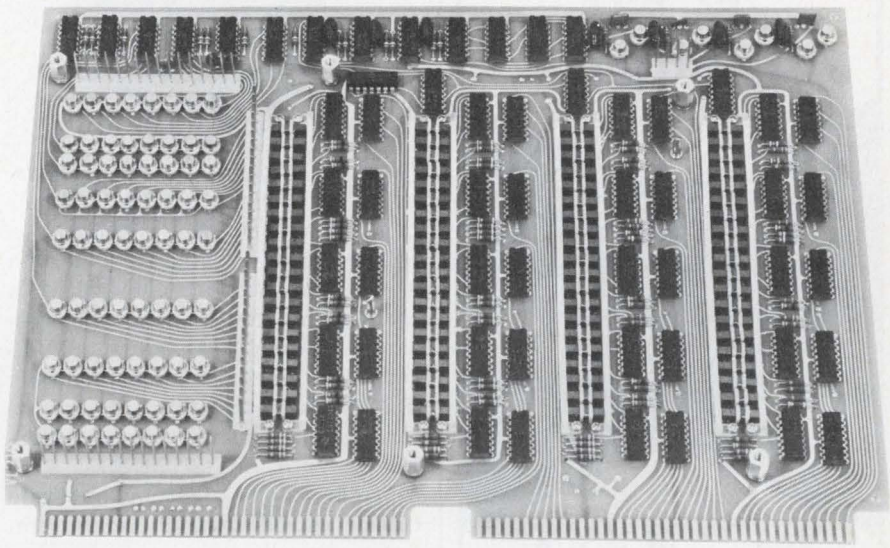
Alterable read-only core memory uses plug-in fixed-program boards

Varian Data Machines, 2722 Michelson Dr., Irvine, Calif. Phone: (714) 833-2400. P&A: 2.5¢/bit; 45 to 60 days.

Able to have its program altered without being returned to its manufacturer, a new read-only core memory offers capacities to 20,480 bits at a cost of only 2.5¢ per bit. The VROM is a mechanically alterable random-access system with a full-cycle time of 350 ns and an access time of 200 ns.

Users can now maintain a library of fixed-program tables since the VROM has a mechanically interchangeable braid and diode board. The braid or information board is mated with a universal logic board through connectors. This reduces program changes to a simple matter of switching a plug-in printed circuit board.

Easy maintenance is another feature of the new read-only memory. In the past, the breakage of

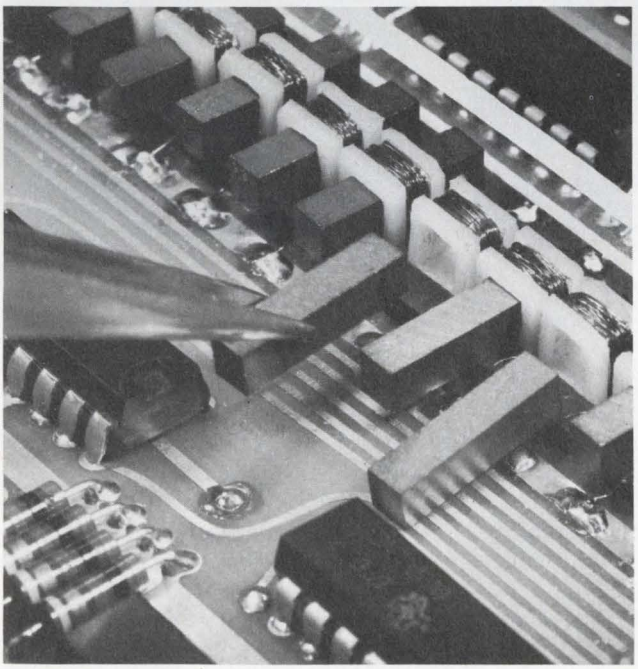


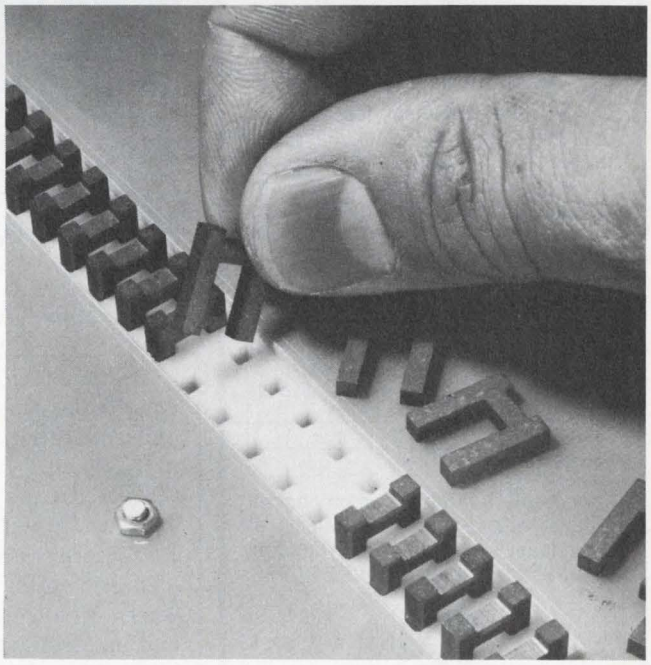
U cores and I bars meant long repair times because both of these are held captive to a PC board by the same sense winding.

The VROM reduces memory downtime through the use of plastic U-core holders and I-bar retainers. These housings, instead of the components themselves, are wrapped with the sense winding, making the components easy to remove and replace.

Maximum current is 900 mA.

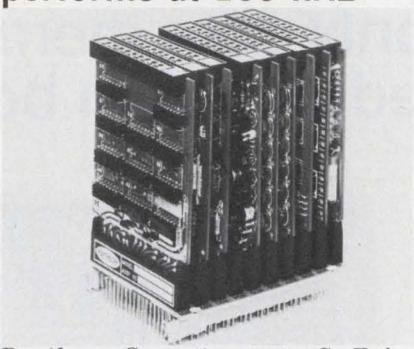
CIRCLE NO. 250





Mechanically alterable read-only memory puts its fixed-program format on plug-in PC boards. In addition, memory downtime is minimized because of easily replaceable U cores and I bars. The retainers for these components are plastic so that the retainers, instead of the components, are wrapped with the sense winding.

A/d 12-bit converter performs at 100 kHz

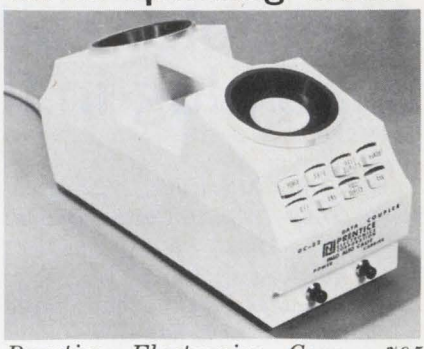


Raytheon Computer, 2700 S. Fairview St., Santa Ana, Calif. Phone: (714) 546-7160. Price: $1950.

The Mod F Miniverter is a data acquisition instrument with a throughput rate of 100 kHz, with sample-and-hold capability, and 16 channels of multiplexing. Basically a 12-bit analog-to-digital converter, the unit has controls for interfacing with digital processors or control systems. Throughput rate can be varied manually or by computer control.

CIRCLE NO. 251

Pushbutton coupler varies operating mode

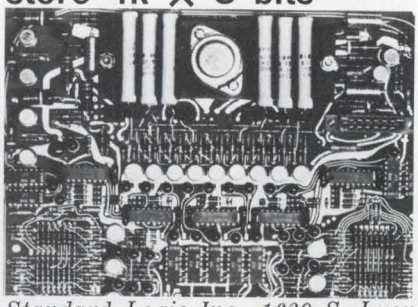


Prentice Electronics Corp., 795 San Antonio Rd., Palo Alto, Calif. P&A: $298; stock.

In a compact plastic case, a new universal data coupler offers pushbutton selection of a variety of operating modes: originate or send (terminal to terminal), full or half duplex, acoustic, and magnetic or direct (DAA) coupling modes. The DC-22 also provides an appropriate interface for Teletype or EIA terminals. In addition, the unit has DAA level adjustments.

CIRCLE NO. 253

Low-cost memories store 4k × 8 bits



Standard Logic Inc., 1630 S. Lyon St., Santa Ana, Calif. Phone: (714) 835-5466. Price: $695 or $1175.

Designed for high-speed random/sequential information storage and retrieval applications, two new low-cost IC core memory systems feature a capacity of 1024 or 4096 words with 8 or 9-bit lengths. Flat-Store units are complete memory systems with a data register, single rail address, timing and control, sense amplifiers, inhibit drivers, decoder drivers and a core stack.

CIRCLE NO. 252

Cartridge disk drives store 12 × 10^6 bits

Diablo Systems, Inc., 23950 Clawiter Rd., Hayward, Calif. Price: $4950.

Intended to simplify maintenance and enhance reliability, series 30 removable-cartridge (single or dual) disk drives provide a file capacity of 12,000,000 bits per cartridge. Including settling time, the units have a track-to-track positioning time of 15 ms and an average time of 70 ms. Average power consumption is under 100 W. Photocells, potentiometers and mechanical detents are not used.

CIRCLE NO. 254

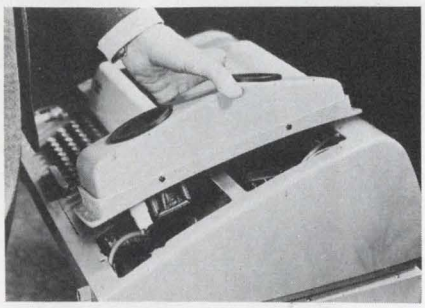
Minicomputer console prints and records

Computer Devices Inc., 167 Albany St., Cambridge, Mass. Phone: (617) 492-4455. Price: $3900.

Designed to satisfy most data handling needs, a new minicomputer console combines the keyboard and printer functions of equipment like the Teletype model 33 with the recording and storage functions of a magnetic tape cassette. Model 3810's keyboard, printer, tape cassette and computer can be connected together in nine different on-line and off-line configurations.

CIRCLE NO. 255

Acoustic data coupler plugs into Teletypes

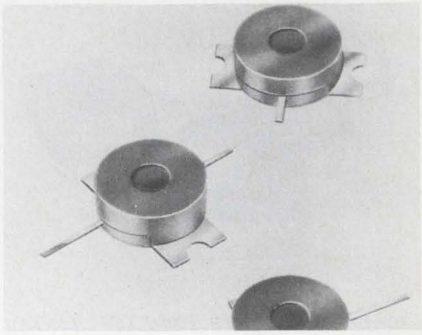


Digital Techniques Corp., 4248 Delemere Court, Royal Oak, Mich.

Quickly installed on Model 33 Teletypes with direct plug-in connections, a self-contained modular acoustic data coupler permits error-free transmission between computers and remote terminals via telephone handsets. Model 3300 is intended for permanent installation on the Teletype machine in place of the normal cover plate. It can be installed in less than five minutes; no Teletype modification is required.

CIRCLE NO. 256

Plastic transistors carry 3 A at 60 V

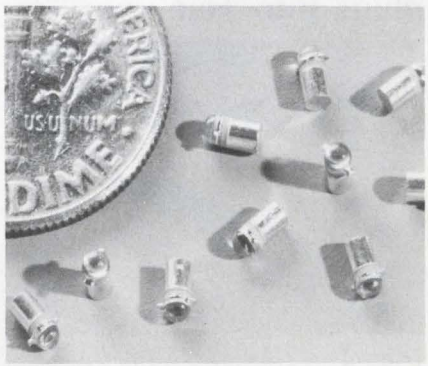


Solitron Devices, Inc., 256 Oak Tree Rd., Tappan, N. Y. Phone: (914) 359-5050. Price: 90¢ typical.

Series B5000 plastic power silicon npn transistors can handle collector currents of 3 A maximum when collector-emitter voltages are as high as 60 V. The new devices are able to deliver short-circuit dc forward current gains as large as 250. Their primary applications include hybrid circuits, power supplies, amplifiers, and industrial driver circuits.

CIRCLE NO. 257

Light-emitting diode mounts on PC boards

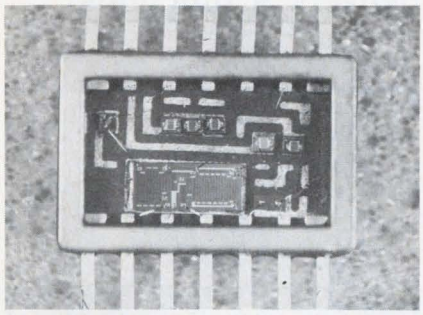


Optron, Inc., 1201 Tappan Circle, Carrollton, Tex. Phone: (214) 242-6571. P&A: $6.60; stock.

A new gallium-arsenide light-emitting diode, model OP-100, is especially suited for mounting directly on printed circuit boards for light-emitter arrays. This miniature component is housed in a glass-to-metal hermetically sealed package. Maximum forward current is 50 mA, and maximum reverse voltage is 2 V. Peak emission is at 9100 Å.

CIRCLE NO. 258

Thin-film regulators drift just 0.001%/°C

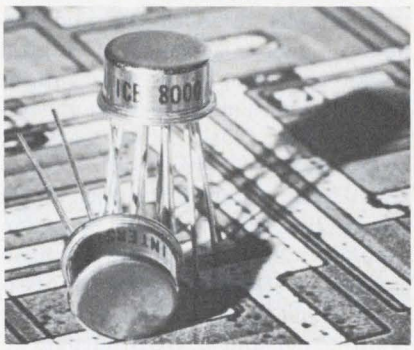


Micro Networks Corp., 5 Barbara Lane, Worcester, Mass. Phone: (617) 756-4635. P&A: $23.40 to $39; stock.

Three thin-film flatpack hybrid voltage regulators feature a typical temperature coefficient as low as 0.001%/°C, a load regulation of 0.001%/mA and a line regulation of 0.005%/V. Models MN210 ($39), MN211 ($31.50) and MN-212 ($26.25) offer maximum temperature coefficients of 0.002%/°C, 0.005%/°C and 0.01%/°C, respectively.

CIRCLE NO. 259

Voltage comparator needs but 5-pA bias



Intersil Inc., 10900 N. Tantau Ave., Cupertino, Calif. Phone: (408) 257-5450. P&A: $22.50; stock.

By using a pair of matched FET devices at its input, the model ICB-8000C low-power voltage comparator achieves an input bias current of 5 pA and an input impedance of 10^{11} Ω. Power dissipation is 30 mW, voltage gain is 60,000, and common-mode rejection is 70 dB. The unit has a response time of only 200 ns.

CIRCLE NO. 262

Power zener diodes trim size by 75%

Components, Inc., Semcor Div., Biddeford, Maine.

One quarter the size of comparable units, new glass power zeners are now available in 1.5-W (1N4461 to 1N4496), 3-W (1N-5063 to 1N5104) and 5-W (1N4954 to 1N4998) ratings. These miniature units offer voltages from 6.8 to 200 V, and operating temperatures of −65 to +200°C.

CIRCLE NO. 260

Programmable UJTs are hermetic units

Solid State Products, Div., Unitrode Corp., One Pingree St., Salem, Mass. Phone: (617) 745-2900. P&A: 90¢; 4 to 6 wks.

Packaged in a TO-18 hermetically sealed metal case, two new programmable unijunction transistors (types ZC1001 and ZC1002) are 40-V devices that can carry forward currents of 150 mA at case temperatures of 75°C.

CIRCLE NO. 263

Double-plug zeners cover 6.2 to 47 V

American Power Devices, Inc., 7 Andover St., Andover, Mass. Phone: (617) 475-4074-5.

Supplied in a double-plug DO-35 package, a new line of zener diodes offers voltage ratings from 6.2 to 47 V. Types 1N710 through 1N730, 1N754 through 1N759, and 1N957 through 1N977 have voltage tolerances of 5, 10 and 20%.

CIRCLE NO. 261

Dual shift registers interface TTL or MOS

General Instrument Corp., 600 W. John St., Hicksville, N.Y. Phone: (516) 733-3333. Price: $13 or $16.75.

Able to interface directly with TTL/DTL or MOS circuits, two new dual static shift registers, a 50-bit (SL-6-2050) and a 64-bit (SL-2064) unit, feature a typical current consumption of only 7 mA.

CIRCLE NO. 264

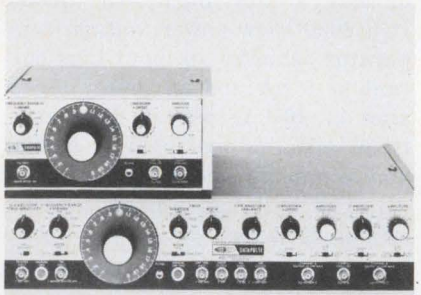
Digital clocks are self-contained

Systron-Donner Corp., Datapulse Div., 10150 W. Jefferson Blvd, Culver City, Calif. Phone: (213) 871-0410. P&A: $395 or $995; 30 or 60 days.

Two new function generators sound a happy note on cost-performance trade-off. The half-rack model 401 for $495 generates sine, triangular and square waves from 0.02 Hz to 2 MHz. The $995 model 410 generates sine, square, triangular, sawtooth, and swept waveforms from 200 μHz to 2 MHz.

CIRCLE NO. 266

Low-cost generators give performance plus

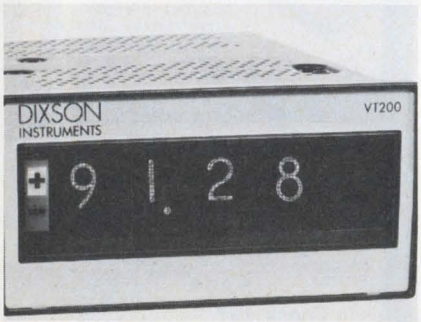


Starmark Electronics, 3710 Main St., Kansas City, Mo.

Available in both 12 and 24-hour models, series 400 digital clocks are completely self-contained and come equipped with the remote control features necessary for systems use. There are three possible time references: the 60-Hz power line, an internal precision oscillator, or input pulses from an external reference. Standard features include presetting from the front panel and a BCD output.

CIRCLE NO. 265

Four-digit panel meter is accurate to 0.05%



Dixson, Inc., P.O. Box 1449, Grand Junction, Colo. Phone: (303) 242-8863. P&A: $330; stock.

Offering either 10-μV or 10-nA resolution, a new digital panel meter features an accuracy of 0.05% of reading (±0.05% of full scale) over the ranges of 100 mV or 100 μA. The VT 200 is a full 4-digit meter with a non-blinking display. It also has automatic polarity, BCD logic output, and an end-of-measurement signal output.

CIRCLE NO. 267

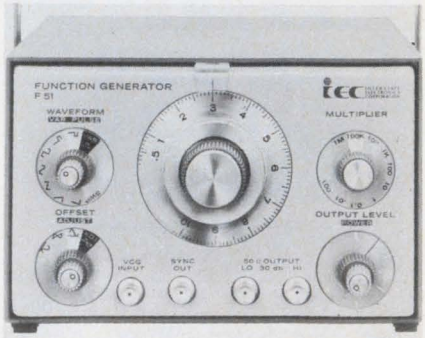
Logic circuit tester eliminates programming

Sangamo Electric Co., P.O. Box 3347, Springfield, Ill. Phone: (217) 544-6411. Price: $7500.

Utilizing a proprietary special-purpose computer, the Comp 200 digital logic circuit tester requires no programming since it generates input word stimuli to a reference logic circuit and the logic circuit under test. The outputs of these two circuits are functionally compared with the final fault detection isolated to an output pin. The tester is DTL/TTL compatible.

CIRCLE NO. 268

Signal source for $595 delivers 9 functions



Interstate Electronics Corp., P.O. Box 3117, Anaheim, Calif. Price: $595.

Operating at an eleven-decade frequency spectrum of 0.0005 Hz to 10 MHz, the model F51 function generator is a universal signal source selling for ony $595. This instrument can produce: variable-width pulses; standard sine, square and triangle waveforms; plus and minus ramps; plus and minus fixed-width pulse waveforms; and sync signals. The output is adjustable.

CIRCLE NO. 269

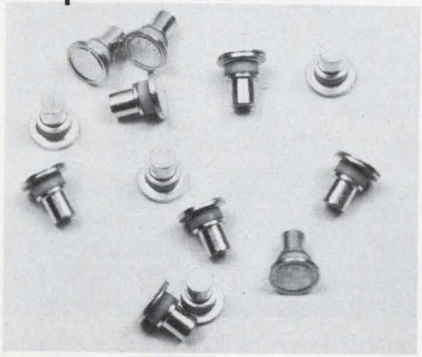
Four-mode generator customizes pulses

Tektronix, Inc., P.O. Box 500, Beaverton, Ore. Phone: (503) 644-0161. P&A: $700; second quarter, 1970.

A new 25-MHz 10-V general-purpose pulse generator offers separately variable period, duration, delay, amplitude and baseline offset. Model 2101 has four operating modes: undelayed pulses, delayed pulses, paired pulses and a dc output. Rise and fall times are 5 ns; pulse duration can range from 20 ns to 400 ms, or to 4 s with an external trigger.

CIRCLE NO. 270

Low-cost 0.5-W impatts keep cool at X band

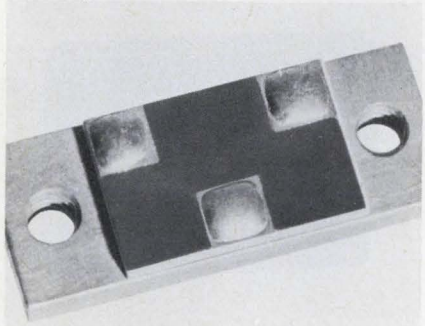


Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 326-7000. P&A: $150; stock.

Generating 500 mW at X band at over 5% efficiency, two impatt diodes with improved heat flow cost only $150 each. Types 5082-0400 (8 to 10 GHz) and 5082-0401 (10 to 12.4 GHz) allow high output power at cool junction temperatures. For example, at a power level of 1/2 W and a diode case temperature of 25°C, the junction temperature is less than 200°C.

CIRCLE NO. 271

Flat attenuator chips dissipate 1/2 to 5 watts

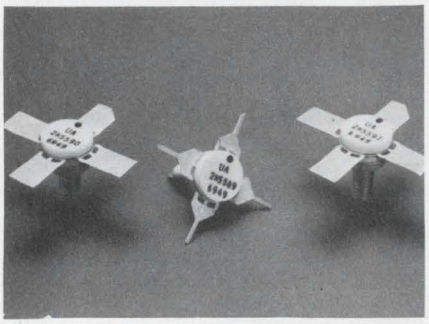


EMC Technology, Inc., 1300 Arch Street, Philadelphia, Pa. Phone: (215) 563-1340. Price: $7.75 to $20.

A new line of flat stripline chip attenuators dissipate from 1/2 to 5 W of power. Attenuations of 1 to 20 dB and tolerances of 10% or 1/2 dB are possible. A VSWR of less than 1.2 and a frequency limit of 4 GHz are featured. The chips are used in circuits where the ground must float a dc voltage at other than chassis ground.

CIRCLE NO. 272

Three power transistors span 3-to-25 Watts



United Aircraft Electronic Components Div., Trevose, Pa. Phone: (215) 355-5000. P&A: $7, $14, $24; stock.

Three new silicon vhf power transistors, 2N5589, 2N5590 and 2N5591, provide outputs of 3, 10 and 25 W, respectively. They operate at 13.6 V and feature tantalum nitride emitter-ballasting resistors. High-tolerance resistors used provide protection against hot spots and premature failure. Strip-line packaging in TO-71 and TO-72 cases ensure low inductances.

CIRCLE NO. 273

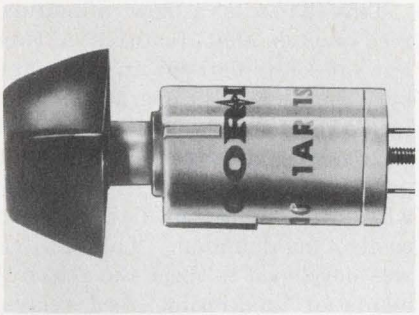
Flatpack film couplers cover 30 MHz to 2 GHz

Merrimac Research and Development, Inc., 41 Fairfield Pl., W. Caldwell, N.J. Phone: (201) 652-7200. P&A: $40; 30 days.

Exhibiting octave bandwidths, Filmbird series of film hybrid quadrature couplers can parallel transistor power amplifiers from 30 MHz to 2 GHz. One coupler in the series, the QHF-2-.312G, spans the frequency range of 225 to 400 MHz at −3-dB coupling. It features amplitude balance of ±0.4 dB and a phase quadrature of 90 ±2 degrees.

CIRCLE NO. 274

Tiny keyboard switch has 5/8-in. centers

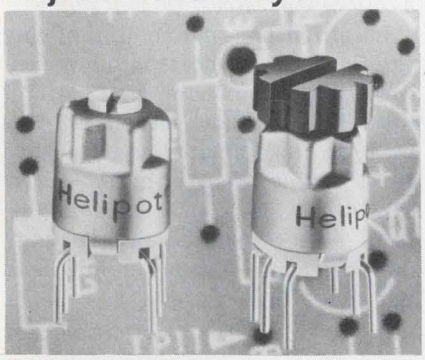


Gordos Corp., 250 Glenwood Ave., Bloomfield, N.J. Phone: (201) 743-6800. Price: $2.40.

Measuring only 1.6-in. long and 0.62-in. in diameter, a new keyboard push-button reed switch reduces keyboard size by mounting on 5/8-in. centers. The Feathertouch uses a pick magnet for switch actuation to eliminate magnetic interaction between closely-spaced switches. Contact resistance is 200 mΩ at 6 V dc and 100 mA, and maximum current is 0.25 A.

CIRCLE NO. 275

PC rotary switch adjusts two ways

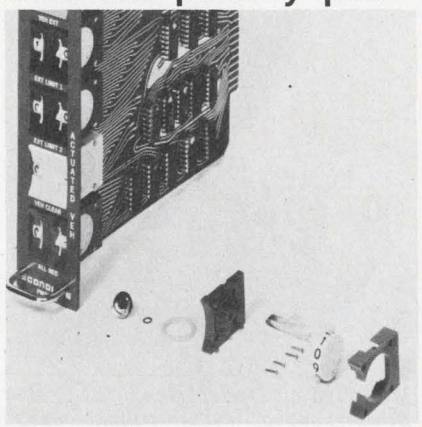


Beckman Instruments, Inc., Helipot Div., 2500 Harbor Blvd., Fullenton, Calif. Phone: (714) 871-4848. Price: $2.75, $3.

Available in two versions, a new one-pole six-position rotary cermet switch is adjustable by a screwdriver slot (model 374) or a thumbwheel control (model 374H). It is designed for PC-board mounting and measures 1/4 in. in diameter. It includes a precious-metal wiper and a positive-action detent. Current rating is 100 mA at 28 V dc.

CIRCLE NO. 276

PC thumbwheel switches assemble part by part

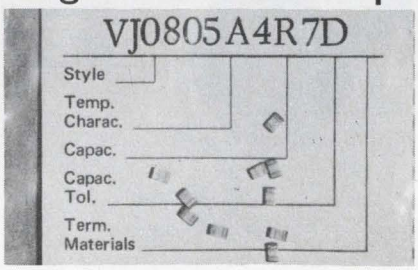


Electronic Engineering Co. of California, 1441 E. Chestnut Ave., Santa Ana, Calif. Phone: (714) 547-5651

Requiring no soldering or wire leads, the series 8000 thumbwheel switches mount directly to printed-circuit cards and become an integral part of the cards. They are shipped in component parts and mount in seconds. The user incorporates the switch stator pattern on the mother board. Mounting can be on any edge of the PC board.

CIRCLE NO. 278

Low-capacitance chips range over 1 to 9.1 pF



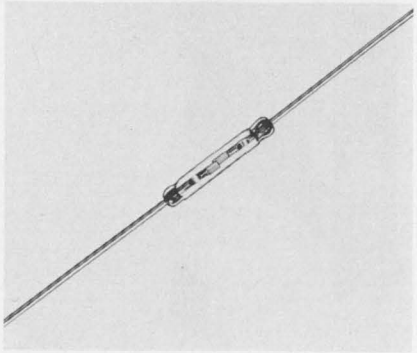
Vitramon, Inc., Box 544, Bridgeport, Conn. Phone: (203) 268-6261.

Developed for requirements of low-value and high-stability capacitance are new NPO ceramic chips with values from 1 to 9.1 pF. They are available in standard decade values and measure 0.8 × 0.05 × 0.01 in. They feature a tolerance of ±0.5% with a temperature characteristic of 0 ±30 ppm/°C. Operating temperature range is −55 to +125°C and dissipation factor is 0.1%.

CIRCLE NO. 277

INFORMATION RETRIEVAL NUMBER 105 ►

Miniature reed switch shrinks dia to 0.07 in.

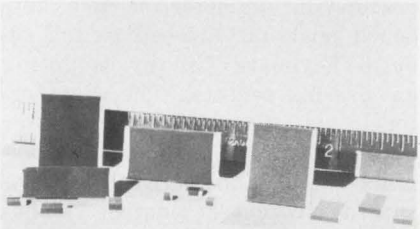


Gordos Corp., 250 Glenwood Ave., Bloomfield, N.J. Phone: (201) 743-6800: Price: $1.20.

Tiny Tina is a new miniature reed switch that features a tiny size of only 0.07-in. in diameter by 0.5-in. long. Its operating time, including bounce, is 250 μs, and it consumes less than 50 mW of power while switching. Its leads, which are 0.02-in. in diameter, are easily manipulated. The switch was developed to meet the requirements of dual-in-line reed relays.

CIRCLE NO. 281

High-capacitance chips up value-to-size ratio

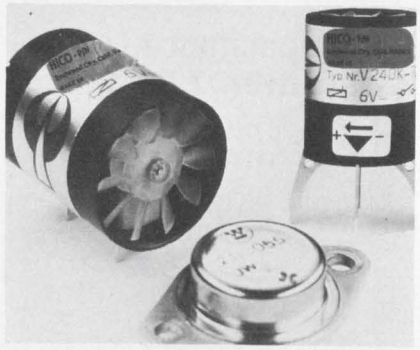


Monolithic Dielectrics, Inc., Box 647, Burbank, Calif. Phone: (213) 848-4465. P&A: from 10¢; stock to 4 wks.

Offering a high capacitance-to-volume ratio, a new line of NPO ceramic chip capacitors includes values up to 1800 pF in a chip size of 0.15 × 0.05 × 0.05 in. Specifications include a dissipation factor of 0.01% and a temperature coefficient of ±20 ppm. Insulation resistance is greater than 10^{12} Ω at 25°C and 5 × 10^{10} Ω at 125°C.

CIRCLE NO. 282

Tiny fast blower cools on-the-spot

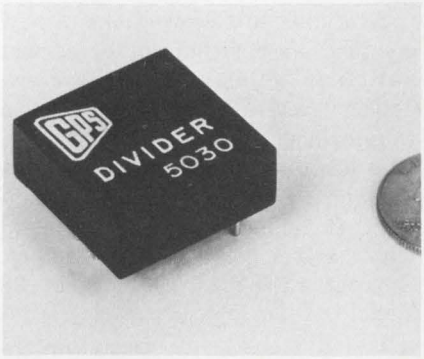


Horizons International, E. Fuller at Middlefield, Redwood City, Calif. Phone: (415) 369-7900. Availability: stock to 2 wks.

Localized hot-spot cooling of any point-source of heat is now possible with the new tiny Micro-Kool blower that measures only 15/16-in. in diameter and operates at 1 cubic foot/minute. It is 1-3/16-in. long and is available with either printed-circuit end/side leg mountings or a bulkhead side mounting.

CIRCLE NO 283

Hybrid 1-MHz divider sizes up to 0.5 in.^{3}

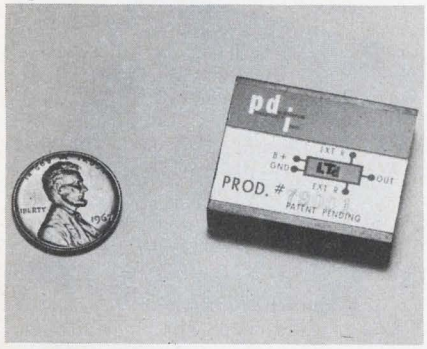


GPS Instrument Co., Inc., 14 Burr St., Framingham, Mass. Phone: (617) 875-0607. P&A: $105; stock to 1 wk.

Requiring no external amplifiers, a new encapsulated hybrid linear divider measures only 1.12 × 1.12 × 0.4 in. The D 5030 has a −3-dB small-signal bandwidth of 1 MHz and a full-power bandwidth of 150 kHz. Full-scale accuracy is 1% for an X input of ±10 V and a Y input from 0 to −10 V. It includes automatic gain control and low-level modulation.

CIRCLE NO. 284

Tiny time-delay units span 10 ms to 100 s

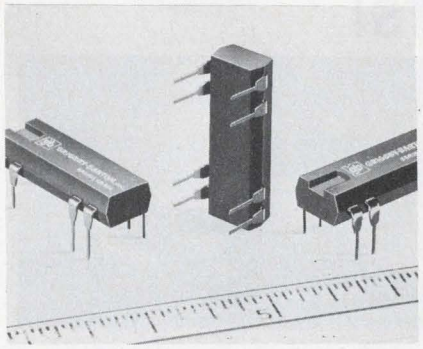


Product Designs Inc., 111 Cardenas, N.E., Albuquerque, N.M. Phone: (505) 265-3551. P&A: from $35; stock.

Occupying less than 0.5 cubic in. are new time-delay modules with delays from 10 ms to 100 s. Overall accuracy is ±5% and repeat accuracy is better than ±0.5%. Operating voltage may be selected in a range of 5 to 50 V dc. Load currents up to 500 mA are provided and only 10 mA of idling current is used.

CIRCLE NO. 285

DIP 8-pin reed relays reduce price to $1.90

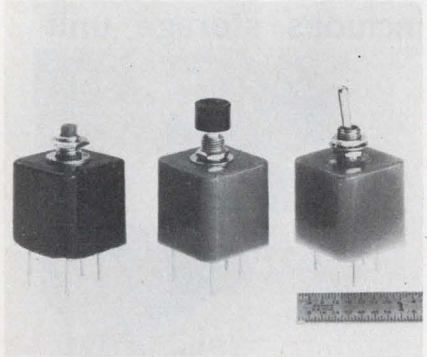


Grigsby Barton, Inc., 107 N. Hickory Ave., Arlington Heights, Ill. Phone: (312) 392-5900. P&A: $1.90; 4 wks.

The GB814 series relays are miniature eight-pin low-cost dual-in-line reed units selling for $1.90 each, in quantities of 1000. They are compatible with all DIP IC devices and fit into 14-pin DIP receptacles. They are designed for spst dry-reed switching and include coils for IC drivers at 10 mA and 40 mA at 5 V.

CIRCLE NO. 287

Solid-state modules ban switching bounce

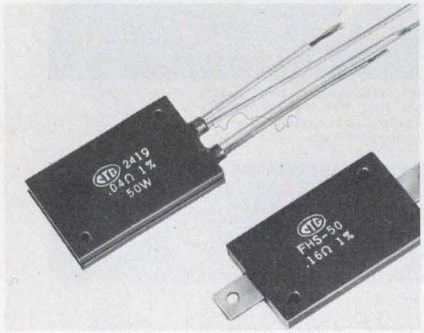


Holiday Engineering, 2540 Teresina Dr., Hacienda Heights, Calif. Phone: (213) 336-0821. P&A: $8.95, $14.50, $11.95; stock to 30 days.

The series 100 solid-state modules use conditioning circuitry for bounce-free switching. Each has complementary outputs and drives 20 5-V TTL or DTL loads. Model 105 has a standard pushbutton. Model 106 has soft-touch pushbutton with an optional colored cap. The model 107 uses a toggle switch.

CIRCLE NO. 286

Wafer-type resistors dissipate up to 50 W



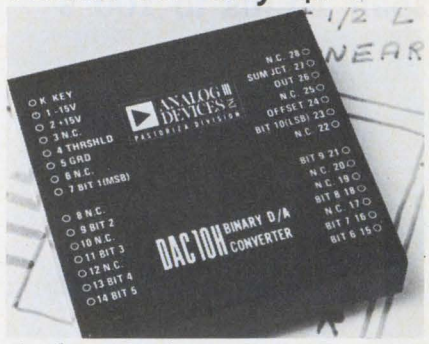
Charles T. Gamble Industries, Fairview St. & New Jersey Ave., Riverside, N. J. Phone: (609) 461-1900.

Featuring wafer construction, a new line of flat heat-sink power resistors dissipate up to 50 W of power. They span the resistance range of 0.003 to 25 Ω and exhibit a low temperature coefficient of ±5 ppm. Standard tolerances are ±5% and extend to ±0.05% (with four-wire construction or at specified termination points). They are non-inductive and can be chassis-mounted.

CIRCLE NO. 288

INFORMATION RETRIEVAL NUMBER 107 ►

Ten-bit d/a converter retails for only $75

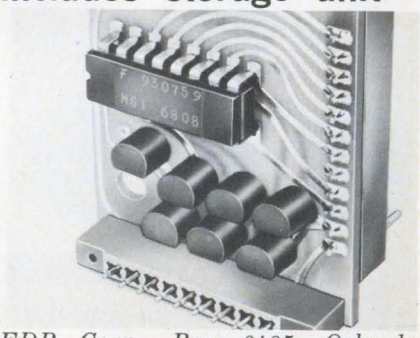


Analog Devices, Inc., Pastoriza Div., 221 5th St., Cambridge, Mass. Phone: (617) 492-6000. P&A: $75; stock.

Including a built-in reference, ladder network switching circuits and an output amplifier, a new 10-bit d/a converter lists for only $75. The DAC-10H has a settling time of 20 μs to 0.05% of output, and an output of 10 V full scale at 5 mA. Linearity is $\pm 1/2$ the least significant bit, and temperature coefficient is ± 70 ppm/°C. Operating power is ± 15 V at 25 mA.

CIRCLE NO. 289

Readout decoder/driver includes storage unit

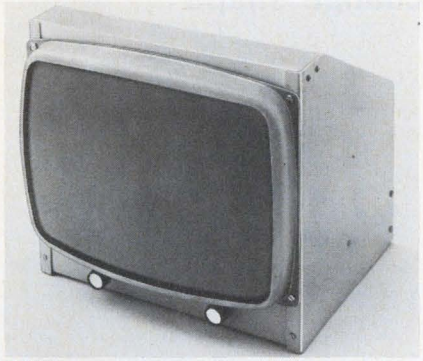


EDP Corp., Box 6485, Orlando Beach, Fla.

Driving seven-segment readouts, the series 100 decoder/driver unit includes a new storage module (number 100A010.) It is compatible with standard DTL and TTL levels and features a small size of only 2 × 1.34 × 0.69 in. Included are a brightness control, a lamp-test capability, zero blanking and a memory. Applications for this modular and compact device include data displays, instrumentation, clocks and counters.

CIRCLE NO. 290

CRT display monitor brings cost under $80

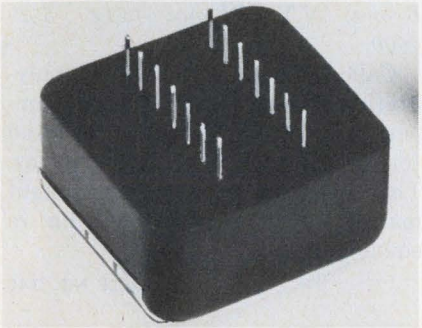


Killian Engineering Corp., 281 Wood Rd., Braintree, Mass. P&A: under $80; 60 days.

A low-cost (under $80 in quantity) video display monitor combines high reliability and simplicity with a size of 10-1/2 × 11-1/2 × 11 in. Using a 12-in. diagonal CRT, it accepts a standard composite video input and displays information with a 500-line resolution. It operates from 12 V dc or 120 V ac 50/60 Hz. Warm-up time is negligible since it is all solid state.

CIRCLE NO. 291

Clock oscillators are 14-pin DIPs



Spectrum Technology, Inc., Box 318, Goleta, Calif. Phone: (805) 964-7791.

Featuring small size and low power consumption, the series 7004 crystal oscillators/IC logic clocks plug into standard 14-pin dual-in-line sockets. They measure only 1/3 $in.^3$ and span the frequency range of 1 to 100 MHz. Their rated accuracy at 25°C is ±10 ppm and operating temperature range is −55 to +105°C. Stability versus temperature is ±0.005%.

CIRCLE NO. 292

Gated hybrid driver handles loads to 1 A

Sylvania Electric Products Inc., 730 3rd Ave., New York, N.Y. Price: $8.50, $17.90.

Available in two versions, a new gated hybrid high-power driver in a TO-100 case drives loads up to 1 A. The industrial version (MS401) operates from 0 to 70°C, and the military version (MS-401M) operates from 55 to 125°C. Both units interface between logic level inputs and high-power loads. The output can accommodate voltage tunings at the load of up to 65 V.

CIRCLE NO. 293

Miniature dual supplies measure 2 × 2 × 0.4 in.

Datel Systems Corp., 943 Turnpike St., Canton, Mass. Phone: (617) 828-1890. P&A: $79; 2 wks.

Measuring only 2 × 2 × 0.4 in., two new dc supplies power MOS/LSI ICs with dual outputs of −28 V dc at 100 mA and −14 V dc at 150 mA. Models BPM 28/14 (115-V-ac input) and BPM 28/14D (5-V-dc input) have input isolation transformers and regulate for line and load at ±0.05%. Transient response from no load to full load is 50 μs. Both mount on PC boards.

CIRCLE NO. 294

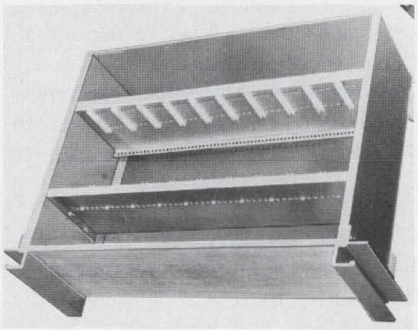
Op amp with 5-pA offset lowers cost to $14.50

Polytron Devices, Inc., 844 E. 25th St., Patterson, N.J. Phone: (201) 523-5000. Price: $14.50.

With an offset current of 5 pA and voltage drift of 35 μV/°C, a new FET operational amplifier retails at only $14.50. The P20107 has an input impedance of 10^{12} Ω and voltage gain of 250,000. Output voltage is ±11 V at ±5.5 mA.

CIRCLE NO. 295

Prefabricated cases adjust card racks



G. C. Electronics Inc., 2126 Hurfus, Houston, Tex. Phone: (713) 622-9983. Price: from $62.50.

Available in full or half-rack sizes for bench or rack designs, prefabricated instrument cases feature pre-punched adjustable card racks with molded PC-board guides. The cases, which are 5-1/2 in. high, use metal trim of clear anodized aluminum for a professional appearance. Special interlocking feet permit stacking with perfect case alignment.

CIRCLE NO. 296

Microcircuit retainer fits 0.65 × 1-in. units

International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif. Phone: (213) 849-2481. P&A: $1.02; stock.

Featuring a staggered-finger design for efficient heat dissipation, a microcircuit dissipator/retainer accommodates packages that measure 0.65 × 1 in. The retainer-clip (DC065100B) may also be used alone.

CIRCLE NO. 297

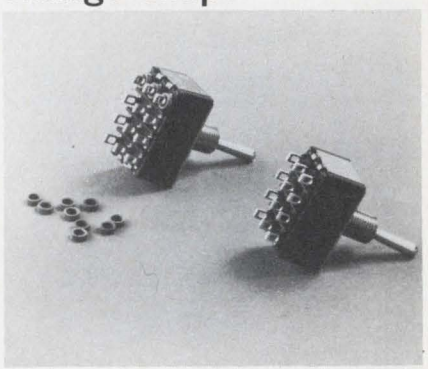
Clear epoxy coating goes up to 500°F

Emerson & Cuming, Inc., Dielectric Materials Div., Canton, Mass. Phone: (617) 828-3300. Price: $36.40/kit.

Eccocoat C-26 is a clear two-part epoxy coating that maintains a surface resistivity of 10^{14} ohms per square at temperatures as high as 500°F. Intermittent use above 500°F is also possible.

CIRCLE NO. 298

Epoxy pellets change shape



Amicon Corp., Polymer Products Div., 25 Hartwell Ave., Lexington, Mass.

A new line of fast-curing epoxy pellets can be supplied in a variety of shapes such as cylinders, discs, or squares with one or more holes. They offer a convenient method of applying a given amount of epoxy to a specific area. In addition, the pellets do not require mixing and cure at 200°F. They can be used to join dissimilar materials.

CIRCLE NO. 299

Flexible foam cures in room

Adhesive Products Corp., Polyurethane Div., 1660 Boone Ave., Bronx, N.Y. Phone: (212) 542-4600.

Called Foamart, a flexible polyurethane foam cures at room temperature, thus eliminating the need for heated molds or curing ovens. This easy-to-use two-component material only requires mixing in equal parts.

CIRCLE NO. 340

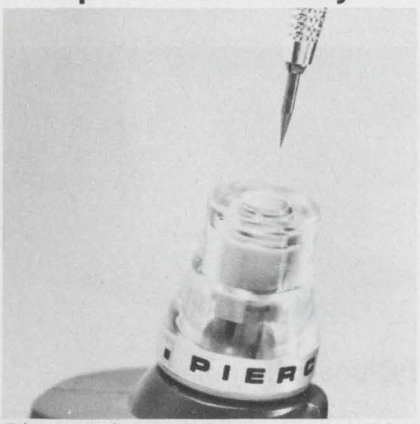
Cryogenic epoxy withstands —400°F

Thermalloy Co., 8717 Diplomacy Row, Dallas, Tex. Phone: (214) 637-3333.

Intended for cryogenic applications, Thermabond thermally conductive epoxy can operate at temperatures as low as —400°F. It bonds equally well to porous and non-porous materials. Minimum dielectric strength is 500 V/mil.

CIRCLE NO. 341

Drafting lead pointer sharpens electrically



Pierce Corp., Instrument Div., River Falls, Wis. Phone: (715) 425-6761.

A lead pointer attachment for several electric erasers puts a strong perfectly tapered point on drawing leads in less than one second. Pointer 1001 slides easily into the rear of the eraser powershaft with no tools required. A special gasket seals in graphite dust and also wipes the point clean as the lead is withdrawn. The unit has carbide blades and a free floating cutter assembly.

CIRCLE NO. 342

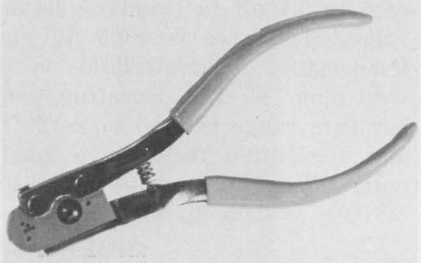
Vacuum solder pickup has reusable filter

Lectro Precision Tools, Inc., P.O. Box 1360, Minneapolis, Minn.

Designed to remove excess solder from printed circuit connections, a new vacuum solder pickup features a Teflon tip, a cleanable reusable filter, and an unbreakable nylon body. The VSP's tip is adjustable, and may be trimmed and shaped to fit the smallest circuit job. There are three tips supplied with each tool. Tip sizes can be 1/8, 3/32 or 1/16 in. Two different body sizes are also available.

CIRCLE NO. 344

Lead shear cutter varies pin length



Techni-Tool, Inc., 1216 Arch St., Philadelphia, Pa. Phone: (215) 568-4457.

Able to cut all three semiconductor leads at the same time, a new lead shear cutter has an adjustable wire stop that can vary lead length from 1/8 to 7/8. The 20245 tool will cut three burr-free leads in TO-92, TO-5, TO-18 and TO-52 packages. The device pins can be on a 0.1 or 0.2 in. diameter. Center in-line patterns of 0.05 or 0.1 in. can also be accommodated.

CIRCLE NO. 343

Fiberglass pen brush cleans without marring

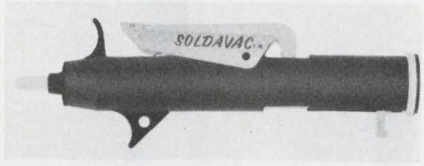
Paragon Sales Co., Wybar Electronics Co., Inc., P.O. Box 81, Brielle, N.J. Phone: (201) 223-3862.

A fiberglass-filament pen brush can clean delicate terminals and contacts without damage to the precious metal plating. Ideal for recapturing, improving or pinpointing corrective areas, the new pen brush eliminates the need for stencil knives by using very fine fiberglass filaments as the cleaning element. Because fiberglass can wear away, the area being corrected can never be harmed.

CIRCLE NO. 345

INFORMATION RETRIEVAL NUMBER 111 ►

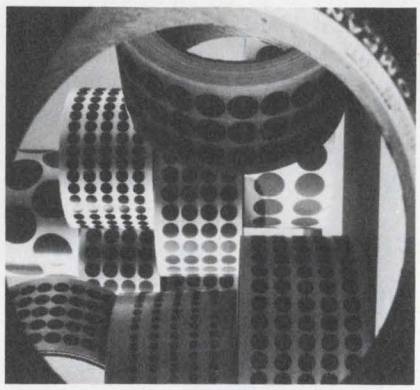
Evaluation Samples



Solder puller

The Soldavac is a new desoldering tool that normally retails for $2.95 but is available free of charge to readers of ELECTRONIC DESIGN on a limited-quantity basis. To use it, simply push its spring-loaded plunger forward until it latches. After a soldered connection is reheated, press a lever on the side and solder will be pulled up instantly and cleanly. The Soldavac can be easily taken apart for cleaning. Edsyn, Inc.

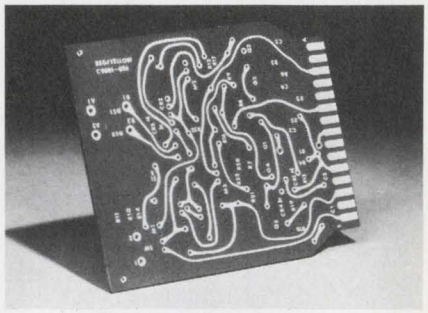
CIRCLE NO. 346



Colored marking discs

Brightly colored and immediately recognizable, new pressure-sensitive colored marking discs can be used for color coding, identification, pricing, chartmaking and decorating. The surfaces of these discs can be labeled since their finish will accommodate almost all commonly used marking or writing implements. Individually die cut, the discs are available in five sizes: 1/8, 1/4, 3/8, 1/2 and 3/4 in. They are packaged in rolls or on an easy-release backing paper. Paper-marking discs come in a choice of six standard and four fluorescent colors; vinyl discs are offered in six colors. Free evaluation samples are available. By-Buk Co.

CIRCLE NO. 347



PC-board laminate

A new printed-circuit board material known as Insultruc is available as a free evaluation sample. It is a copper-clad glass polyester laminate that is useful in applications requiring superior toughness at low costs. Its Izod impact strength is 1 ft-lb and its solder dip resistance is 20 seconds. It is available in standard sheets of 30 × 48 in. Cut panels can be furnished on special order. Cincinnati Development & Manufacturing Co.

CIRCLE NO. 348

Chip capacitors

A free sample packet of new low-value chip capacitors is available. These NPO ceramic chips span the capacitance value range of 1 to 9.1 pF in standard decade values. Tolerance is ±0.5 pF and temperature characteristic is 0 ±30 ppm/°C. The operating temperature range is −55 to +125°C and dissipation factor is a maximum 0.1%. Dimensions are 0.08 × 0.01 × 0.05 in. Vitramon, Inc.

CIRCLE NO. 349

Self-adhesive labels

Brushed Metallic are new labels that use a silver-coated polyester film to give the appearance of brushed aluminum. They are available in a glossy or matte finish with four-color printing. Five colors can be achieved with a pretint process. Uses include electronic instruments, home appliances, office and automotive equipment plus many other items. Free evaluation samples are available. Avery Label Co.

CIRCLE NO. 350

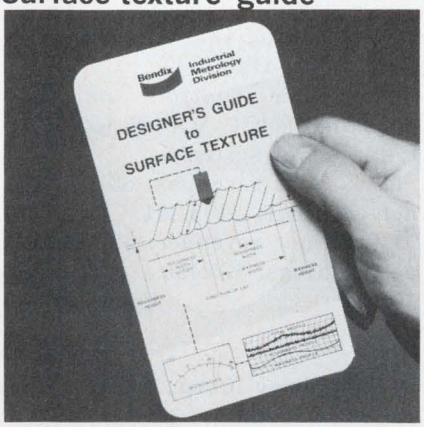
Design Aids

System/frequency card

Pinpointing various Army-Navy system designations, a new wallet-size card describes the method used for classification of Army and Navy systems. On the back side of the card is a complete table of frequency bands—P band through V band. This chart lists the frequency ranges as well as the wavelength for each of the bands. Electronic Resources.

CIRCLE NO. 351

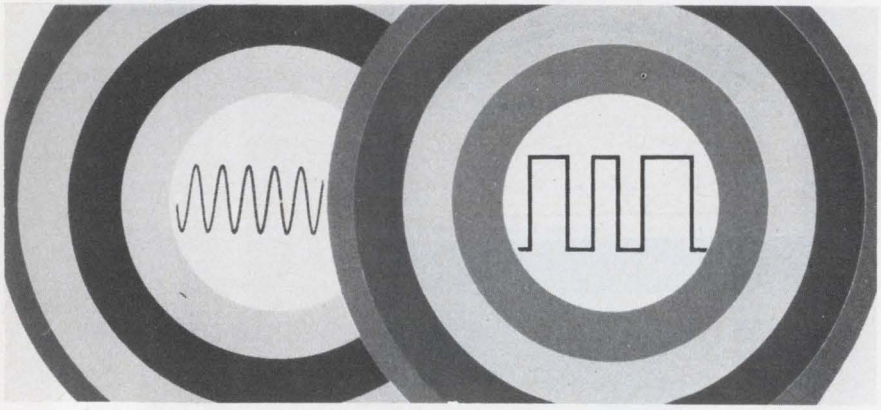
Surface-texture guide



A pocket-size booklet provides designers with a handy reference guide on surface texture. Comprised of four pages, it lists the characteristic properties of surface textures and explains their relationship to each other. It also shows the methods recommended by American Standard ASA B46.1 for specifying surface finish on drawings. Also given are examples of various lay patterns and the symbols used to designate them. In addition, there is a table showing the effects of different machining methods on surface texture. Bendix Automotive & Automation Co., Industrial Metrology Div.

CIRCLE NO. 352

Annual Reports



Stepping motors for control processes, electronic translators and indexers, numerical-positioning tables and computer software are the many products of the **Superior Electric Co.**, of Bristol, Conn. Its net sales for 1969 were $24,958,963 and net earnings were $1,702,863. For 1968, net sales were $19,462,940 and net earnings were $706,894.

CIRCLE NO. 353

Aerospace Corp., 2350 El Segundo Blvd., El Segundo, Calif.

Systems engineering and research for aerospace vehicles, missiles and solar systems.

1969: income from contracts including fees, $76,318,801.

1968: income from contracts including fees, $75,092,122.

CIRCLE NO. 354

Analog Devices, Inc., 221 Fifth St., Cambridge, Mass.

Operational amplifiers, comparators, analog-to-digital and digital-to-analog converters.

1969: net sales, $8,764,933; net income, $615,692.

1968: net sales, $5,749,590; net income, $500,903.

CIRCLE NO. 355

Baird-Atomic, Inc., 125 Middlesex Turnpike, Bedford, Mass.

Spectrochemical equipment, nuclear medical instruments, optics and electro-optics.

1969: net sales, $14,368,384; net income, $781,316.

1968: net sales, $11,911,152; net income, $1,343,625.

CIRCLE NO. 356

Digitronics Corp., 1 Albertson Ave., Albertson, N.Y.

Tape and printer readers, terminals, handlers and recorders, keyboards, indicator lights.

1969: sales, $13,583,754; net income, $1,030,666.

1968: sales, $11,176,218; net income, $183,591.

CIRCLE NO. 357

Dyansil Corporation of America, P.O. Box D, Berlin, N.J.

High-purity synthetic fused silica for laser optics and optical instrumentation.

1969: net sales, $292,075; net income, $66,605.

1968: net sales, $220,915; net income (loss), ($51,247).

CIRCLE NO. 358

Graphic Sciences, Inc., Corporate Dr., Danbury, Conn.

Graphic transmission systems for automatic answering and unattended reception, data modems.

1969: revenues, $3,397,864; net income (loss), ($2,209,168).

1968: revenues, $341,333; net income, $26,993.

CIRCLE NO. 359

Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif.

Instruments for electronics, medicine, biology, and chemistry.

1969: total income, $326,542,000; net income, $25,585,000.

1968: total income, $272, 416,000; net income, $20,825,000.

CIRCLE NO. 360

Lundy Electronics & Systems, Inc., Glen Head, N.Y.

Computer peripherals, marine pollution control and defense.

1969: net sales, $15,646,556; net earnings, $107,482.

1968: net sales, $15,363,611; net earnings, $544,616.

CIRCLE NO. 361

Ohmart Corp., 4241 Allendorf Dr., Cincinnati, Ohio.

Electronic controls and systems and density gauges for pollution control systems.

1969: net revenues, $3,231,585; net earnings, $107,251.

1968: net revenues, $2,814,967; net earnings, $75,485.

CIRCLE NO. 362

Perkin-Elmer Corp., Main Ave., Norwalk, Conn.

Analytical instruments, optics and electro-optics, avionic control and navigation systems.

1969: net sales, $199,446,000; net income, $7,571,000.

1968: net sales, $151,159,000; net income, $5,946,000.

CIRCLE NO. 363

Worldwide Computer Services, Inc., 280 N. Central Park Ave., Hartsdale, N.Y.

Computer software for education and communications.

1969: net sales, $126,969; net income, $9,804.

1968: net sales, $92,570; net income, $5,677.

CIRCLE NO. 364

Application Notes

Unijunction transistors

Starting off with a look at a basic unijunction transistor (UJT), including equivalent circuits, a 10-page application note goes on to explain the dependence of UJTs on temperature. Another topic is the programmable UJT. There are also examples of how to use these devices efficiently. Illustrated applications include pulse generators, thyristor firing circuits, and timing circuits. Telefunken Sales Corp.

CIRCLE NO. 365

Electro-optics

"Advances in Optical Technology and Electro-Optical Systems for Space" is a 76-page illustrated collection of selected talks presented at the 1969 Electro-Optical Design Conference. Articles include beryllium mirror technology, low-light-level lenses, X-ray telescopes, membrane optics, holography, and laser space communication. Optical Operations Div., Perkin-Elmer Corp.

CIRCLE NO. 366

Strain gauge handbook

Consisting of eight information-packed sections, a semiconductor strain gauge handbook covers theory, data reduction, n-type self-compensating gauges, applications, transducers, gauge selection and strain measurement. The last and newest section on computer data reduction describes the basic problems involved, the availability and applicability of time-share computers for data reduction, guidelines for computer analysis programs, and five appropriate programs, each with its own typical data run. BLH Electronics, Inc.

CIRCLE NO. 367

Computer software

The pros and cons of developing your own computer software versus purchasing existing software packages are discussed in a new booklet. It outlines the area that should be considered when estimating in-house costs of software development. It also shows what to look for in procuring software packages that have already been developed. Computing Corp. of America, Inc.

CIRCLE NO. 368

Microwave devices

A revised 16-page technical brochure on microwave devices describes performance and typical applications of a new generation of microwave gridded vacuum tubes and microwave circuit modules. The microwave gridded vacuum tube is considered as a planar triode in terms of modern electronic system needs. Also discussed are applications and the general performance and feature comparisons of various microwave devices. Tube Dept., General Electric Co.

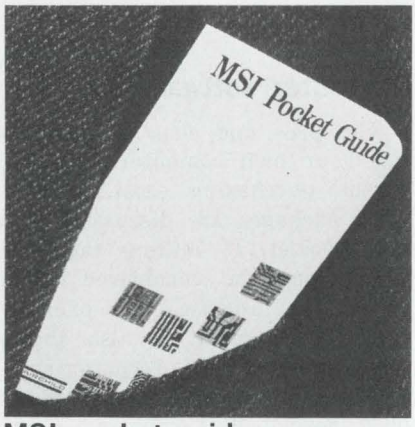
CIRCLE NO. 369

Insulating resins

Two new publications describe different aspects of silicone resins for electrical insulation. One publication provides a summary of the properties and applications of silicone resins for electrical insulation. Graphs, tables, general information and applications data are included. The other publication serves as a detailed guide to various products for applications in silicone varnished flexible insulation, silicone resin-bonded rigid insulation, silastomer flexible insulation and other silicone insulants. Midsil Corp.

CIRCLE NO. 370

New Literature



MSI pocket guide

The "MSI Pocket Guide" is a new 100-page reference source that is available to those who seek basic information about MSI (medium scale integration) products. It provides easy-to-find data on MSI circuit function, pin-out and loading rules, thereby eliminating the time-consuming task of extracting this information from data sheets. A basic description of many simple bipolar integrated circuits commonly used with devices in the MSI family is also given. Fairchild Semiconductor.

CIRCLE NO. 371

Digital instruments

Digital voltmeters, panel meters, thermometers, data acquisition systems and calibrators are described in a 35-page catalog. It contains discussions, general specifications and illustrations of these instruments. It also includes applications information and dimensional outlines. Digitec Div. of United Systems Corp.

CIRCLE NO. 372

Terminal blocks

Catalog C-106 is a 36-page publication listing a wide variety of terminal blocks, connectors, cable fittings and crimping tools. It includes all pertinent specifications, descriptions, dimensions and illustrations. Also included is the necessary ordering information. Buchanan Electrical Products Corp.

CIRCLE NO. 373

Switches

Several types of switches are fully described in a new 44-page catalog. It details 21 series of switches with specifications and descriptions, including rotary, selector, snap-action, low-energy contact, push-button and subminiature types. A separate page includes a switch selector-locator table to assist in choosing the right switch. Another page defines and illustrates some common snap-action switch terms. Cherry Electrical Products Corp.

CIRCLE NO. 374

Connectors

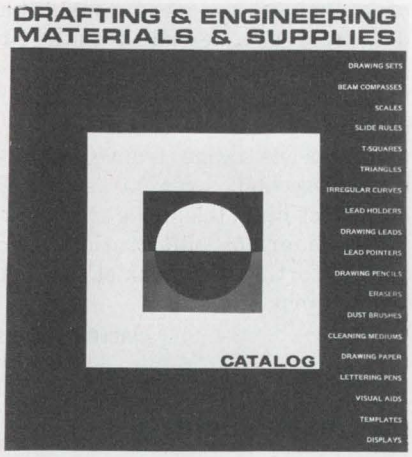
Detailed information on two series of rack-and-panel connectors is contained in a 12-page illustrated catalog. The connectors listed include one series of connectors with 8 to 32 contacts and another series of connectors with 14 to 50 contacts. The catalog includes complete mechanical and electrical specifications, performance characteristics and available hardware and accessories. Data for ordering variations of stock units to meet specific requirements is also included. Cinch Manufacturing Co., Div. of United-Carr Inc.

CIRCLE NO. 375

HV power supplies

A six-page brochure describes high-voltage dc power supplies and the design of ion optical systems. The power supplies are extremely compact with maximum dc voltages from 100 kV up to several million volts and current capabilities of tens of milliamperes. Their ripple is lower than conventional capacitor-rectifier voltage multipliers, and they stabilize to a few parts per million. High voltage is generated by a series of independent, identical 40-kV decks placed adjacent to one another in a manner analogous to the stacking of flashlight batteries. Deltaray Corp.

CIRCLE NO. 376



Drafting supplies

A wide selection of drafting, drawing and engineering supplies are covered in a new 72-page catalog. It includes such items as drawing sets, compasses, scales, lettering pens, cleaning mediums, slide rules, T-squares and triangles. Also included are irregular curves, lead holders and pointers, drawing leads, erasers, dust brushes, templates, visual aids, displays and drawing paper. Alvin & Co. Inc.

CIRCLE NO. 377

Process instrumentation

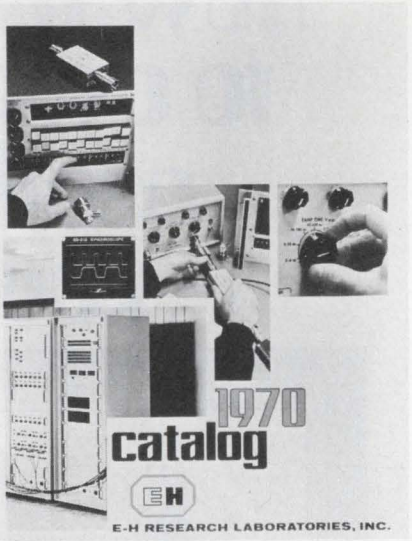
A variety of publications on the subject of process instrumentation are described in a 24-page booklet. It lists textbooks written by experts in their field, as well as handbooks, article reprints, and product and application bulletins. Each publication listed is described with a short summary. The Foxboro Co.

CIRCLE NO. 378

Screen inks and resists

Screen inks and resists for printed-circuit applications are described in a new twelve-page reference brochure. Included are applications characteristics and detailed instructions for using alkali removable etch resists, plating resists and board-marking inks. Also included are instructions for permanent and removable-type masks. Colonial Printing Ink Co.

CIRCLE NO. 379



Instruments and systems

A new four-color catalog contains information on instruments, components and systems in three sections. One section shows pulse generators, oscillators and accessories. A second section contains data on analysis, stimulus and control modules. The last section describes automatic test systems for semiconductors and magnetic memories. E-H Research Laboratories, Inc.

CIRCLE NO. 380

PC-card enclosures

A 16-page guide describes and illustrates a complete line of aluminum PC-card enclosures. They are equipped with connectors and wire-wrapped interconnections and can be supplied as complete packaging systems. They are available in 32 standard models and accommodate special packaging requirements at little or no tooling cost. Elco Corp.

CIRCLE NO. 381

Silicones

A complete line of silicone industrial products is cataloged in a new 44-page book. It is divided into four sections—RTV silicone rubber, greases and compounds, fluids, and insulating varnishes. Each section contains a product and property listing, application techniques and recommended handling procedures. General Electric Silicone Products Dept.

CIRCLE NO. 382

Data sets

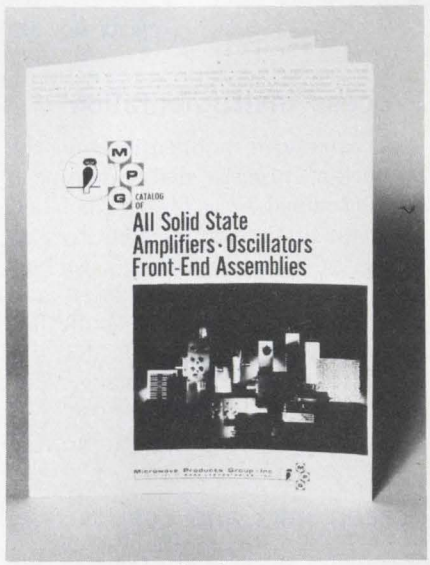
The general operating features of a line of low-speed compatible data sets are described in a 24-page technical booklet. They provide full duplex FM transmission of synchronous serial binary data. Speeds range from 0 to 300 bits-per-second over a switched or direct-dial telephone network. Block diagrams, illustrations and curves fortify the booklet's notes. Vadic Corp.

CIRCLE NO. 383

Automatic counters

Eight series 8100 automatic counter models are described in a new eight-page brochure. The counters range in capabilities from a 50-MHz model to a 100-ns time-interval resolution unit and include frequency measurements to 500 MHz with 500-μV sensitivity. Four of the counter models provide a complete TTL-interface system. Dana Laboratories, Inc.

CIRCLE NO. 384



Microwave devices

Solid-state amplifiers, oscillators, and front-end assemblies are featured in a new catalog. The catalog includes an expanded product line of microwave devices with reduced prices. These include such devices as low-noise pre-amplifiers and post-amplifiers. Sage Laboratories, Inc.

CIRCLE NO. 385

Software packages

A new software applications brochure offers a wide range of software packages just right for today's digital computers. These FORTRAN-IV-written programs were based on years of experience in scientific studies. They include such programs as KDA, OPRAN, HEATRON, GEOPOL, PARTRAN and DYDAT. Each of the six packages is described in terms of application, operation and capability. Electronic Associates, Inc.

CIRCLE NO. 386

Film hybrids

Several data sheets on film hybrid devices describe high-gain video amplifiers, memory drivers and clock and i-f amplifiers. The data sheets contain electrical data, physical and functional descriptions, characteristic operating curves and device circuit diagrams. Also included are dimensional information and temperature curves. Sylvania Electric Products Inc.

CIRCLE NO. 387

Connectors

An expanded line of microminiature rectangular connectors are included in a new 16-page catalog. They feature fixed or wire crimp-removable contacts in sizes from 5 to 200 contacts. Five groups are included: four with removable and one with fixed contacts. Hand tools for removable contacts, aluminum hoods, cable brackets and contacts are outlined in detail. Continental Connector Corp.

CIRCLE NO. 388

Broadband transformers

New miniature broadband transformers featuring transmission line techniques are described in a four-page brochure. Offering unusual flexibility in both application and packaging, these broadband balanced and unbalanced units feature frequency ranges up to 500 MHz. Frequency-response curves are included. Vanguard Elecronics, A. Wyle Co.

CIRCLE NO. 389

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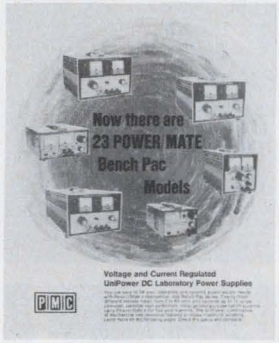
Design Data from

Free Catalog: New DC Lab Power Supplies



Power/Mate Corp. has introduced its new line of 23 **current and voltage** regulated laboratory and bench supplies — now described in this 4-page brochure. These 23 UniPower models collectively cover form 0 to 60 volts and currents up to 15 amps. They feature adjustable current limiting, low cost, high performance and Power/Mate's full five year warranty. The brochure covers complete specifications, model numbers, sizes, and prices. Write or call for your free copy.

Power/Mate Corporation
514 South River Street
Hackensack, New Jersey 07601
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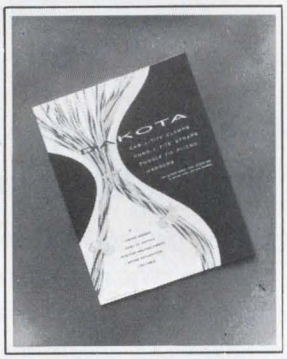
Clamp or Tie Wire Bundles In Seconds!



Six-page catalog contains complete ordering information for CAB-L-TITE® clamps and BUND-L-TITE® straps, devices which provide a fast and reliable means of securing wires and wire bundles. Units withstand loadings greater than 50 G's, are removable in seconds for re-routing wires, and are self-locking—no tying, no knots, no hitches to come loose. Lightweight Du Pont Zytel meets MIL-P-17091 and MIL-P-20693. Proved in aircraft and missiles. Photos, dimensional drawings, tables, physical properties, specifications, price list. Request catalog A.

Dakota Engineering, Inc.
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Culver City, California 90230

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New Super Boxer Axial Fan

For efficient cooling in space critical systems enclosures, the new Super Boxer provides exceptional output at high back pressure . . . 88 cfm at .15 inches H_2O, 102 cfm at .1 inch, 117 cfm in free air. Both ball and sleeve bearing models are available. Compact (4.687-in. sq.), slim profile (1.5-in. dp.) styling facilitates mounting inside or outside the equipment to be cooled.
For complete specifications, send for your free copy of bulletin NT8.

IMC Magnetics Corp.
New Hampshire Division
Route 16B
Rochester, N. H. 03867

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Manufacturers

Advertisements of booklets, brochures, catalogs and data sheets. To order use Reader-ServiceCard.
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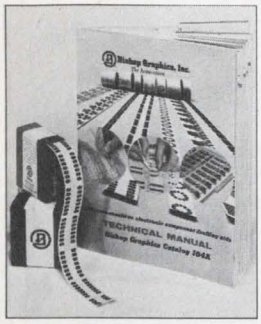
1970 Electronic Components Drafting Aids Catalog



Free Catalog! Free Samples! Exciting innovations in pressure-sensitive electronic component drafting aids and methods are detailed in the new 1970 edition of the combined Bishop Technical Manual and Catalog 104A.

68 illustrated pages of over 15,000 multi-pad configurations, symbols, tapes, sequential reference designations plus hundreds of time-and-money-saving hints in making artwork for PC boards. Includes instructions for using the industry's only red and blue tape system for making two-sided boards in perfect registration.

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Quality Fasteners For All Designs

This 8-page catalog provides design data on the complete group of DZUS 1/4-turn self-locking fasteners for standard, high speed and panel applications, as well as universal high strength multiple thread fasteners for high tensile and shear stresses. Dzus stud assemblies, wire forms and receptacles offer an exceptional, wide variety of combinations from stock to fit specific fastening requirements. Diagrams and tables give full details for rapid, unlimited design selection. Condensed or complete Catalog available on request.

Dzus Fastener Co., Inc.
425 Union Boulevard
West Islip, L. I., N. Y. 11795

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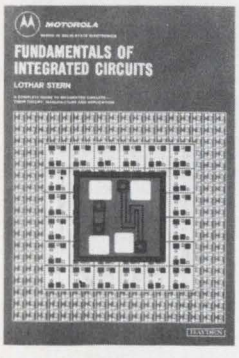
FUNDAMENTALS OF INTEGRATED CIRCUITS



A practical guide to integrated circuits, their theory, manufacture, and applications. This new guide by Lothar Stern offers compete, highly readable coverage of the various techniques of circuit fabrication, and their effect on circuit design and performance. As to marketing considerations, it compares the characteristics of the numerous IC structures devised to date in terms of economics and logistics. A volume in the **Motorola Series in Solid-State Electronics.** 198 pages, 7 x 10, illustrated. $8.95, clothbound. Circle the reader-service number below for 15-day examination copies.

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Product Index

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New Literature

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Design Aids

Evaluation Samples

Dale connector line grows with new SHP-40 modular style

Make sure you have Dale on your list of connector sources. Describe Dale's connector line as: *"Small, but growing...able to supply volume quantities of all items in line...capable of meeting special design requirements."*

Among the new models now being produced by Dale is the SHP-40. This NAFI design conforms to BUWEPS 63A49F100 and gives us a strong entry into the modular field. For a quick look at some of the popular models we can supply, see below. Then make sure you have our new connector catalog. It lists complete details on these styles:

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UMBILICAL • Missile & Avionics Models • Shorting Plugs

NAFI • 40 pin

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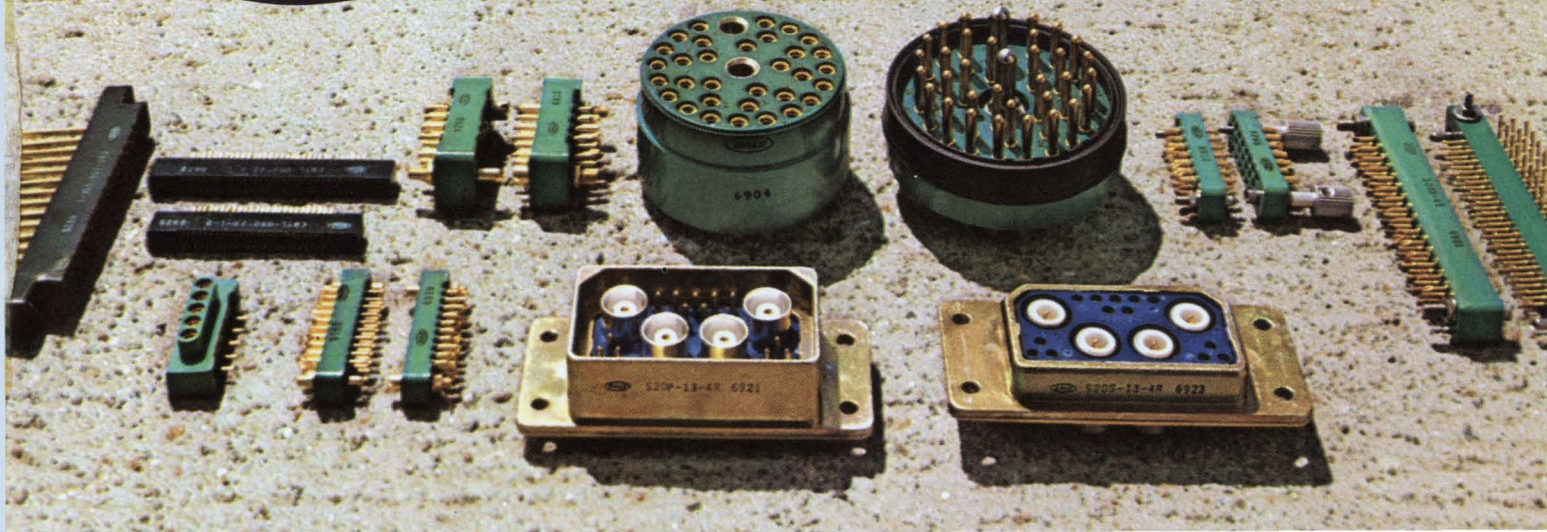

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SCR Family	Rating		Triac Family	Rating	
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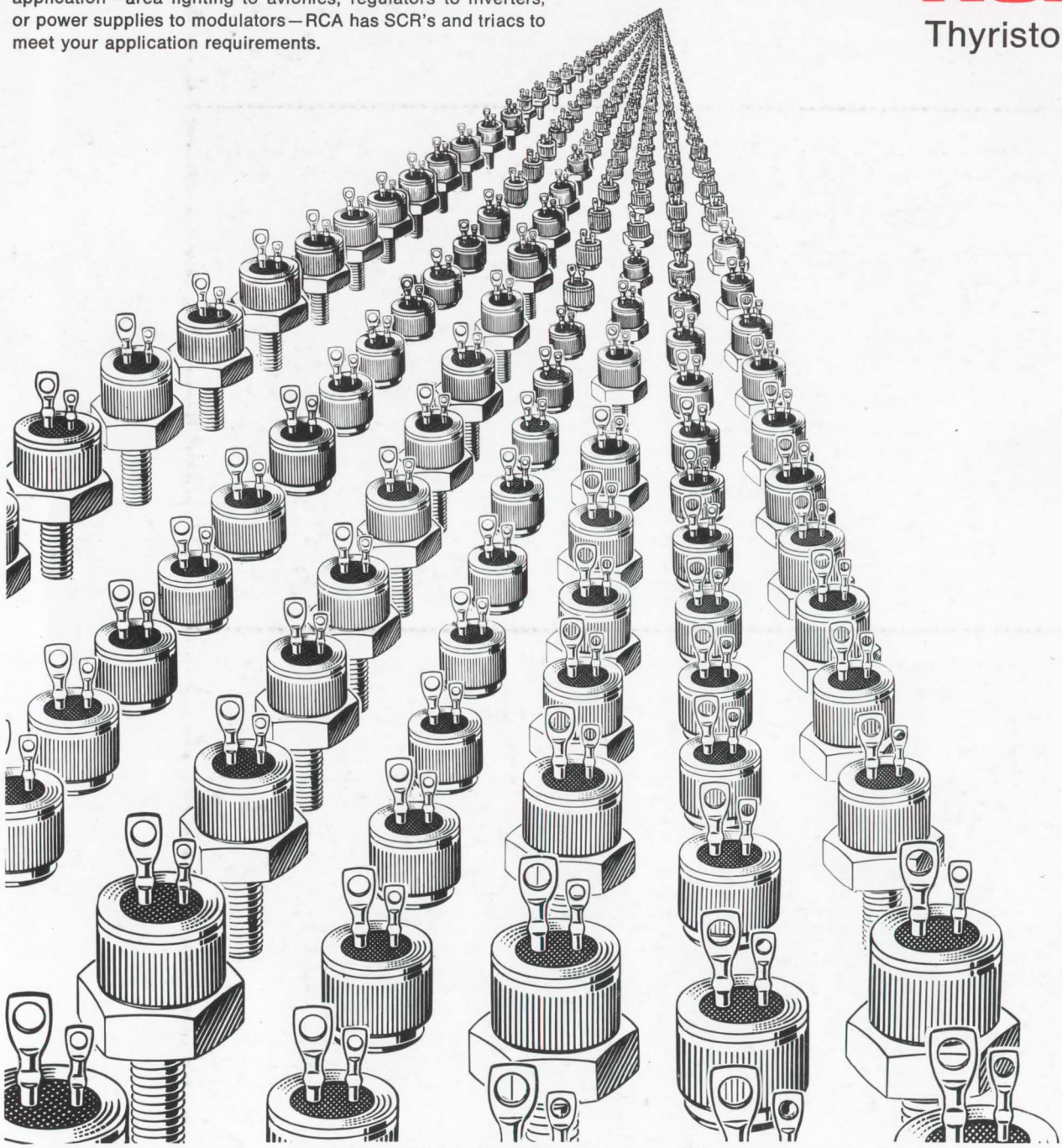
40740	10 A	600 V	2N5568	10 A	400 V
40752	20 A	600 V	2N5572	15 A	400 V
2N690	25 A	600 V	40671	30 A	600 V
2N3899	35 A	600 V	2N5543	40 A	600 V

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

For further details and your copy of the latest thyristor catalog, THC-500, see your local RCA Representative or your RCA Distributor. Or write RCA Electronic Components, Commercial Engineering, Sec. RD18-2/UR6, Harrison, N. J. 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

RCA

Thyristors



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