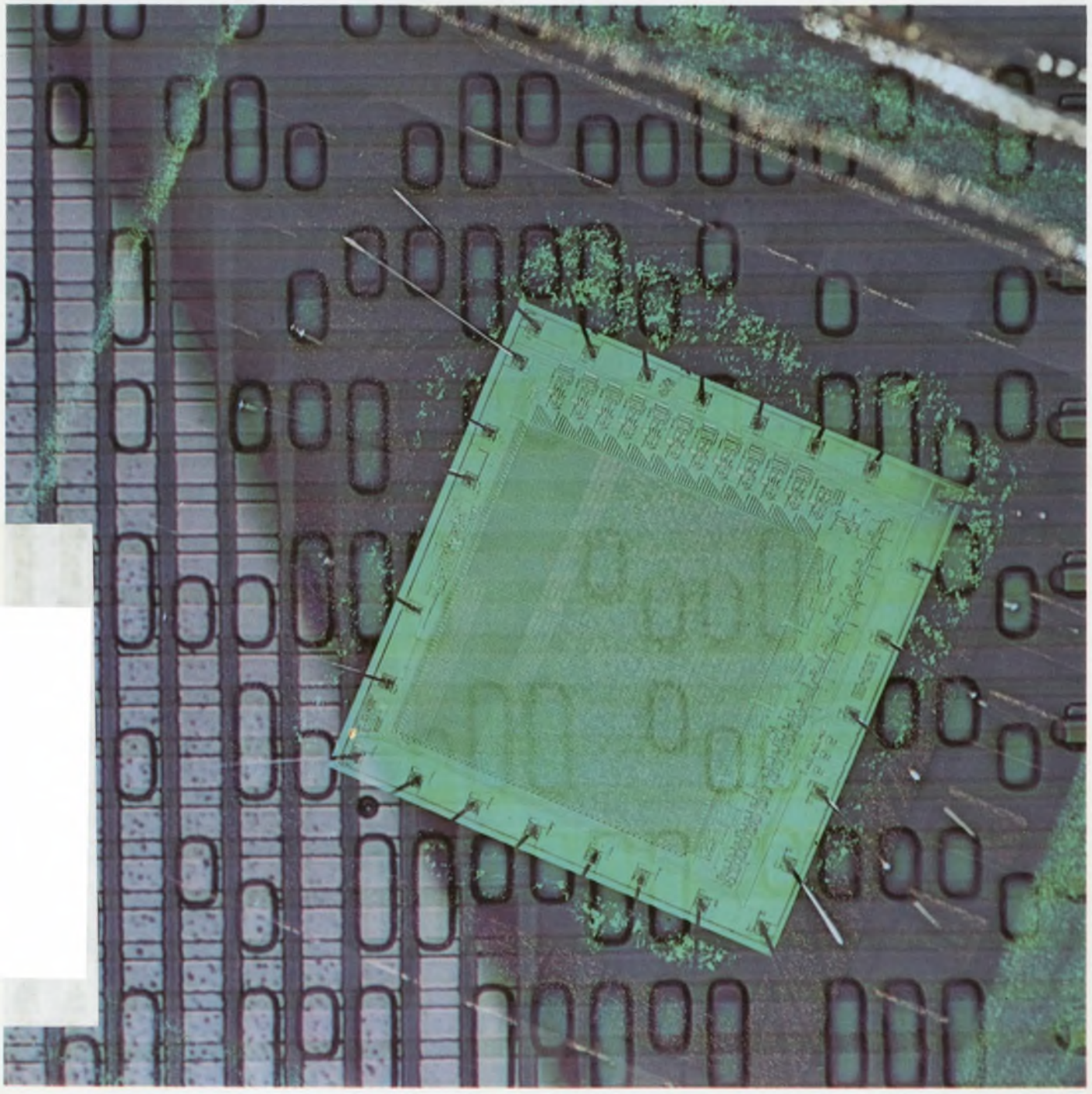
VOL. 19 NO.

Electronic Design 19

FOR ENGINEERS AND ENGINEERING MANAGERS

SEPT. 16, 1971

Semiconductor memories dazzle with greater density, lower power, higher speed. They give more bits per board, per second, per buck, per watt. They want less support circuitry, too. But there are problems. For products that look real may not be and specs can mislead. For a look at hot developments, turn to page 50.



New Dale Fastpacks!

3/4″ DIP Trimmers—wirewound or film—ready for automatic testing and insertion

Count us in when you design or specify trimmers for automatic assembly. New Dale 3/4″ DIP trimmers give you a choice of wirewound or film element performance—plus full compatability with your high speed automatic testing and insertion equipment. Shipped in ready-to-use magazines, these new DIP trimmers are ready to go now. Prices and delivery schedules meet or beat the best you've seen. Check the specs, then see your Dale distributor or call the number below.

SPECIFICATIONS

	2600 Wirewound	8600 Film
Resistance Range	10 ohms to 50K ohms	10 ohms to 2 Megohms
Tolerance	±10%	±10% 100 ohms thru 500K ±20% all others
Power Rating	1 watt at 40°C derated to 0 at 125°C	.75 watt at 25°C, derated to 0 at 125°C

NEW Space-saving 1/2″ Film Trimmer

Dale's new film element 800 Series lets you squeeze 10-turn adjustment and infinite resolution into a .500″ x .100″ x .150″ space. Dissipates .3 watt over a resistance range of 10 ohms to 2 megohms.

For details call 402-564-3131 today

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INFORMATION RETRIEVAL NUMBER 241

Introducing the little counter that can.

It can become four different systems.
It can go anywhere you do.
It can protect you against obsolescence.
It can make buying and maintaining a counter less expensive than ever before.

Meet the Hewlett-Packard 5300, the snap-together counter that's not much bigger than the palm of your hand. It has six digit accuracy, solid state display and autoranging. It'll make period, frequency, time interval and ratio measurements, operate on its optional snap-on battery pack and drive a printer. Rugged dust-proof aluminum case resists almost any bumps it might get in the field. Prices start at only $520 for one of the most amazing counters you've ever owned.

Start with the basic mainframe ($395). Then snap on any of the following modules (more on the way) to make just the counter you need, and avoid obsolescence, too:

10 MHz frequency module. Model 5301A, $125.

50 MHz all-purpose module includes period, time interval. Model 5302A, $250.

500 MHz module with both 50Ω and 1 MΩ inputs. Model 5303A, $750.

100 ns time interval module with: unique "time holdoff" feature, dc coupling, slope and trigger level controls, and period and frequency measurements to 10 MHz. All the functions you'd pay $1200 for in a universal counter. Model 5304A, $300.

Rechargeable battery pack module works with any of the other modules for cord-free operation. Model 5310A, $175.

The 5300 is one system you have to use to appreciate. If you've ever needed to accurately measure frequency or time interval, you owe it to yourself to call your nearby HP field engineer for further information. Or write Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

Counters that promise a lot and deliver it all.

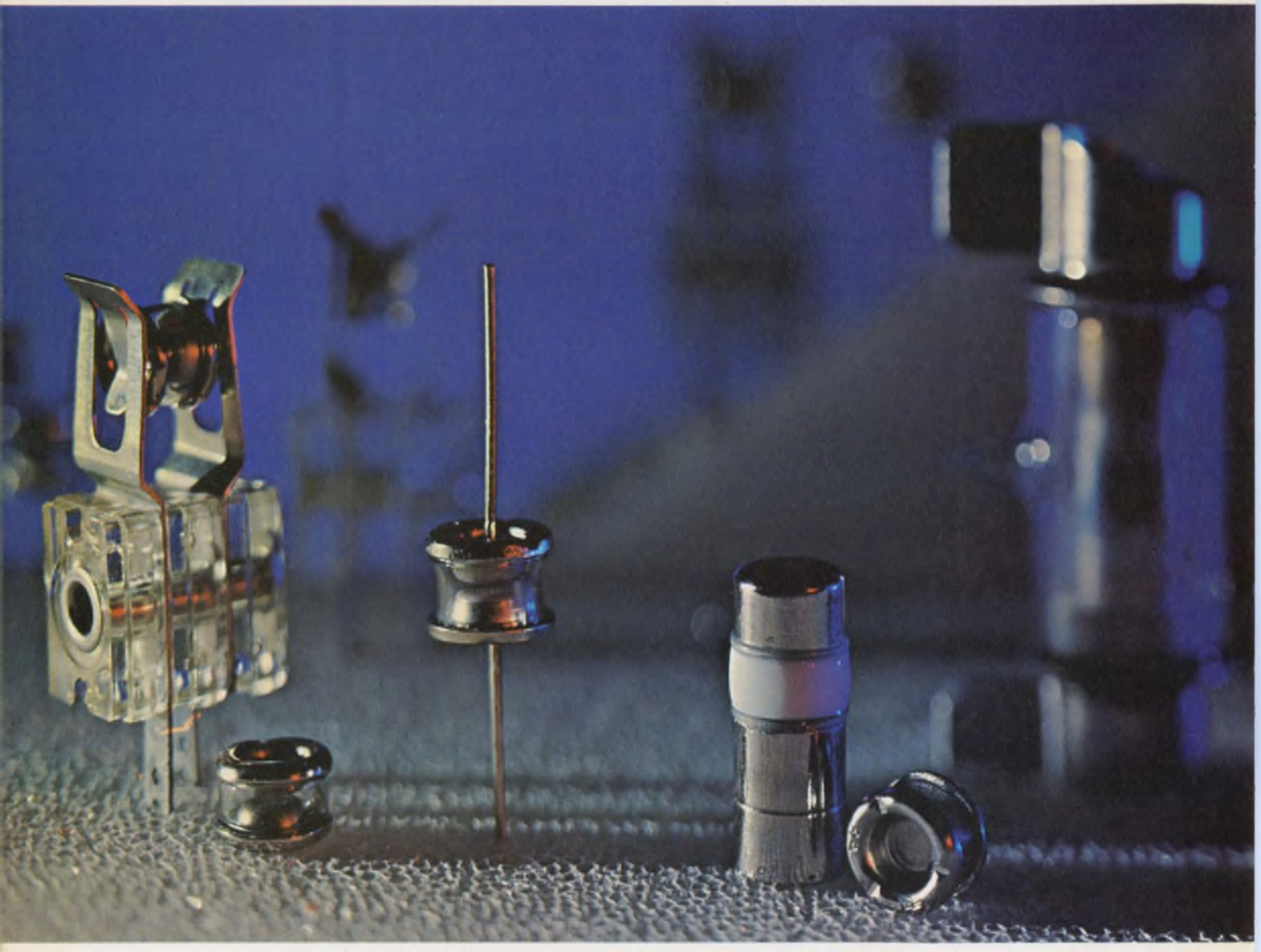
02109

HEWLETT hp PACKARD

ELECTRONIC COUNTERS

INFORMATION RETRIEVAL NUMBER 2

Siemens



Low-cost SVP™ devices can save your valuable equipment from destruction by voltage transients.

You can no longer overlook the need for protecting your circuits. New sources of transients are cropping up every day. And any one of them might cause operational failure of your equipment.

Now there is an easy low-cost way to protect your circuitry from these transients. It's a simple little gas-filled surge voltage protector. We call it an SVP. Only this Siemens SVP offers high-current capability (up to 50 kiloamps) in such a small package and a high impedance when not conducting (10^{10} ohms, 1 to 6.8 pF depending on model).

Siemens is the world's largest manufacturer of surge voltage protectors. More engineers are using them every day. You can benefit by doing the same.

Siemens Corporation, 186 Wood Avenue South, Iselin, N.J., 08830. (201) 494—1000.

Siemens. A three billion dollar name in quality products.

SIEMENS

INFORMATION RETRIEVAL NUMBER 3

VOL. 19 NO.
Electronic Design 19
FOR ENGINEERS AND ENGINEERING MANAGERS
SEPT. 16, 1971

NEWS

TECHNOLOGY

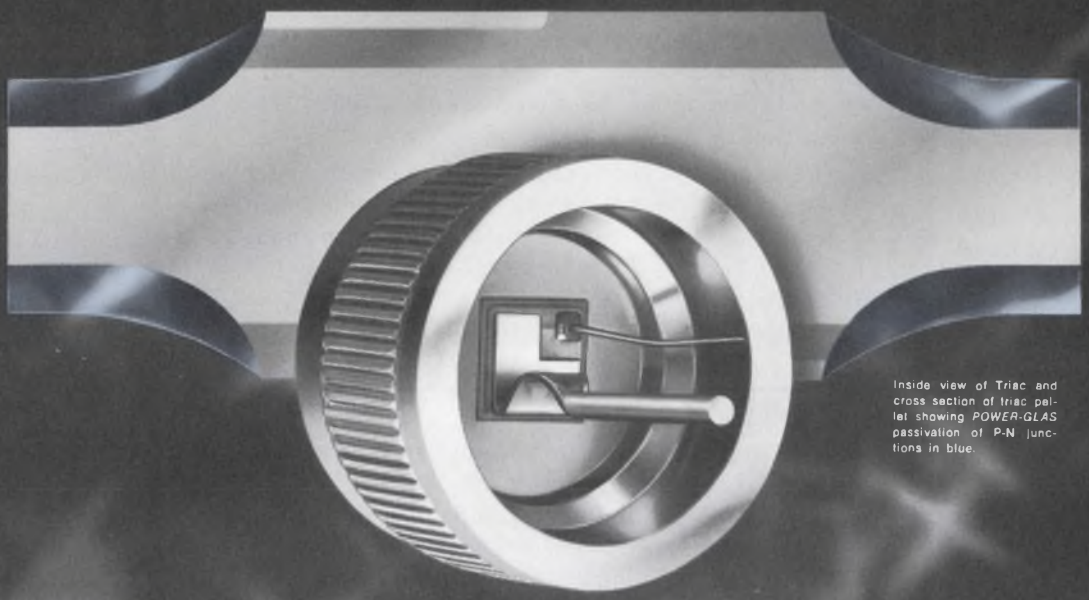
PRODUCTS

Departments

Cover: The largest available single-chip memory, a 12,288-bit dynamic MOS ROM from Electronic Arrays.

ELECTRONIC DESIGN is published biweekly by Hayden Publishing Company, Inc., 50 Essex St., Rochelle Park, N.J 07662. 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. 82501 copies this issue.

GE GLASSIVATED TRIACS MAKE THE CLEAR DIFFERENCE.

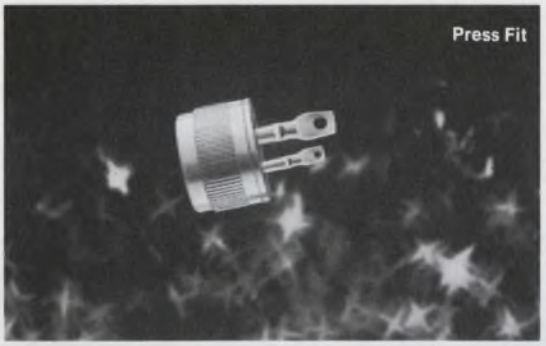


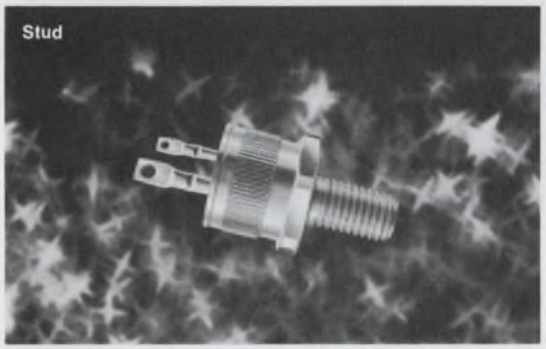
Inside view of Triac and cross section of triac pellet showing *POWER-GLAS* passivation of P-N junctions in blue.

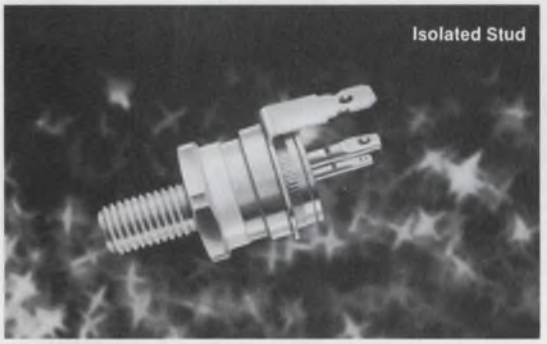
Having introduced the triac in 1962, who is better qualified to improve upon the original? General Electric solid state research has provided the answer with a proprietary glass formula and deposition process that improves upon the normal passivation techniques. GE's new ***POWER-GLAS*** process makes the clear difference. It provides for an intimate void-free bond between the silicon chip and the matched glass. The resulting stable low level off-state current significantly improves performance and reliability.

POWER-GLAS

6, 10, 15 Amp Metal Can Triacs Available Now At Competitive Prices.







Now General Electric introduces a new triac series which capitalizes on GE's new ***POWER-GLAS*** process . . . the new SC240, SC245 and the SC250 series at 6, 10, 15 amperes respectively with voltage ranges of 200, 400 and 500 volts each. This new series features very low off-state currents (typically less than 100μa) and high commutating dv/dt (4v/μsec.). Like other GE triacs, the new series comes in three industrial packages . . . Press Fit, Stud and Isolated Stud.

GE's ***POWER-GLAS*** is the clear difference—adding greater reliability and increasing AC blocking life stability.

POWER-GLAS TRIAC PRICES (1000 UNIT LEVEL)

PACKAGE	RATING	200V TYPE	400V TYPE	500V TYPE
PRESS-FIT	6A	$1.63	$2.11	$2.37
STUD	6A	1.83	2.31	2.57
ISOLATED STUD	6A	2.53	3.01	3.27
PRESS-FIT	10A	1.98	2.35	2.81
STUD	10A	2.18	2.55	3.01
ISOLATED STUD	10A	2.88	3.25	3.71
PRESS-FIT	15A	2.10	2.49	2.98
STUD	15A	2.30	2.69	3.18
ISOLATED STUD	15A	3.00	3.39	3.88

The prices above for the SC240, SC245 and SC250.

Write for your copy of "IMPROVED TRIAC RELIABILITY THROUGH ***POWER-GLAS***" for the full story on improved performance under worst case electrical stress conditions.

More *Power-Glas* Semiconductors To Come.

Additional new series of SCR's, Triacs and other semiconductors with the GE ***POWER-GLAS*** process will be introduced soon. To familiarize yourself now with the superior performance of the new GE Triac Series, send for product specifications. For prices and availability, call your local GE authorized distributor.

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GENERAL ELECTRIC
SEMICONDUCTOR PRODUCT DEPARTMENT
Inquiry Clerk, Electronics Park, Bldg. 7 Box 49
Syracuse, New York 13201

Please send one ☐ 200V or ☐ 400V TRIAC:
RATING: ☐ 6A ☐ 10A ☐ 15A

NAME_____
FIRM_____ POSITION_____
STREET_____
CITY_____ STATE_____ ZIP_____

OFFER EXPIRES SEPTEMBER 13, 1971

INFORMATION RETRIEVAL NUMBER 4

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Peter Coley

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letters

A profit-motive system or a loss-motive one?

I would like to comment on the letter from David Wald in ED 16, Aug. 5 ("A Cheer for Editorial, a Razz for the System") and ask a question or two.

I agree that engineers should exercise responsibility to their planet as well as to their jobs—for example, the decision an electric power company sometimes must make: pollution or reduced profit. Profits may soar, but the quality of life may plummet.

I would like to question Mr. Wald's "sacred cow" comment, though. If the "profit motive . . . is now inherently incompatible with the needs of humans," what alternative would he propose? If his job isn't secure now, would it be more secure if he were working for a "loss motive" company? Or would he prefer all companies to be nonprofit organizations?

Alan L. Falk
86A Old New Brunswick Road
Piscataway, N. J. 08854

Mr. Wald's letter stating that the Free Enterprise System is inherently incompatible with the needs of humans proves that Mr. Wald is the "emperor with no clothes." Free enterprise is the only system compatible with human life. What Mr. Wald refuses to see is that we do not have free enterprise in this country and that this fact is causing our economic problems.

It is unbelieveable that anyone could look at Government control of—and interference with—farming, transportation, finances, business, etc., and still contend that we have free enterprise. He probably refuses to see that the Government just nationalized the railroads. Face the truth, Mr. Wald. Stop blanking out. Is your alternative to have the Government take over engineering, to hold your hand, to tuck you into bed.

Each year, because of government, there is a lower percentage of people in this country producing the goods we all need. Think that over and you will see why government is lowering our standard of living, and you will also see that such nonsense can only lead to a permanent depression.

Richard J. Savadel
11 Clifford Blvd.
Hauppauge, N. Y. 11787

Modular television sets? He remembers when

I noted that Motorola finally received credit for "pioneering" modular construction in its TV sets (see "In Consumer Packaging, It's Modules, Modules Everywhere," ED 15, July 22, 1971, p. 22).

Doesn't anyone recall Setchell-Carlson's modular construction of TV assemblies as far back as 20 years ago? At the time I recall other engineers shaking their heads at such an unorthodox method of construction.

The "quick-service" feature (each set involved a main chassis with five or more plug-in modules) was not a success because owners were worried about having "older" parts exchanged for their "newer" parts. I wonder if Motorola has had this experience with its Quasar sets?

Dan A. Armstrong, B.E.E.
East Waupun
Oakfield, Wis. 53065

Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Managing Editor, Electronic Design, 50 Essex St., Rochelle Park, N. J. 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld on request.

We have no RAMs, ROMs, PROMs nor PRAMs

Just now.

But we do have a variety of shift registers plus CMOS and PMOS multiplexers. Like these:

RD 65 426 bit dynamic SR
SL-6-2050 Dual 50 bit static SR
SL-6-2064 Dual 64 bit static SR
SL-6-4025 Quad 25 bit static SR
CM 110 16-ch CMOS digital multiplexer
DG 506 16-ch CMOS analog multiplexer

All of these are also available with internal pull-up elements for true TTL compatibility without need for external resistors.

If you were one of our present customers you would enjoy the advantages of our MOS-LSI capability for standard and custom design.

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Not PRAMs, though.

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Publication 5409: type FA, FB, FW, SB, SS ceramic disc capacitors for VHF/UHF.

Publication 5410: type FCS, SMFB, SMFO filters for the 50 MHz to 10 GHz range.

Publication 5411: type CL multi-layer, coaxial capacitors for connectors.

Publication 5414: type MT, MS by-passing capacitors for 50 KHz to 1 GHz.

Publication 5416, 5417: type BE, SF filters for RFI/EMI suppression.

Publication 5418: type AB broad band filters in Pi, T and L configurations.

NEW DIMENSION ELECTRONICS

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A-B QUALITY

INFORMATION RETRIEVAL NUMBER 8

The first PROM to offer an extra *bit*...

...for greater reliability!

Introducing the MCM5003A, the industry's first field-programmable ROM with a built-in reliability factor. Basically a 512 bit bipolar device organized as 64 eight-bit words, the MCM5003A offers "instant customizing" by merely "blowing" nichrome resistors and thus breaking metalization links. The blown links change the initial logic "0" state to a logic "1" state to meet specific program requirements.

A *bit* more for reliability

Since unprogrammed ROM's have all outputs low regardless of address, testing does not detect many faults in amplifier inverters, address decoders, memory array and sense amplifiers. Special consideration is required in the areas of Program Element Testing, Functional Testing and AC Testing. To solve these problems, Motorola expanded the memory from a 64 word, 8 bit memory to a 64 word, 9 bit memory with the 9th bit dedicated to testing.

By blowing some of the 9th bits, we can assure that the links can be blown without using up any of the normal 64 x 8 bit array. With some of the links blown, functional and AC performance testing is now possible. This is important in that all of the 64 x 8 bit array elements are in a logic "0" state regardless of the address selected, and no way would be available to determine whether the functions are correctly operating without the 9th testing bit.

The MCM5003A circuit contains six address inputs to select the proper word and two chip enable inputs, as well as outputs for each of the eight bits. Supplied in a hermetic 24-pin dual in-line ceramic package, the MCM5003A has positive enable with open collector outputs. Another version, the MCM5004A, has positive enable with 2.0 kilohm pullup resistors on the collector outputs. Both devices are MDTL/MTTL compatible and access times are less than 75 ns.

By stocking the MCM5003A you can work up custom microprograms, lookup tables, code and number conversions without the worry of turnaround time and costly mask charges. And speaking of costs, either the MCM5003A or 5004A is available for $45.00 (100-up price) — less than 9¢/bit. Programming can be accomplished at your facility, through your distributor, or here at Motorola.

Take advantage of the MCM-5003A's "instant customizing" by calling your local Motorola distributor for evaluation devices today. Or write to Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, Arizona 85036. We'll send complete specifications plus our latest application note describing several programmers that can be built specifically for programming the MCM5003A/5004A.

It'll pay to evaluate the MCM5003A . . .

A Memory To Remember For Reliability

Motorola can now supply memories to meet your specific requirement, whether it be high-speed, low power, or custom products. In traditional Motorola fashion we can draw from the technologies of MOS (Ion-Implanted, Silicon Gate CMOS, N-Channel) or advanced bipolar techniques — each technology offering specific advantages to meet your application.

MEMORIES TO REMEMBER

RAMs				
DEVICE	**FUNCTION**	**TECHNOLOGY**	**ORGANIZATION**	**ACCESS TIME**
MC1680/81	4 Bit RAM	ECL - BiPolar	2 x 2	≤ 4 ns
MC1682/83	4 Bit RAM	ECL - BiPolar	2 x 2	≤ 4 ns
MC1684/85	4 Bit CARAM	ECL - BiPolar	2 x 2	≤ 4 ns
MC1036/37	16 Bit RAM	ECL - BiPolar	4 x 4	≤ 50 ns
MC4004/5	16 Bit RAM	TTL - BiPolar	16 x 1	≤ 25 ns
MCM4064	64 Bit RAM	TTL - BiPolar	16 x 4	≤ 60 ns
MCM1170	64 Bit Static RAM	Metal Gate P-MOS	16 x 4	500 ns
MCM14505	64 Bit Static RAM	Metal Gate CMOS	64 x 1	200 ns (typ.)
MCM1173/72	1024 Bit Dynamic RAM	Metal Gate P-MOS	1024 x 1	400 ns
ROMs				
MCM4001 (XC170/171)	128 Bit ROM	TTL - BiPolar	16 x 8	≤ 45 ns
MCM4002	256 Bit ROM	TTL - BiPolar	32 x 8	≤ 50 ns
MCM4004	1024 Bit ROM	TTL - BiPolar	256 x 4	≤ 60 ns
MCM4006	1024 Bit ROM	TTL - BiPolar	256 x 4	≤ 50 ns
MCM5003A/4A	512 Bit PROM	TTL - BiPolar	64 x 8	≤ 75 ns
MCM1130	2240 Bit Static ROM	Metal Gate P-MOS	Open Option	500 ns
MCM1131/32	2240 Bit Char. Gen.	Metal Gate P-MOS	Col. Sel. 64 x 35 (5 x 7)	500 ns

MEMORIES TO COME

RAMs				
DEVICE	**FUNCTION**	**TECHNOLOGY**	**ORGANIZATION**	**ACCESS TIME**
MC10140	64 Bit RAM	ECL - BiPolar	64 x 1	≤ 15 ns
MCM4256/7	256 Bit RAM	TTL - BiPolar	256 x 1 / 128 x 2	≤ 60 ns
MCM2372	1024 Bit RAM (1103 Equiv.)	Si-Gate P-MOS	1024 x 1	300 ns
MCM2374	1024 Bit RAM (1103-1 Equiv.)	Si-Gate P-MOS	1024 x 1	180 ns
MCM2377	2048 Bit RAM	Si-Gate P-MOS	2048 x 1	360 ns
ROMs				
MCM4003	512 Bit ROM	TTL - BiPolar	64 x 8	≤ 75 ns
MCM4005	1024 Bit ROM	TTL - BiPolar	1024 x 1	≤ 50 ns
MCM4007	1024 Bit ROM	TTL - BiPolar	512 x 2	≤ 50 ns
MC10139	256 Bit PROM	ECL - BiPolar	32 x 8	≤ 17 ns
MCM5005	1024 Bit PROM	TTL - BiPolar	256 x 4	≤ 60 ns
MCM1110	2048 Bit ROM	Metal Gate P-MOS	256 x 8	600 ns
MCM1120	2240 Bit ROM	Metal Gate P-MOS	64 x 7 x 5	700 ns
MCM1140	4096 Bit ROM	Metal Gate P-MOS	512 x 8	700 ns
MCM1150	2560 Bit ROM	Metal Gate P-MOS	256 x 10	600 ns

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MOTOROLA MEMORIES
. . . IC Systems for the 70's!

INFORMATION RETRIEVAL NUMBER 9

Our new DIP gives you just what you need

and no more.

First we put four fixed resistors and a trimmer in one module. We called it our TRN (Trimming Resistive Network) package. Great.

Now you can get the same module, with the same dimensions for automatic insertion and the same excellent characteristics, in a DIP trimmer. And just a trimmer.

Not just a ¾-inch commercial trimmer turned on its side, but one that has been developed from the ground up to meet all dimensions in accordance with EIA Microelectronic Outline DIP Family with 0.300-inch-row spacing.

Resistance range of our new DIP is from 10 ohms to 1 megohm. The resistance tolerance is ±10%. And like the TRN, the DIP offers excellent TC of 100 ppm standard with 50 ppm available. The operating temperature range of this DIP is —55°C to +125°C. Power rating is ¾-watt at 40°C.

So if you want the whole works—trimmer and from 1 to 4 fixed resistors—in one package, get our TRN. But if you want a trimmer and no more, then our new DIP will give you just what you need. Both are now available through Amphenol's distributor network.

For more information write Amphenol Controls Division, Bunker Ramo Corporation, 120 South Main Street, Janesville, Wisconsin 53545.

BUNKER RAMO AMPHENOL

INFORMATION RETRIEVAL NUMBER 10

designer's calendar

OCTOBER 1971

S	M	T	W	T	F	S
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17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Oct. 4-5

Joint Engineering Management Conference (Los Angeles) Sponsor: IEEE et al, L. D. Chipman, Western Electric Corp., 218 Lynn Lane, Westfield, N. J. 07090

CIRCLE NO. 409

Oct. 11-13

International Microelectronics Symposium (Chicago) Sponsor: International Society for Hybrid Microelectronics, 1410 Higgins Road, Park Ridge, Illinois 60068

CIRCLE NO. 410

Oct. 11-13

International Electron Devices Meeting, (Washington, D. C.) Sponsors: IEEE, G-ED, D. P. Kennedy, IBM Corp., E. Fishkill, Rte. 52, Hopewell Jct., N. Y. 12533

CIRCLE NO. 411

Oct. 18-20

National Electronics Conference (Chicago) Sponsors: IEEE, Region IV, et al, J. B. Kreer, Michigan State Univ., E. Lansing, Mich. 28823

CIRCLE NO. 412

Oct. 31-Nov. 4

Engineering in Medicine & Biology Conference (Las Vegas) IEEE, John Hanley, Brain Research Inst., Univ. of Calif., Los Angeles, Calif. 90024

CIRCLE NO. 413

A better way to specify oscillators.

We have a special coding sheet that lets you specify one or more models from over 700 different temperature compensated and clock oscillators.

Our oscillators are made with a unique cold weld crystal which eliminates heat and flux contamination found in regular sealing methods. As for size, we have models as small as 1.16 cubic inch.

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this power/mate laboratory power supply got bent out of shape,,,

but our customer didn't!

He never got it. Just as well.

When you ship as many power supplies as we do . . . day after day . . . to almost as many places . . . day-in-day out, these things are bound to happen.

But, we put this power supply through a complete electrical performance test . . . just like we do with each and every power/Mate Power Supply that leaves our plant.

If you know anything about Power/Mate . . . you know the answer.

This power supply meets every electrical performance specifications, except for the meters . . .

We confess, we weren't surprised.

Because, we at Power/Mate know what goes into each and every power supply . . . and what's more, they are built by people who *care!*

(P.S. we shipped the customer another power supply the same day . . . . from stock . . . after all, 90% of our power supplies are in stock for same day shipment.)

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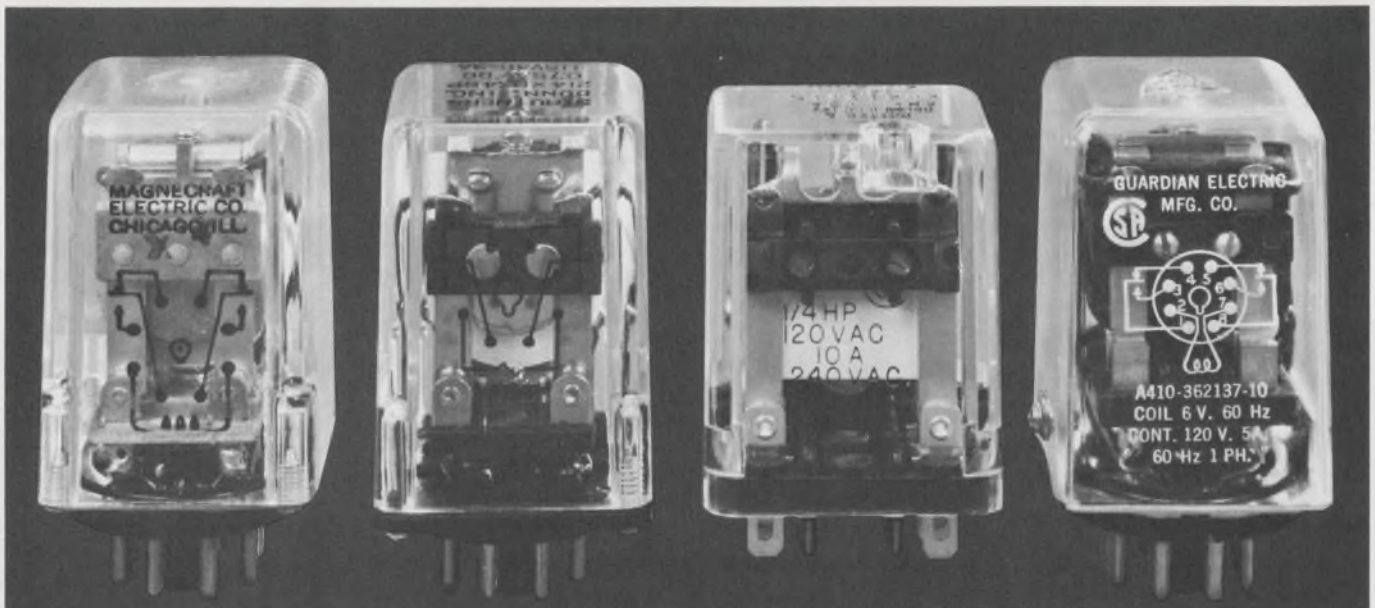
INFORMATION RETRIEVAL NUMBER 13



Switching 10 amps with a relay this size?

Shown actual size
(1.0" x 0.8" x 1.6")

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SIGMA
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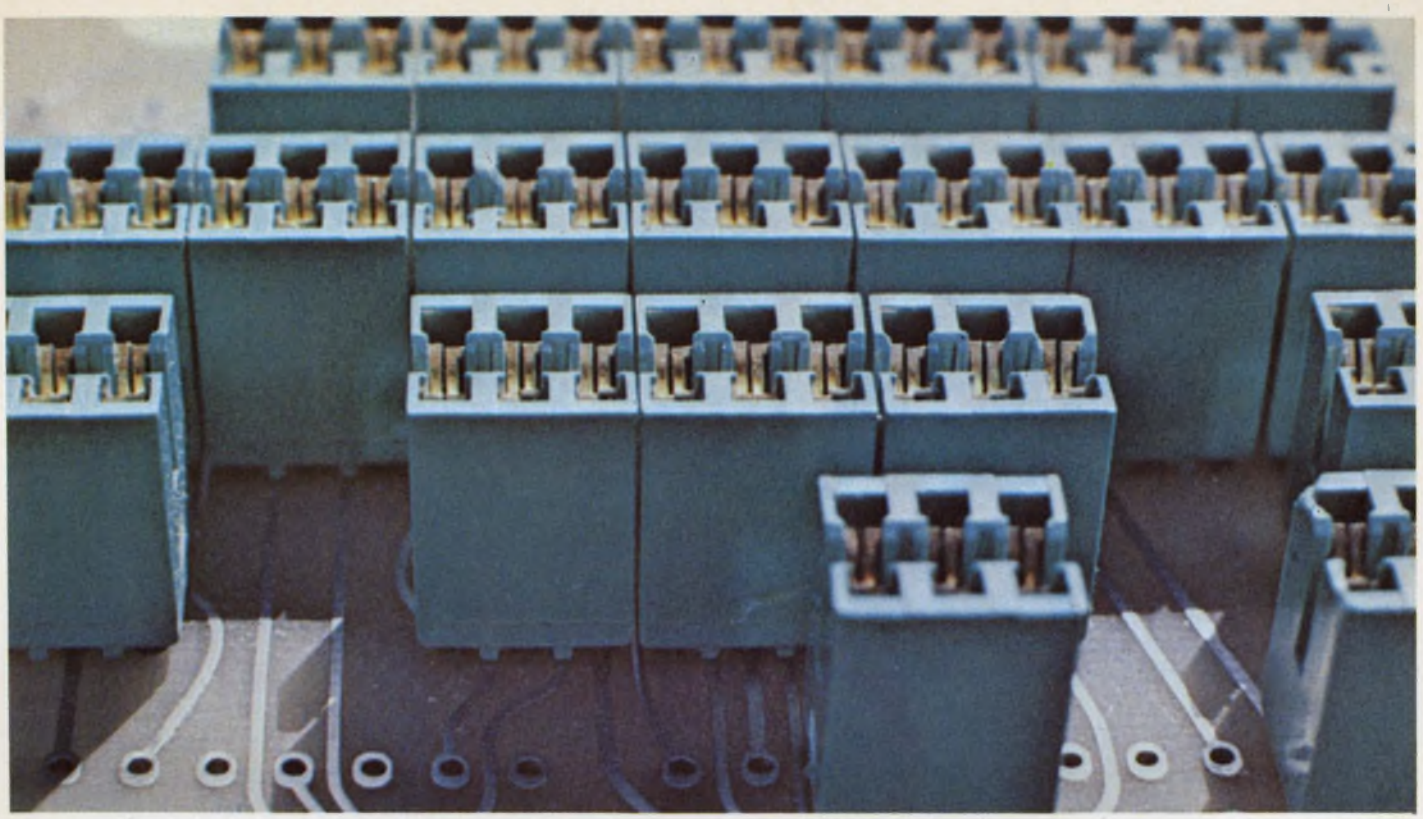
INFORMATION RETRIEVAL NUMBER 14



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INFORMATION RETRIEVAL NUMBER 15

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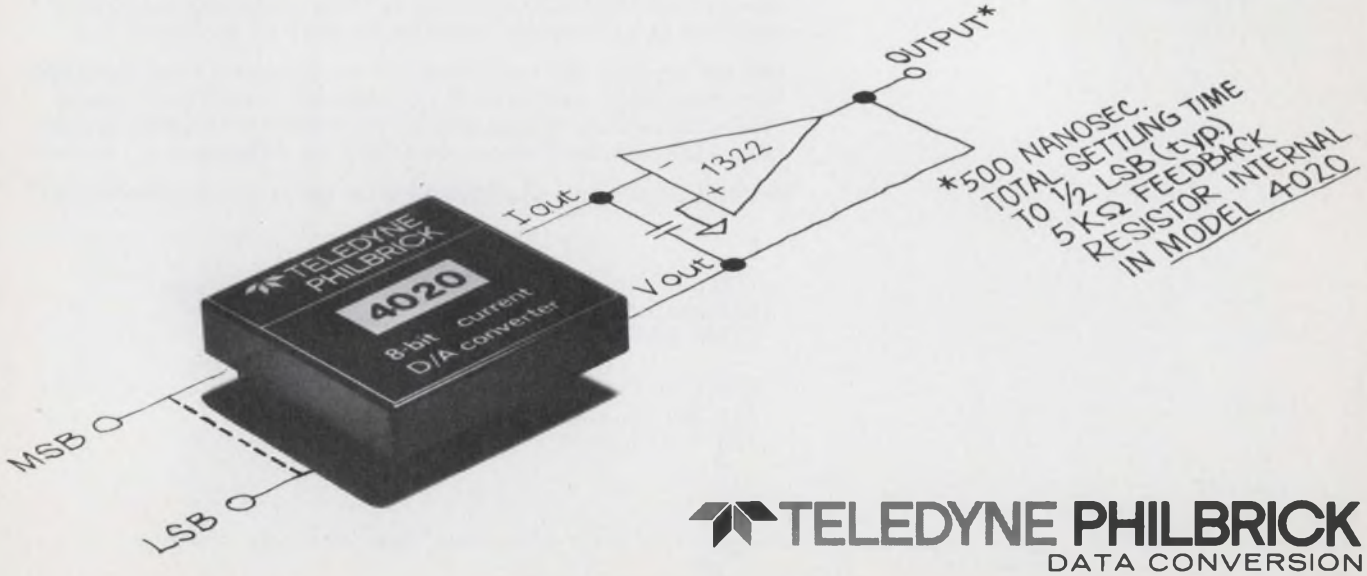

TELEDYNE PHILBRICK
DATA CONVERSION

INFORMATION RETRIEVAL NUMBER 16

Industry leaders laud Nixon's economic moves

Reaction in the electronic industry to President Nixon's new economic package—a 90-day price-wage freeze, a 10% investment tax credit and a 10% surcharge on imports—is universally favorable, according to those surveyed by ELECTRONIC DESIGN.

Even manufacturers with offshore plants that produce TV and radio sets or components subject to the 10% import tax are behind the moves.

Typical of industry reaction is this comment by Leslie H. Warner, chairman and president of General Telephone and Electronics, New York City: "The President's actions will prove to be a vitally important factor in promoting strength and stability in the nation's economy."

Magnavox, which recently established a policy against buying Japanese components and said it would return all of its color television set manufacturing to this country (see "Magnavox Cuts Its Buying of Japanese Components," ED 15, July 22, 1971, p. 20), is backing the Nixon package.

"Its construction and psychology are favorable to consumer electronics business," a spokesman for the company's president said.

Motorola expects the new policies to have favorable long-range impact on the economy, but it does not expect the Nixon moves to have any significant impact on its earnings this year.

"In the short term," a spokesman in Chicago said, "our costs will be increased in certain areas by the 10% surtax. On the positive side, the 10% investment tax credit will offset the increased cost due to the import tax."

Joseph Wright, chairman of Zenith Radio Corp., Chicago, welcomes the Nixon moves as showing that "the Government, at the highest level, has shown awareness of some of our major problems and given them high priority." In the past, he notes, trade matters often took a back seat to diplomatic and other international considerations.

Wright believes that "the new measures should help get our trading partners overseas to understand that we expect trade relations to be conducted on a fair and equitable basis."

The Electronic Industries Association says importers will be permitted to pass the new 10% surcharge on imports along to consumers. But this will make American-made electronic products more competitive with the foreign.

LED makers reaching for consumer markets

The optoelectronic industry sees light-emitting diodes (LEDs) replacing small tungsten bulbs in consumer applications. A glimpse of this future appears in LED-illuminated house numbers, fabricated by Earl Cole, application engineer for Monsanto Electronic Special Products Div., Cupertino, Calif.

LED-illuminated house number operates 24 hours a day.

The numbers on Cole's plastic sign were originally lighted by two toy-train bulbs, supplied by a 16.3-V ac bell transformer. The Monsanto engineer removed the bulbs and drilled holes for 48 LEDs in the numbers. He connected the LEDs in two parallel strings.

Half of the diodes light up on one-half the cycle, the rest on the other. Total current drain is 10 mA for each string, with a power drain of 320 mW. To limit the current to safe values, Cole installed 15-ohm resistors in series with the strings. The sign has operated 24 hours a day for 18 months.

In another LED development, a line of interchangeable lamps and light-emitting diodes with IC compatibility has been developed by General Instrument's Chicago Miniature Lamp Works.

Miniature lamp users now have the option of using LEDs, which have the advantages of long life and high resistance to shock and vibration, or miniature lamps, which excel in brightness and the number of colors available.

The interchange is possible because the LEDs are packaged for direct replacement with submidget-flange-base and bi-pin-base miniature lamps. The light sources operate on 1.5 to 5 V and 8-30 mA, producing .001 to .030 candlepower.

14 to 18 GHz obtained with transistor amplifier

What are believed to be the highest high-frequency transistorized amplifiers and oscillators ever developed have been fabricated at the IBM Research Laboratory in Zurich, Switzerland. To obtain their (14-to-18-GHz) performance, the experimental units employ gallium arsenide Schottky-barrier FETs.

These transistors, which IBM calls MESFETs (for metal-semiconductor FETs) have provided as much as 8 dB of gain at 15 GHz. A three-stage amplifier made from these devices had a power gain of 6 dB at 16.9 GHz, with a 3-dB bandwidth of 520 MHz and a noise figure of approximately 14 dB.

A four-stage narrowband ampli-

fier provided a gain of 16 dB at 14.9 GHz, with a 150-MHz bandwidth.

When operated as an oscillator, a MESFET produced 4 mW at 17 GHz.

IBM expects the transistors to be used mainly in space and satellite communications.

Threefold rise foreseen in Japanese exports

Exports of Japanese electronics should triple from some $2-billion in 1970 to $6-billion in 1980, thereby giving the United States intense competition in world electronic markets, says Robert Peters, senior industrial economist of the Stanford Research Institute, Menlo, Park, Calif.

Peters, commenting on the conclusions of a recent institute report, "Electronic Equipment in Japan," points out that while in the past the Japanese threat has been in consumer electronics products, in the future it will come from industrial and telecommunications exports, which should increase more than fivefold over the decade.

The recent Nixon economic moves will not change this picture much, says Kenneth W. Taylor, another senior industrial economist at the Stanford Research Institute. Japan, he notes, will be exporting to countries other than the U.S., such as to Western and Eastern European markets, while at the same time she is penetrating the developing countries—Sountheast Asia, for example.

Taylor points out that the industrial electronic market in Japan alone is expected to rise from $1.5-billion in 1970 to more than $10-billion in 1980—a 21% annual growth rate. Imports into Japan are also expected to increase—from $325-million this year to $1.6-billion over the next decade.

Machine-tool makers see spurt in sales to Red bloc

A potential boom in machine-tool sales to East European countries could reverse what may be the worst depression to hit that industry since the early Thirties, according to James A. Gray, executive vice president of the National Machine Tool Builders Association.

Gray led a group representing 15 American machine-tool makers to Moscow this summer, and he plans another trip this winter to the Soviet Union and Poland on behalf of 25 companies. On his recent trip, he returned with inquiries for prices on $45-million worth of machinery.

Gray's reaction is reported International Market Letter, a new publication put out by GMS Associates International of Arlington, Va., which reports on U.S.-East European trade matters. The publication forecasts a $1-billion market for U.S. machine tools and associated control and measurement instrumentation in East Europe by 1974.

According to Gray, the Soviet machine-tool industry is large and modern, but production still can't keep up with demand. The market, he says, includes "sophisticated machines with numerical control as well as equipment of more conventional design." He emphasizes that he is speaking of "machine tools to build everything from pencils, ballpoint pens and other consumer goods to heavy construction and read-making equipment."

New U.S. patent policy draws mixed reviews

Proposed changes in the Government's patent policy are stirring mixed reactions in the electronics industry.

The changes are intended "to provide greater utilization of inventions paid for by Government contract and more flexibility on the part of Government agencies in achieving this," according to O.A. Neumann, executive secretary of the Committee on Government Patent Policy in the Federal Council for Science and Technology.

A patent expert for a large electronics company, however, says the change will simply make it easier for the agencies to do whatever they like.

One proposed change will be to add another reason for the Government to take title to an invention. Besides "public welfare" and "public health," now "public safety" has been added.

"This was done at the request of the Dept. of Transportation, to make it easier to take complete title to all inventions they have under contract," the electronics patent specialist, who requested anonymity, told ELECTRONIC DESIGN. "This presumably is for DOT's Federal Aviation Administration."

On the other hand, other changes give each agency more discretion in giving title to an invention to the contractor. "How this is handled will depend on how each agency interprets the case, which makes for a bureaucratic boondoogle," the expert continued.

A benefit to the public, Neumann says, is a clause that permits the Government to give exclusive licensing to a contractor after two years. Nonexclusive licenses don't promote the private investment to produce an invention, for fear that after a company spends money for production and promotion, competitors will jump in and take away the business.

More power added to Arecibo antenna

A high-power transmitter being added to the 1000-foot-diameter radio telescope near Arecibo, P.R., is expected to make it the most powerful antenna available for making radar studies of the planets and their satellites.

The addition of a 1 MW, S-band radar transmitter and receivers—plus other modifications to the antenna's surface—will allow the radio telescope to be operated on a 10-cm wavelength. It presently operates at 70 cm and seven meters.

The modifications will make Arecibo useful for such studies as these:

- Mapping the surface of Venus to a resolution of from 1.2 to three miles using doppler techniques.
- Mapping the surface of Mercury with a resolution of about 31 miles.
- Getting the first recognizable radar signal return from the four brightest satellites of Jupiter and attempting detailed studies of at least the two largest, Callisto and Ganymede.

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INFORMATION RETRIEVAL NUMBER 17

Hospital maintains largest patient monitoring system

Located on Manhattan's West Side, Roosevelt Hospital has all the drama of the big city hospital so often seen in television serials. A century old this year, the 595-bed hospital averages about 700 surgical procedures a month in more than a dozen operating rooms.

Large and venerable though it may be, the institution is still most proud of its very special scientific skills. For one thing, the hospital has an innovative medical electronics department that is often charged with keeping this machine-dependent institution running. Its newest development is an extensive patient monitoring system, designed largely by its own staff.

Mr. Ronald Conners, the department's director, thinks the mere existence of such a separate electronics department in a hospital is unusual, but is certain that the idea is spreading. Conner's department, which is responsible for specifying and maintaining all medical electronics used in the institution also must see to its safe operation. In cases where special equipment must be designed—as when several pieces of hardware must be interfaced, or for safety and maintenance checkouts—his department designs and builds it.

But what he feels is his department's special contribution is one of the largest data processing systems for patient monitoring in existence. According to Conners, most systems now working in other institutions are different from his in two basics:

- They can monitor only one to four patients while Roosevelt's system can monitor up to 20 intensive-care patients, simultaneously.
- They are mainly oriented toward research and can only answer specific questions posed by the user. As such, they are expensive. The installation at Roosevelt, on the other hand, maintains a comprehensive medical file on each patient monitored and pays for itself by being clinically invaluable to the doctor and nurse.

Conners says that the goal of his system is to keep cost-per-patient down by being able to cover all intensive-care patients in the typical community hospital. "We believe that our kind of approach is the only valuable one for the computer in medicine," he says.

The system is comprised of Xerox Data Systems Sigma-5 computer with 32,000 words of core storage; peripherals include two disc files, each with a 3-million byte capacity and fast access time, two high speed magnetic tapes, card readers, line printers and teletype. Analog waveforms obtained from the patient are displayed on bedside monitors and cabled to buffer amplifiers which are used to eliminate ground-loop problems and provide a low-impedance output to an analog-to-digital converter.

So far, the system is connected to operating rooms, a cardiac catheterization laboratory (see box), a surgical research laboratory which employs animals and three five-bed intensive care units—a respiratory unit, a coronary care unit and a surgical unit for post-operative patients.

Michael P. London
News Editor

Performance of the Sigma 5, built by Xerox Data Systems, is demonstrated by Ronald Conners, Director of Roosevelt Hospital's medical electronics department. This computer, along with the peripheral equipment shown, represents the heart of Roosevelt's 20-bed patient monitoring system.

Useful in operating rooms

Most of the experience with the system at Roosevelt has been in the operating rooms. It was here that Conners felt it would be exposed to the widest range of patients with whom to evaluate its effectiveness, and also it was here that it was first completed. "What we've found," says Conners, "is that the system provides the sur-

geon and anesthesiologist with an ability to continuously monitor the patient's status while he is undergoing the surgical procedure." This might include a display of the patient's ECG, half a dozen different cardio-vascular system pressures and several body temperatures.

"I think that this operating room set-up is one of the foremost in the country. Other institutions are getting involved in this area, but ours is the only system of its kind in New York," he believes.

The biggest design problems associated with the installation have been electrical transmissions and the operating room displays. Conners views the difference in ground potential as a big problem. "The difference between two rooms, often separated by 150 feet, can be fairly high—a volt, a volt and a half, or even two volts. We've had great difficulty equalizing the ground potential between the remote monitoring equipment and the central computer facility. As a result, we went to a double buffering technique which brought the ground reference from the remote location into one arm of a common mode differential amplifier and utilized the capability of the common-mode rejection to balance out differences in potential."

The other difficulty was selecting the appropriate display system for the operating rooms. The way Roosevelt is laid out, a central equipment bank is located in an alcove between every two major operating rooms. The necessity for remote zero and gain control between the centrally amplified signals and the remote displays suggested the use of closed circuit television. "We put raw analog waveforms from our signal processing amplifier directly onto an oscilloscope in the alcove and photographed the display through a mirror system. This allowed us to remotely adjust the gain and zero control on the oscilloscope, position the tracing and transmit via closed circuit to a 23-inch display in the operating room."

Conners says this eliminates the requirement for an electronics technician getting dressed up in a scrub suit to make adjustments in the operating room.

One problem they haven't solved is electrical interference. "When electro-surgical units are used, interference obliterates the ECG signal. We've really not yet found a solution," he says. ■■

Heart-data monitoring in real time

Probably the most outstanding feature of Roosevelt's monitoring system is the analysis it can do for a cardiologist performing a heart catheterization while it is underway. Catheterization is performed on patients to obtain blood samples and pressure readings from within the heart. It is done in the operating room during open-heart and other major surgery, and at Roosevelt Hospital, in the cardiac-catheterization laboratory shown in the photo.

The catheter (blurred in foreground) is a thin tube which is usually made of woven plastic to which blood will not adhere. It is inserted into a vein or artery in the arm and threaded into the heart, guided by the physician who watches its progress on a fluoroscope.

Pressures sensed by the catheter are converted into electrical signals by transducers and fed, via cable, through the floor to the monitoring equipment shown on the table. This allows the cardiologist to observe raw analog signals while these same signals are fed to buffer amplifiers and then to the main computer room where they are processed.

A number of sub-programs are available to analyze wave forms emanating from various locations in the patient's cardiovascular system. For example, programs can perform a complete pattern recognition on left or right ventricular pressures, right atrial pressure, and aortic pressure. These programs take the raw pressure wave from the appropriate heart chamber, analyze it, pick out its important points and present the results to the cardiologist on the keyboard display shown at left.

If the cardiologist were to desire left ventricular pressure, the display would show end diastolic pressure, systolic pressure, diastolic pressure (each occurs during a different phase of the heart cycle), heart rate, mean ventricular pressure, maximum rate of change of pressure and the time at which it occurred. This would give him the ability to calculate the gradient across the aortic valve by comparing the aortic pressure tracing with the left ventricular pressure tracing. By calculating the pressure drop across the valve, he could determine if it were defective.

Tracings are displayed in graphic form on an oscilloscope chart recorder and on paper. The cardiologist can obtain a hard copy of the entire procedure by dumping the data onto a line-printer when he is completed.

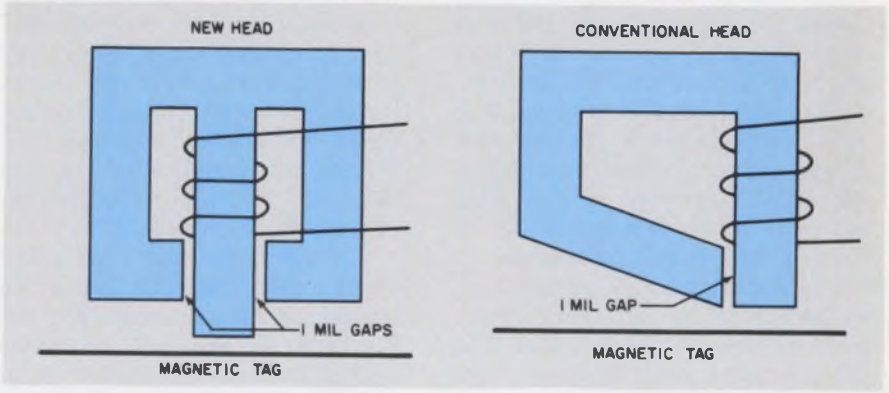
MAG head solves a tilt problem

A new magnetic recording head allows accurate recording when the head is displaced or tilted by as much as 45°. Present recording heads can only stand about 15° of angular displacement and 10° of tilt off the vertical axis.

The main application of the new head will be for point-of-sale terminals, says its developer, Keonics, Inc., of Glendale, Calif. The head will be built into a probe that a sales clerk will hold and pass over magnetic tags that have been attached to each item being sold. The tags will have magnetically encoded information identifying the merchandise and giving the price. Passing the magnetic head over the tags will automatically send the information to a computer for charging to the customers' accounts.

James Flora, president of Keonics, notes that such hand-held probes already are in use. However, he asserts, a small angular displacement of the probe can result in an erroneous reading. The Keonic probe can read the tag even if it is passed over it backwards.

The usual recording head contains an almost rectangular magnetic core, with a small gap at the recording surface and a coil around one of the vertical legs of the core. The Keonics head looks like a square core, with a break in the bottom leg. Protruding through that break is a vertical rod that is attached to the middle of the core's top leg. There are two gaps, each about 1 mil wide, on either side of the vertical rod where it passes through the lower leg of the core. The vertical rod extends below the lower leg of the core for a short distance, and the coil is wound around it.



Double-gap magnetic recording head gives an accurate recording with up to 45° angular displacement or tilt from the data line. Present recording heads work only with about 15° of angular displacement and about 10° of tilt.

Keonics guarantees that flux through the coil will be the same, no matter how the head is moved. In the more conventional head, the direction of the flux through the coil depends upon the direction of motion of the head. A patent is pending on the Keonics design.

Flora explains: "It is because of the extension of the vertical rod below the rest of the core, and the fact that we have two gaps, that the probe can stand as much angular displacement and tilt as it does."

He notes that the head is capable of reading densities of up to 200 bits per inch.

The head's output impedance is 200 ohms. Its output signal level is 0.5 to 1 mV, for a velocity range of about 5 to 15 inches per second. The faster the head is moved, the faster the rate of change of flux, and therefore the higher the output level.

Since 1 mV is a low level for a noisy environment, Keonics plans to incorporate an op amp after the head to increase the level to about 1 V. The company has built a prototype, using a Fairchild μA741 op amp. It expects the OEM price for the probe to be about $75 in quantity.

In operation, the probe will read such tags as the Kimball, a widely accepted one made by the Kimball Div. of Litton Industries in Orange, N.J. It has two magnetic stripes, each about 1-1/4 inches long and consisting of a layer of gamma-Fe_2O_3 covered by a 3-mil protective layer of a paper-like material. These tags have phase-encoded information on them—that is, a positive-going pulse is a ONE and a negative-going pulse is a ZERO.

Other applications envisioned for the Keonics head include the automatic reading of tags in warehouses for inventory and the reading of encoded credit cards. ■■

David N. Kaye
West Coast Editor

What time is it? Your TV set may tell

With components costing $10 to $20 extra, television sets of the future will display the time in hours, minutes and seconds—accurate to a tenth of a second—in the lower lefthand side of the screen. Viewers will be able to get the time by pressing a button on the TV set.

That's how it's envisioned by the National Bureau of Standards in Boulder, Colo., where the experimental system is being developed.

The system consists of a precise time-code signal that can be sent to the home by TV networks along with ordinary programs. The TV receiver would contain a special

LSI circuit with decoding and display logic.

If a resettable clock is built into the TV set, the circuit will automatically reset the clock every time it loses or gains time.

For more money—up to $1000, depending on whether the modified TV sets are mass-produced or custom-made—a much more sophisticated time service could be bought. It would display the time to the microsecond, and it would display a 1-MHz frequency standard.

The time and frequency would be transmitted by network broadcasters on cues from atomic clocks installed by the Bureau of Standards in television stations. The accuracy of the clocks would be monitored on TV receivers at the bureau's center in Boulder.

The time code would not affect TV broadcast operations. During four of the 60 frames per second that appear on the screen, the time-code signal sent by the station would impose a coded 1-MHz signal on the active trace of line 1 on the screen, without disturbing the equalizing pulse. The code would carry information designating hours, minutes and seconds. This part of the code would contain a unique digital prefix, enabling the decoder to recognize it and display it in proper sequence. To avoid error, the code would be sent twice.

Encoded time and frequency measurements can be sent via television broadcasts to industry and homes without affecting normal transmissions, says the National Bureau of Standards, which is developing the system.

Once the code is received and recognized, it would be displayed as small numerals, 20 lines high, at the bottom of the screen. The numbers would change in exact step with the master clock at the broadcast station or network origin.

For frequency standards, the system would transmit a 1-MHz carrier frequency during the active portion of line 1. During the interval between the first and second equalizing pulses of line 1 and line 262 1/2, the stable 1-MHz carrier would be transmitted without code modulation. At the decoder, this signal would be recovered by a phase-locked oscillator, in much the way the color subcarrier is detected in a color-TV receiver. ■■

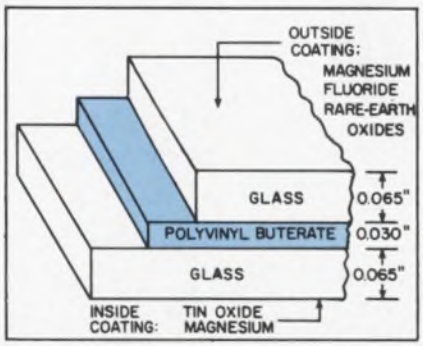
CRT faceplate screens out glare and RFI

Protection from glare, RFI and implosion are all achieved with a unique CRT faceplate design. This faceplate could also be used as a filter for any other type of display.

Developed by Tektronix, Inc., of Beaverton, Ore., for use on its line of interactive graphics terminals, the faceplate is a sandwich of coated glass and plastic.

According to Roger A. Frankland, project manager and developer of the faceplate: "We have a sandwich consisting of two pieces of coated glass surrounding a layer of blue-green polyvinyl buterate. Blue-green was selected in this instance because it well matches the wavelength of the trace on the CRT."

Sandwiching plastic between the two pieces of glass not only reduces glare through filtering but also provides protection against implosion and the resultant shattering of glass. RFI shielding is provided by a coating on the glass.



CRT faceplate is a sandwich of blue-green polyvinyl buterate between two pieces of coated glass.

To match the refractive index of the faceplate to the air, the outside layer of glass is coated with one layer of magnesium fluoride and two of rare earth oxides. The coating has a transmission efficiency of greater than 99% at the desired wavelength. Two layers of coating are used on the inside layer of glass. First transparent tin oxide is deposited and then magnesium fluoride. The tin oxide provides RFI shielding, and the magnesium fluoride provides impedance matching.

Total transmission efficiency of the faceplate is about 70%, according to Frankland, and total thickness of the sandwich is about 0.150 inches. ■■

New high-k ceramic materials make smaller MICs possible

Two new ceramic materials that combine low loss tangents with high dielectric constants promise greater microwave miniaturization than materials now available.

Because of their high dielectric constants, the materials make it possible to use microstrip fabrication techniques in the construction of low-frequency—say, below 1 GHz—circuitry without the penalty of excessive size.

Although the materials are not yet being produced commercially, pilot quantities are available for evaluation by prospective users.

One of the ceramics, K-38, is part of a family of materials developed by the Research Div. of the Raytheon Co. in Waltham, Mass., under contract with the Army Electronics Command, Fort Monmouth, N.J. The material has a dielectric constant of 38 and a loss tangent of approximately 4 x 10^{-4} at X-band (see table). Chemically, K-38 is composed of pure barium tetratitanate, $BaTi_4O_9$.

Michael J. Riezenman
Microwaves Editor

TC is kept down

Perhaps the most important property of K-38 is its relatively low temperature coefficient ($TC = (1/k)dk/dT \cong -49$ ppm/°C). Alumina, by contrast, with a dielectric constant of approximately 10, has a TC of +150 ppm/°C.

According to Dennis W. Readey of Raytheon's Research Div., materials with essentially zero TCs can be produced for dielectric constants below about 30. Mixtures of titanium dioxide, TiO_2, and various titanates are used to achieve these results. For higher values of dielectric constant, Readey says, it has not been possible to obtain zero TCs.

Mechanically the K-38 material is quite similar to alumina. Because of its small grain size and high density, it can be polished to a surface finish on the order of 0.5 micro-inch rms.

The material exhibits excellent adherence characteristics when metallized with a conventional chrome-gold metallization system. The test metallization consisted of evaporated layers of 100 Å of chromium and 2000 Å of gold followed by a layer of 5 μm of electroplated gold.

K-38 is available in samples up to 2 inches square.

'Mystery' material has k of 66

A second high-k material with a dielectric constant of 66 and a TC of 0 ±30 ppm is being produced in small quantities by American Technical Ceramics, Huntington Station, N.Y. According to Victor Insetta, the company's president, who declined to disclose the composition of the material, the ceramic has a Q of 5000 at 100 MHz, which corresponds to a loss tangent of 2 x 10^{-4}. Its properties have not yet been measured at higher frequencies.

Samples of the new material have been supplied to the Army Electronics Command for evaluation of their high-frequency properties, Insetta said.

In tests of its suitability as an MIC substrate material, the new ceramic has been polished to a finish of 1 micro-inch using standard alumina-polishing techniques.

Like Raytheon, American Technical Ceramics is not yet producing its material in commercial quantities. However, samples up to 1 inch square are available.

Although small-quantity costs are high, both manufacturers emphasize that there are no technical obstacles to high-volume, low-cost production. In fact, Readey claims that, in principle, K-38 can be produced more cheaply than alumina, because it is easier to machine. ■■

Summary of properties of K-38 ceramic

Composition (single phase)	$BaTi_4O_9$
Water Absorption (per cent)	< 0.00
Specific gravity (per cent theoretical)	98.6 ± 0.3
Color	tan
Hardness (Moh's)	7
Coefficient of Thermal Expansion (°C^{-1})	9.4×10^{-6}
Modulus of Rupture (psi)	16,000 ± 1400
Dielectric Constant (X-band)	37.97 ± 0.29
Dielectric Loss Tangent (X-band)	$3.9 \pm 0.8 \times 10^{-4}$
Temperature Coefficient of Dielectric Constant (X-band, ppm °C^{-1})	−49 ± 3.9

Note: All properties are room-temperature values and tolerances are standard deviations.

NEW OP AMP CHAMP.

The new LM118 may well be the ultimate true differential operational amplifier. It not only has the fastest slew rate ever offered (a minimum of 50 volts per microsecond at A_V=+1), but *guarantees* it for every single device. In writing.

As if that weren't enough, the highly versatile LM118 is pin for pin compatible with general purpose op amps, has a 1MHz full power bandwidth, a unity gain crossover frequency of 15MHz, is internally compensated, can be offset nulled to zero with a single potentiometer, doesn't sacrifice dc performance for speed, comes in a TO-5 package and will soon be second sourced. (Once again giving testimony to the now-famous National Linear Circuit Motto: *"In order to be followed you have to lead."*)

Naturally, the entire LM118 series is available for immediate delivery at the following (100 up) prices: LM318H, $9.95; LM218H, $19.95; LM118H, $29.95.

For more information, contact your nearest National distributor. Or write, phone, TWX or cable us direct.

National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, California 95051. Phone (408) 732-5000. TWX: (910) 339-9240. Cable: NATSEMICON.

National

INFORMATION RETRIEVAL NUMBER 18

An Electronic Design Survey

7% industry growth in 1972 predicted by EOEM companies

What is the business outlook for the electronic original equipment market for the rest of this year and 1972? A survey conducted by ELECTRONIC DESIGN last month reveals a positively bullish view of the industry's future.

More than 70% of the top executives of leading EOEM companies expect both sales and profits to increase in the latter half of 1971. For 1972, over 90% expect sales increases and over 80% look for a profit increase.

626 executives polled

On July 21, 1971 questionnaires were mailed to 626 EOEM executives across the nation. They were asked to comment on their company's plans (see table) for capital equipment and research and development expenditures, new product introductions, gross sales and profit, as well as percentage growth of the electronics industry and primary growth areas in the years ahead.

On August 11, a few days before President Nixon's new economic policies were announced, the results of the survey were analyzed. On the basis of nearly a 15% return, here are some of the key findings:

- The respondents predict a 5.2% growth for the electronics industry this year compared to 1970.
- They foresee an even healthier 7.1% boost for the industry in 1972 compared to 1971.
- Over one-third of the respondents expect to increase their expenditures for capital equipment in the second half of this year, while nearly half expect spending to remain the same.
- Over one-half of the respondents expect capital equipment spending to increase in 1972 over 1971.
- Slightly over half expect an increase in new product introductions during the second half of this year, while a whopping 75% predict an increase in new products in 1972.

Over 60% of the respondents expect their share of the market to increase, while about 37% expect it to remain the same during the second half of 1971. Nearly 80% expect to increase their market share in 1972.

- More than 60% expect their overseas sales to increase during the remainder of this year, while nearly 80% envision an increase in 1972. Less than 3% expect a decline in overseas business.

Critical economic factors

The respondents were asked what economic or market factors do they see as critical in assessing their company's outlook for the second half of 1971 and into 1972.

The answers to this question were varied, ranging from tight money—to wage stabilization to cost of labor and materials. But, not surprisingly, the majority of executives tied their company's business outlook to the following factors:

- Control of inflation.
- General economic recovery and an end to the recession.
- Government spending programs.
- Role of investment in new capital equipment.
- Consumer spending.
- Competition from abroad.
- Growth of the computer industry.

Asked to predict the primary growth areas for the electronics industry over the next three years, the respondents came up with the following list in order of importance:

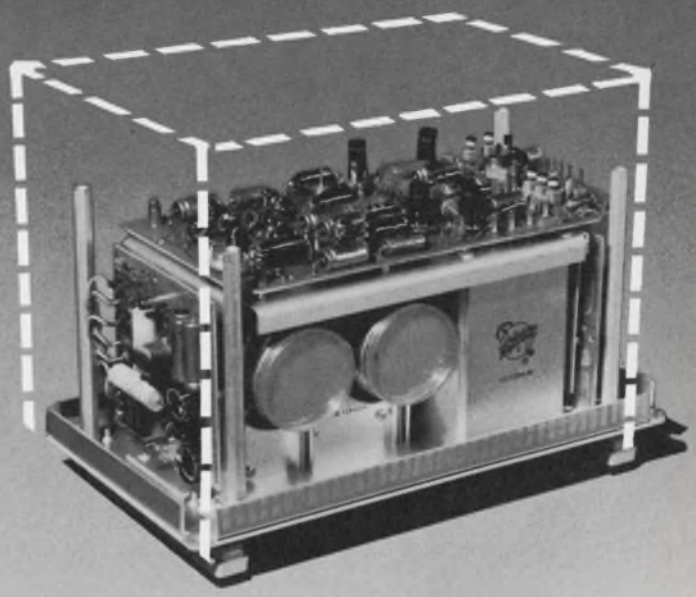
- Computers, including minicomputers and all types of peripheral equipment.
- Microwaves and data communications hardware.
- Industrial processing and control equipment.
- Medical electronics.
- All solid-state product areas including semiconductor memories, MOS in general and linear ICs.
- Consumer electronics.

In view of the considerable impact that President Nixon's new economic policies are expected to have on the general business picture, ELECTRONIC DESIGN will repeat this survey in November. ■■

EOEM business predictions for 1972

	Total responses	Increase	Decrease	Remain the same
a. Expenditures for capital equipment	96 -- 100.0%	50 -- 52.1%	7 -- 7.3%	39 -- 40.6%
b. Expenditures on research and development	96 -- 100.0%	56 -- 58.3%	2 -- 2.1%	38 -- 39.6%
c. New product introductions	96 -- 100.0%	72 -- 75.0%	-- -- --	24 -- 25.0%
d. Expenditures on marketing programs	96 -- 100.0%	67 -- 69.8%	1 -- 1.0%	28 -- 29.2%
e. Employment	80 -- 100.0%	54 -- 67.5%	2 -- 2.5%	24 -- 30.0%
(1) engineering	93 -- 100.0%	49 -- 52.7%	4 -- 4.3%	40 -- 43.0%
(2) production	93 -- 100.0%	65 -- 69.9%	9 -- 9.7%	19 -- 20.4%
(3) other	82 -- 100.0%	25 -- 30.5%	8 -- 9.8%	49 -- 59.7%
f. Gross sales	95 -- 100.0%	86 -- 90.5%	5 -- 5.3%	4 -- 4.2%
g. Profit	96 -- 100.0%	77 -- 80.2%	4 -- 4.2%	15 -- 15.6%
h. Market share	92 -- 100.0%	72 -- 78.2%	3 -- 3.3%	17 -- 18.5%
i. Overseas sales	93 -- 100.0%	74 -- 79.6%	3 -- 3.2%	16 -- 17.2%

Imagination and Stackpole ferrites can cut a power supply down to size



Tektronix, Inc. uses Ceramag® ferrite materials to achieve efficiency and significant savings.

Conventional power supplies are bulky, heavy and inefficient. Tektronix, Inc. changed all that. With ferrites and a fresh idea.

By rectifying line voltage, converting it to 25kHz and rectifying it again, Tektronix, Inc. engineers produced a power supply that was 50% lighter, over 25% smaller and consumed ⅓ less power. And the overall operating efficiency of 70% is a big improvement over the 50% typical of conventional power supplies.

Ferrites can offer the unique advantages, design freedoms and electronic characteristics that produce exciting new ideas. Stackpole Ceramag ferrites were used throughout the power supply design. Because Stackpole has a wide variety of materials and configurations, designers can unleash their imaginations.

Ceramag 24B

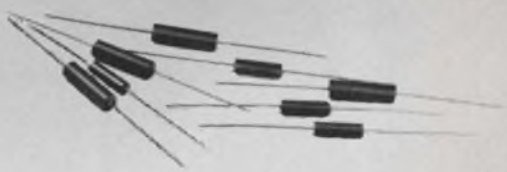
Tektronix, Inc. selected 24B for their "U" and "E" cores. This proven material has seen years of service in flybacks for television. Ideal for power applications, it can be operated at higher frequencies than laminated steel. It is cool running, due to low losses under power conditions and controlled power permeability. Tooling is available for a wide range of "U", "E" and "I" configurations.

Ceramag 24

Toroids of Ceramag 24 were used by Tektronix, Inc. for transformer cores. Again, this is a proven material, widely used by the computer industry for pulse transformer cores. It has a tightly controlled initial permeability, and tooling for a variety of sizes is also available.

Ceramag 7D and 27A

Multiple material selection for coil forms allowed Tektronix, Inc. maximum flexibility and design freedom. Proper inductance values could be achieved in the allotted amount of room. In addition, the high resistance of 7D



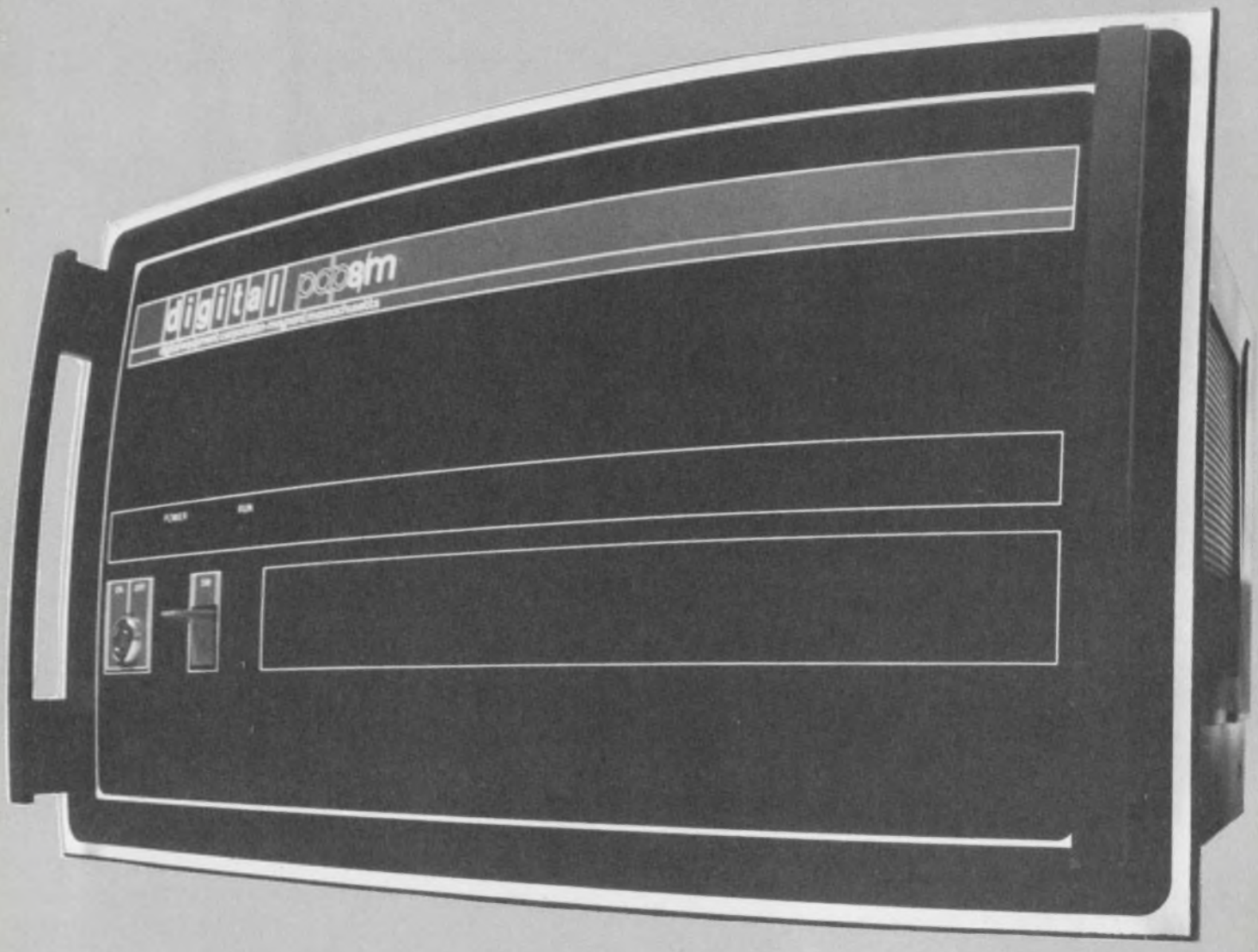
material prevents accidental shorting on printed circuit boards.

Great new designs happen when you *start* with the idea of ferrites. Particularly Stackpole Ceramag ferrite components. Why? Because Stackpole offers the variety of materials, numerous tooled configurations and the technical back-up you need. Twenty-four years of television and computer experience makes Stackpole one of the largest and most experienced domestic suppliers of quality ferrites.

Consider ferrites on your next prototype or redesign. But give us a call when you start. Perhaps we (and some Ceramag® ferrites) can help you cut a problem down to size. Stackpole Carbon Company, Electronic Components Division, St. Marys, Pa. 15857. Phone: 814-781-8521. TWX: 510-693-4511.

STACKPOLE
ELECTRONIC COMPONENTS DIVISION

Introducing the



On your left, the 12-bit PDP-8/M. On your right, the 16-bit PDP-11/05. Our brand new additions to the world's most popular families of minicomputers.

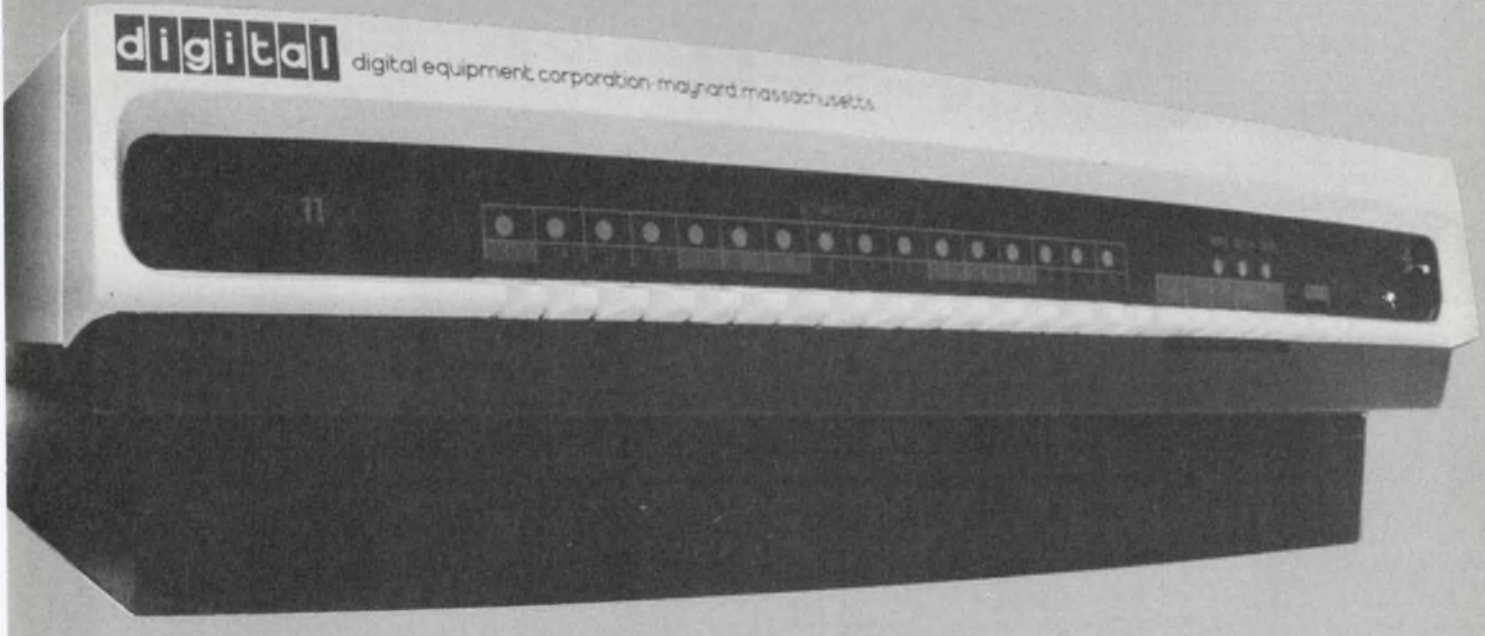
Complete computers — at incredibly low prices. Like $3,069.00 for the 11/05, and $2,362.00 for the 8/M in quantities of 100. Even the discount schedule is new. Very attractive.

In addition, they're compatible with the rest of the family members. Their options. Their peripherals.

They have the features of their bigger brothers. And, a full instruction set. OEM-oriented architecture. Both the UNIBUS™ architecture of the 11/05 and the OMNIBUS™ architecture of the 8/M permit easy, flexible configuring and interfacing. Real pluses for the OEM.

They're built with the kind of reliability that comes easy after delivering over 11,000 minicomputers.

OEM Yardsticks



And, they're supported with more field backup than you can get anywhere else. Worldwide.

PDP-11/05. PDP-8/M. Designed for the OEM. Priced for the OEM. Choice for the OEM. From the leader in OEM computer applications.

Now there's a whole new set of standards to measure up to.

Write for more information. Digital Equipment Corporation, Main Street, Maynard, Massachusetts 01754, (617) 897-5111.

digital

INFORMATION RETRIEVAL NUMBER 98

When you don't need a custom circuit...

AMI, the leader of custom MOS, has a completion record of a new circuit every three days. Filling the needs of over 650 specific applications. But, we don't stop there. Knowing the need for standard products in design, we have engineered, tested and put into production reliable lines of devices for you to choose from . . . If standard products fill your needs, we have them. If your needs are better filled by a custom circuit . . . we'll design it. For the full story call or write today to . . . American Micro-systems Inc., 3800 Homestead Road, Santa Clara, California 95051 (408) 246-0330

American Micro-systems, Inc.

	PART NUMBER	DESCRIPTION	LEADS/PKG.	FREQUENCY RANGE	NUMBER OF BITS	TYPICAL POWER DISSIPATION	CLOCK LEVELS	GATE THRESH-OLD
DYNAMIC SHIFT REGISTER	RD55G	Dual 50	10 TO5	10KHz - 1MHz	100	240mw	-27V	HVT
	S1708	Quad 40	12 TO8	10KHz - 1MHz	160	200mw	+5, -12V	LVT
	RD63G	Triple 66	10 TO5	10KHz - 1MHz	198	125mw	-27V	HVT
	S1724	Variable 256	14 DIP	10KHz - 1MHz	2-257	200mw	+5, -12V	LVT
	S1606	Quad 84	16 DIP	10KHz - 2MHz	336	200mw	+5, -12V	LVT
	RD65G	Single 426	10 TO5	1KHz - 5MHz	426	280mw	+5, -12V	LVT
	S1723	Dual 256	10 TO5	10KHz - 2MHz	512	150mw	+5, -12V	LVT
	S1705	Dual 256	10 TO5	10KHz - 1MHz	512	300mw	+5, 0V	LVT
	S1685	Dual 480	12 TO8	10KHz - 2MHz	960	200mw	+5, -12V	LVT
	S1687	1000/1024	12 TO8	10KHz - 2MHz	1000/1024	150mw	+5, -12V	LVT
	S1701	Dual 512	14 DIP	10KHz - 2MHz	1024	250mw	+5, -12V	LVT
	S1709	FIFO 8 x 13	24 DIP	10KHz - 100KHz	104	500mw	+5, -12V	LVT
STATIC SHIFT REGISTERS	SP51L	12 bit Serial/Parallel	24 DIP	DC - 2MHz	1-12	250mw	-27V	HVT
	RS53G	Dual 40	10 TO5	DC - 1MHz	80	150mw	-27V	HVT
	S1463	Dual 64	12 TO5	DC - 3MHz	128	180mw	+5, -12V	LVT
	S1670	Dual 100	14 DIP	DC - 3MHz	200	250mw	+5, -12V	LVT
RANDOM ACCESS MEMORIES	S1509	128 x 1, 64 x 2, 32 x 4	28 DIP	1.5 MHz	128	300mw	+5, -12V	LVT
	S4006	1024 x 1, Static	16 DIP	1.5 MHz	1024	600mw	None	I^2 *
	S2103	1024 x 1, Dynamic	18 DIP	1.5 MHz	1024	320mw	-15V	SIGATE
READ ONLY MEMORIES	S8452	256 x 4	28 DIP	DC - 200KHz	1024	500mw	None	HVT
	S8457	128 x 12 Hollerith to ASC II	24 DIP	DC - 300KHz	1536	500mw	None	I^2 *
	S8539	128 x 12 ASC II to Hollerith	24 DIP	DC - 300KHz	1536	500mw	None	I^2 *
	S8538	2048 x 1	24 DIP	20KHz - 1MHz	2048	400mw	+5, -12V	LVT
	S8453	512 x 4	28 DIP	DC - 200KHz	2048	500mw	None	HVT
	S8502	256 x 8	28 DIP	DC - 1MHz	2048	650mw	+5, 0V	LVT
	ME51L	2240 - 5 output	28 DIP	DC - 1MHz	2240	300mw	None	LVT
	S8327	2240 - 5 output	24 DIP	DC - 2MHz	2240	400mw	+5, -12V	LVT
	S8499	2240 - 7 output	28 DIP	DC - 300KHz	2240	300mw	None	HVT
	S8501	256 x 10	40 DIP	DC - 1MHz	2560	650mw	+5, 0V	LVT
MULTIPLEXERS	MX52D	6 Channel	14 FP			NA	NA	HVT
	MX53C	10 Channel	22 FP			NA	NA	HVT
	MX54C	4 Channel, 50Ω	22 FP			NA	NA	HVT
	MX55C	4 Channel, 50Ω	22 FP			NA	NA	LVT
STANDARD LOGIC ARRAYS	UL51L	Dual FF, Dual Excl OR	24 DIP	1 - 100KHz		60mw	-27V	HVT
	UL52L	Quad 2 NAND Expandable	24 DIP			40mw	-27V	HVT
	UL53L	Quad 2 NOR Expandable	24 DIP			120mw	-27V	HVT
	MX53L	10 Input Expander	24 DIP					HVT
	SP51L	12 bit Serial/ Parallel	24 DIP	DC - 2MHz	12	250mw	-27V	HVT
	S1694	8 bit Counter/ Shift Register	40 DIP	DC - 1MHz	8	15mw		LVT

	PART NUMBER	DESCRIPTION	LEADS/PKG.	RON @ -15V	PROTECTION	TYPICAL V_{GST}
DISCRETES	DM01B	Dual Matched 50mw	6 TO5	1250	No	-4V
	DM02B	Dual Matched 100mw	6 TO5	1250	No	-4V
	DM03B	Dual Matched 150mw	6 TO5	1250	No	-4V
	DM05A	Dual	8 TO77	250	Yes.	-4V
	DM06A	Dual	8 TO77	250	No	-4V
	DD07K	Single	4 TO72	125	Yes	-4V
	DD08K	Single	4 TO72	125	No	-4V
	DD09K	Single	4 TO72	250	Yes	-4V
	DD10K	Single	4 TO72	125	Yes	-2V
	DD11K	Single	4 TO72	700	Yes	-4V
	DD12J	Single	3 TO5	32	Yes	-4V
	DD13K	Single	4 TO33	32	Yes	-4V
	DD15K	Single	4 TO33	18	Yes	-2V
	T1368	Quad	14 FP	125	Yes	-2V
	T1337	Quad	14 DIP	125	Yes	-2V

*I^2 is a registered trademark of the American Micro-systems, Inc. Ion Implant Process . . .

Belden the Special "Specials" specialist

Here's what to do when cable catalog specs just won't do the job: Dial Area Code 317 ■ Then dial 966-6681 ■ You'll get action ■ From a man who devotes full time to solving engineered cable problems ■ A Belden specialist that "lives" with your design parameters from engineering through the actual production run ■ Cables for underwater-underground devices . . . extra-high voltage and pulse applications . . . medical instrumentation . . . low-level signal interference problems . . . unusual environmental conditions . . . he's tackled them all ■ Phone now.

8-5-0

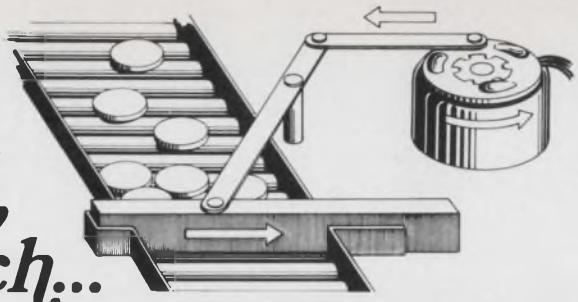
DIAL (317) 966-6681

BELDEN

. . . new ideas for moving electrical energy

Belden Corporation, P. O. Box 1100, Richmond, Indiana 47374. TLX 20-712, TWX 810-345-1393

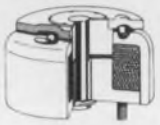
snap, lock, index, punch...



To move a load in an arc or a straight line . . . consider a Ledex rotary solenoid

A Ledex rotary solenoid gives you a down-hill solution to an up-hill problem.

The force of an electromagnet is inversely proportional to the square of the distance between the pole faces. Most solenoids live with this problem, which means less force in the beginning, where you need it, and wasted energy at the end, where you don't need it.



The Ledex rotary solenoid starts off working where the force is really at, about .030" between the pole faces. Then the armature rides a helical ramp, to distribute the force over the stroke you need. It gives you efficient, direct rotary action and uniform linear movement.

The Ledex rotary solenoid delivers a lot of power for its size. That's because it works in the tiny area where magnetic attraction is highest. It's efficient because it spreads this high concentration of energy over a longer useful stroke.

For rotary or linear positioning it's hard to beat its simplicity and high output. Choose from a family of eight models, with strokes from 20° to 95° and torque to 117 pound-inches. For a quick prototype, there are over 250 shelf models. Then, for a custom snap / lock / index / punch solution, you just talk to our positioning technology people.

LEDEX *the total technology people*

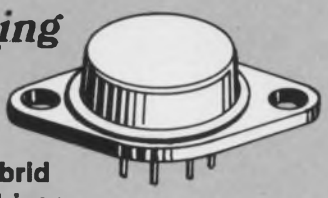
LEDEX INC.
123 Webster Street
Dayton, Ohio 45401
(513) 224-9891

POSITIONING Rotary solenoids for fast, direct action with strokes to 95° and torque to 117 lb-in; life over 100 million actuations. Push & pull solenoids for short, medium and long strokes; built for speed, durability. Stepping motors, for precise incremental power positioning.

SWITCHING Manual rotary switches, featuring Starmate detent for positive indexing. Stepping switches for dependable remote multi-pole switching, programing, checkout. Packaged switches—solid state and electromechanical black box solutions to complex switching and timing problems.

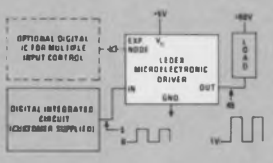
MICROELECTRONICS Power drivers, pulsers, time interval controls, level adapters/shifters, voltage regulators—standard and custom circuits to blend microelectronic miniaturization and power with the higher current and voltage levels needed to drive electromechanical products.

new things keep happening at Ledex



. . . like this hybrid thick film driver

If you're working with a control signal that can only deliver 10 milliamps and you really need 5 to 7 amps, consider the Ledex LMD-5 power driver.



With the LMD-5 you can switch up to 325 watts. It has an expander node terminal, so you can add multiple inputs. An internal diode protects the circuit from damage when driving inductive loads.

Available from the shelf in 1-9 quantities at $32.07 each. Only $14.30 each in 1,000 lots.

INFORMATION RETRIEVAL NUMBER 22

INFORMATION RETRIEVAL NUMBER 23 ►

ERIE EMI Filters

WORLD'S BROADEST LINE OF MINIATURE CERAMIC FILTERS AND FILTER SYSTEMS

FIRST— in subminiature design capability

FIRST— in total in-house production capability

FIRST— in Quality and Volume Production

FIRST— to develop a complete line of subminiature EMI Filters

ERIE's stature as undisputed world leader in subminiature high performance Ceramic EMI Filters has been earned by our ability to apply 35 years of sophisticated ceramic and related technology to developing superior EMI Filters. Virtually all other presently known ceramic EMI filters are a copy of an Erie design. Yet, no firm has been able to equal Erie's combined in-house filter capability and proprietary ceramic technology.

Today these miniature filters "do their thing" in noise pollution control, eliminating extraneous noises and emissions from air waves.

There's an application for reliable Erie filters in your communications, aerospace, aircraft and industrial equipments. We'll be happy to help solve the problem.

Write for our new EMI Filter brochure
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Erie, Pennsylvania 16512

ERIE TECHNOLOGICAL PRODUCTS, INC. • Erie, Pennsylvania 16512

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Model 5100

FREQUENCY SYNTHESIZER

- **Full Programmability** BINARY OR BCD
- **0.001 Hz to 2 MHz Range**
- **No Switching Transients**
- **0.001 Hz Resolution**
- **Direct Digital Technique**
  NO MIXING OR PHASE LOCKING
- **High Spectral Purity** —70db SPURIOUS —60db HARMONIC
- **High Stability** $\pm 2 \times 10^{-8}$/°C STANDARD $\pm 2 \times 10^{-10}$/°C OPTIONAL
- **Precision Attenuator**
  0 TO 85db IN 1db STEPS PLUS CONTINUOUS CONTROL
  (PROGRAMMABLE ATTENUATION OPTIONAL)
- **High Output Voltage**
  10 VOLTS P-P, 50-OHM SOURCE IMPEDANCE

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ROCKLAND

INFORMATION RETRIEVAL NUMBER 24

Because it is there.

There, on the top of the largest line of multipliers available, is our 530. It's not quite the fastest: our #422 module slews at 120v/usec. Nor the most accurate: #427 provides 0.1% of full scale. But by jingo, it's the only complete monolithic multiplier – divider – squarer–square rooter on a chip, op amp included. The specs are exhilarating and the price is right. Why the 530? That and other questions pertaining to multipliers are dealt with at length in a unique document published by us: "Evaluating, Selecting, & Using Multiplier Circuit Modules for Signal Manipulation & Function Generation." Unlike this ad, it's not so commercial as to dwell crassly on the 530. Rather, it is an impartial 16-page booklet that sets forth the theory and applications of multipliers in general. Just ask for "the multipliers booklet." Analog Devices, Inc., Norwood, Mass. 02062. (617) 329-4700.

ANALOG DEVICES

INFORMATION RETRIEVAL NUMBER 25

if we can supply memory cores at $.001 each...

can you produce memory systems at $.005 per bit?

If you need bulk quantities of cores, we can meet our part of the bargain . . . at a profit.

And we think you can do the same. In fact, if you use our new 18-mil "low-drive" cores, it's almost a certainty. These devices have very low switching currents . . . and they don't need a lot of costly electronic support.

If you'd like to cut the cost of your next memory, but not its reliability, contact us for a down-to-earth talk about core quantities and prices . . . even design. Remember we produce memories too. For quick reaction write
MEMORY PRODUCTS GROUP,
PHILIPS ELCOMA, EINDHOVEN,
THE NETHERLANDS.

In the U.S.A.: Ferroxcube Corporation, Mt. Marion Rd., Saugerties, N.Y. 12477; Phone (914) 246-2811, Twx 510-247-5410.

In Canada: Philips Electron Devices a division of Philips Electronics Industries Ltd. 116, Vanderhoof Avenue TORONTO 17 - Ontario

Test conditions and typical values at 25 °C.

Core type		18PH2*	18PH4	18PH5	18PH6
I_f	(mA)	213	425	500	580
I_p	(mA)	130	259	305	354
rV_1	(mV)	11	31.4	36	39
wV_z	(mV)	1.2	6.8	6.0	6.2
t_p	(ns)	230	142	136	123
t_s	(ns)	490	290	270	230

*With this core, wired in a 2D configuration and used under asymmetrical drive conditions, read/write switching times of 150/300 ns can be obtained, applying read-, write- and digit currents of about 440, 220 and 110 mA respectively.

Philips designs and produces memories of all kinds . . . core and non-core. We are sure that, for some time to come, only the core technology will offer the full combination of low price, assured non-volatility of information, realistic system speeds, and 100% component reliability . . . and be able to prove it.

Philips' advanced production methods can make more memory cores . . . to highest standards . . . cheaper . . . than anybody else. Make us prove it!

PHILIPS

electronic components and materials

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INFORMATION RETRIEVAL NUMBER 26

INFOMATION RETRIEVAL NUMBER 27 ►

BOLD NEW LOOK IN ILLUMINATED SWITCHES!

It not only looks good, the Series 67000 illuminated DW "Multi-Switch"® switch is a glamorous bit of switch packaging. It's compact, low-cost and operates beautifully, too!

Large, square pushbuttons (19/32″ sq.), in 6 different colors, provide brilliant (or soft), evenly—diffused lighting over the entire face of the pushbutton. Front relamping. Really, this is a honey!

Versatility? It's a low cost multiple station push-button switch available up to 18 stations in a row, in interlock, all-lock, non-lock and push-lock/push-release, with up to 4PDT switching per station.

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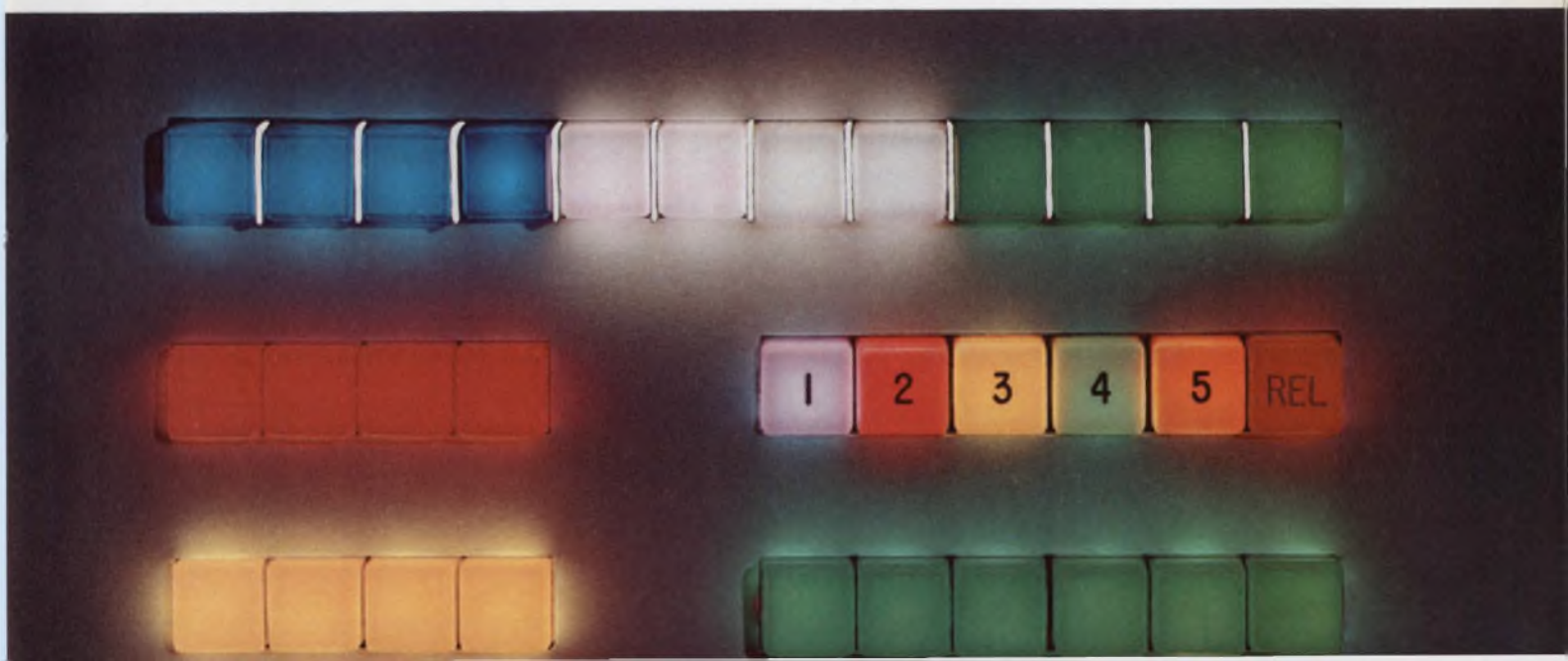

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INFORMATION RETRIEVAL NUMBER 29

technology abroad

A new class of ceramic dielectric with a permittivity three times that of a conventional alumina substrate has been developed by GEC Hirst Research Centre. A size reduction of 2-to-1 can be obtained in the fabrication of microstrip circuits. The new material has a very low dielectric loss ($Q=2000$) and a low, controllable temperature coefficient. Stable resonators can be made in small size. The material may also possibly be used in bandpass filters.

CIRCLE NO. 451

An all solid-state unit that will switch high-voltage induction motors from one supply to another with an interruption of less than 60 ms has been developed by Brown Boveri. The unit, which incorporates a thyristor output stage, contains three independent measuring channels for phase-angle, frequency and residual voltage. And if these quantities are not within limits the circuit automatically triggers a circuit breaker.

CIRCLE NO. 452

A civilian warning system that could be operated over the public telephone at 12 different sites was called for by the Israel Ministry of Defense after the six day Arab-Israeli war. The system had to be secure against false alarms and also needed a facility to check that the alarms which triggered air-driven sirens were working properly. The system, offered commercially by Telrad Telecom and Electa Industries Lod., comprises a central control unit and 12 terminal units. The alarms—attack, all-clear, or danger—are sounded by blasts of three tones operated in different combinations.

CIRCLE NO. 453

A ruggedized magnetic-disc memory that can withstand a jouncing ride in a tank and still perform with an error rate of less than one in 10 billion has been developed by Process Peripherals, a new company in Berkshire, England. The secret of its performance lies in a flying magnetic read/write head designed to a very high order of stiffness by the Royal Aircraft Establishment at Farnborough. Also novel is the use of a quartz crystal oscillator to control disc speed. The crystal is also used to clock data both on and off the disc, eliminating the need for control tracks. The memory has 64 tracks with a 4.2-million-bit capacity and a typical access time of 10 ms. However, this may be halved by switching rapidly from track to track.

A new image-storage electroluminescent panel that is a reusable industrial X-ray plate has been developed by scientists at the Enfield laboratories of Thorn Lighting in England. The new device is similar to a standard electroluminescent panel but functions in a completely different way. In the conventional panel, a layer of phosphor (zinc sulphide) is embedded between flat layers of protective materials and an electrically conductive layer. When ac is applied to the panel, it glows. In the new tube the phosphor glows only when it is simultaneously activated by the application of voltage and an external source of radiation such as X-rays. The image can be retained on the plates for a half hour or more. Among its applications are the detection of faults in encapsulated electronic components, or the detection of explosive devices in sealed parcels or luggage.

Half the length (11.5") of conventional cathode ray tubes, and operating up to 24 KV for improved visual and photographic writing speed, the Thomson-CSF F 8071 (right) requires no transmission line technique for operation up to 150 MHz at 0.2 dB.

Capable of high frequency (800 MHz), yet only 14" long, the OEE 1108 (left) utilizes the transmission line technique for operation up to 350 MHz bandwidth at 0.2 dB, with a sensitivity of 3.2 V/inch.

Type	Frequency Limit (MHz)	Bandwidth at 0.2 dB (MHz)	Y Deflection Factor (V/CM)	Useful Screen Area (inch)	Length (inch)
F 8071	300	150	4	4 x 2.5	11.5
OEE 1406	300	150	3	4 x 3.2	14
OEE 1108	800	350	1.3	4 x 3.2	14

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INFORMATION RETRIEVAL NUMBER 31

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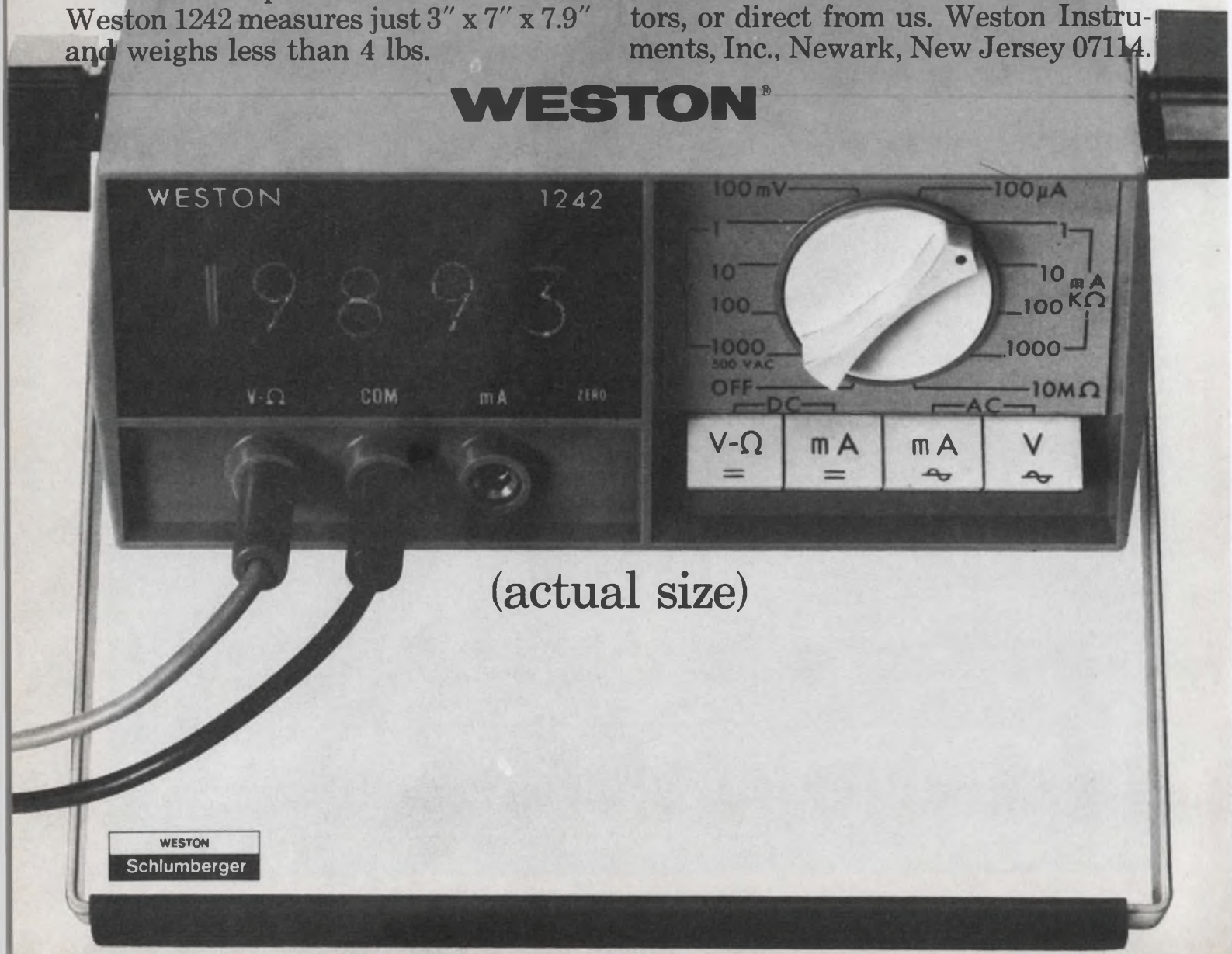

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washington report

DON BYRNE, WASHINGTON BUREAU

NASA fighting severe budget cuts for next year

The National Aeronautics and Space Administration is locked in a bitter struggle with the Office of Management and Budget—formally called the Budget Bureau—and the outcome may well determine the shape of the country's space effort over the next decade. The President is not due to present his fiscal year 1973 budget to Congress until sometime late in January but Federal agencies are now dealing with the OMB to see just how much money they will be allowed to "request" in the January budget. OMB has told NASA that it wants the space agency to hold its request to $2.8-billion, a cut of some half billion from this fiscal year's funding. NASA brass feel they cannot live with that figure or even this year's money which they say was merely bare bones funding. At stake is the space shuttle, for which Congress appropriated $100-million this year. If the program encompassing the re-usable booster continues, NASA will have to have somewhere near $400-million in the coming fiscal year and this now seems impossible. NASA, therefore, is studying, very quietly, the possibility of going to an expendable booster and putting off the development of the re-usable booster—in effect stretching out the program to a time when funding may be more likely. The booster switchover is called "phasing" and a decision is expected within NASA in a month or so. Meanwhile, this year's budget entailed a job cut of 1500 in NASA and it is not certain whether the President's announced 5% across-the-board cut in Government personnel will be added to the 1500. The Apollo 16 and 17 shots scheduled in the next calendar year will probably not be affected one way or the other, say NASA sources, since they are virtually already paid for.

U.S. airlines opposition to aeronautical satellite continues

Aeronautical Radio Inc., the communications arm of the U.S. airline industry, says the industry is still opposed to the aeronautical satellite system being pushed by the Federal Aviation Administration and the European Space Research Organization because it is "unsound." Arinc made its views known after a briefing at FAA on the developments in a Madrid conference last month on establishing pre-operational satellites for the Atlantic and Pacific. Arinc said the experimental work could be done better and cheaper with NASA's ATS-F and ATS-G satellites, already in the works. The crux of the matter continues to be the airlines' desire to stick with the vhf band while the Europeans and FAA want to go to uhf.

Import surcharge liable to be around a long time

Opposition from the European common market countries, Japan and others notwithstanding, the 10% surcharge on imports into the U.S. is liable to be around for awhile, say Treasury officials. Treasury Secretary John Connally himself has added that the surtax will stay until

U.S. products and manufacturers start getting a better shake in the world markets. The balance of trade situation—the difference between exports and imports—is what triggered the Administration's action as it faced the fact that the U.S. would probably have an unfavorable balance of trade for the first time since 1893. Typical of the flood of goods pouring into the U.S., Treasury said, was the surge in electronics imports this year. Electronics imports in the first half of this year totalled $998-million compared with $798.4-million over the same period last year. The Commerce Department noted that almost 30% of the consumer electronics goods sold in the U.S. are now imports. Commerce also said that although the policy was not yet firm, articles entering the U.S. under Section 807 of the tariff code would have the surcharge added if they are currently taxed at all—value added products. If they were not subject to any tax before, the surcharge will not apply.

Laird sees defense spending increase next year

Defense Secretary Melvin Laird says that he will probably seek a defense budget of around $80-billion for the coming fiscal year, an increase of around $4-billion to $5-billion over this year's request, and the Joint Chiefs of Staff say they see a defense budget need of $83-billion. Their friends in Congress, however, say Defense will be fortunate if it can hold the line at the current rate of spending, let alone succeed in getting any increases. Sources on the Appropriations Committees are reluctant to even look ahead to next year, uncertain as they are about what will happen this year when the defense appropriations bill comes before both houses. About the only thing certain for next year, one congressional source told ELECTRONIC DESIGN, is that the Navy will not get an appropriation for its long delayed nuclear attack carrier.

Capital Capsules:

NASA and Japan's Hitachi Central Research Laboratory have reached agreement for swapping computer programs. Four programs were included in the initial agreement . . . . **The Army and Lockheed Aircraft will try again on the Cheyenne gunship helicopter.** The Army has issued a $47.8-million development contract for work on the helicopter which originally was cancelled by the Army in 1969 after Lockheed failed to meet specifications. Lockheed agreed to take a $120-million loss on the old contract with the provision that the government would resume paying for continued development work . . . . NASA is asking for bids on an eight-month, $100,000 **study to determine the possibilities of converting its Nerva nuclear engine to a dual mode** which could provide power for spacecraft . . . The Pratt & Whitney Division of United Aircraft has filed **a complaint** with the General Accounting Office claiming **that NASA's $500-million contract award to North American Rockwell for development of the space shuttle engine "violated statutes, regulations, GAO decisions, and reports and prudent procurement policies."** P&W and Aerojet General were losers in the engine bid. . . .Western Union International has asked the FCC for permission to bid on the **contract covering communications services for the Apollo flights now handled by Comsat.** The Comsat contract is nearing expiration date. . . .**Treasury turned down a special exemption request from the 10% import surcharge on the Rolls Royce engines for Lockheed's L-1011 Tristar.** A new levy could up the cost as much as $300,000 per airplane and would presumably be passed on to purchasers.

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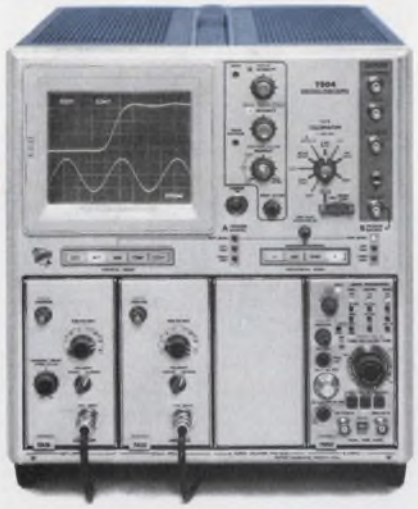

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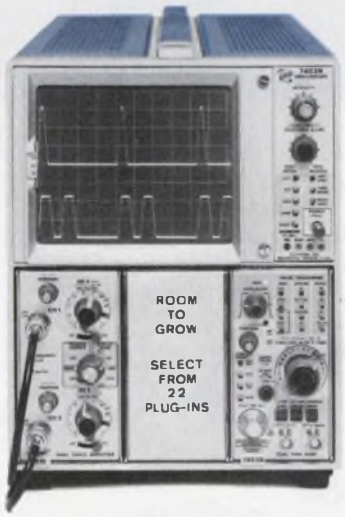

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INFORMATION RETRIEVAL NUMBER 33

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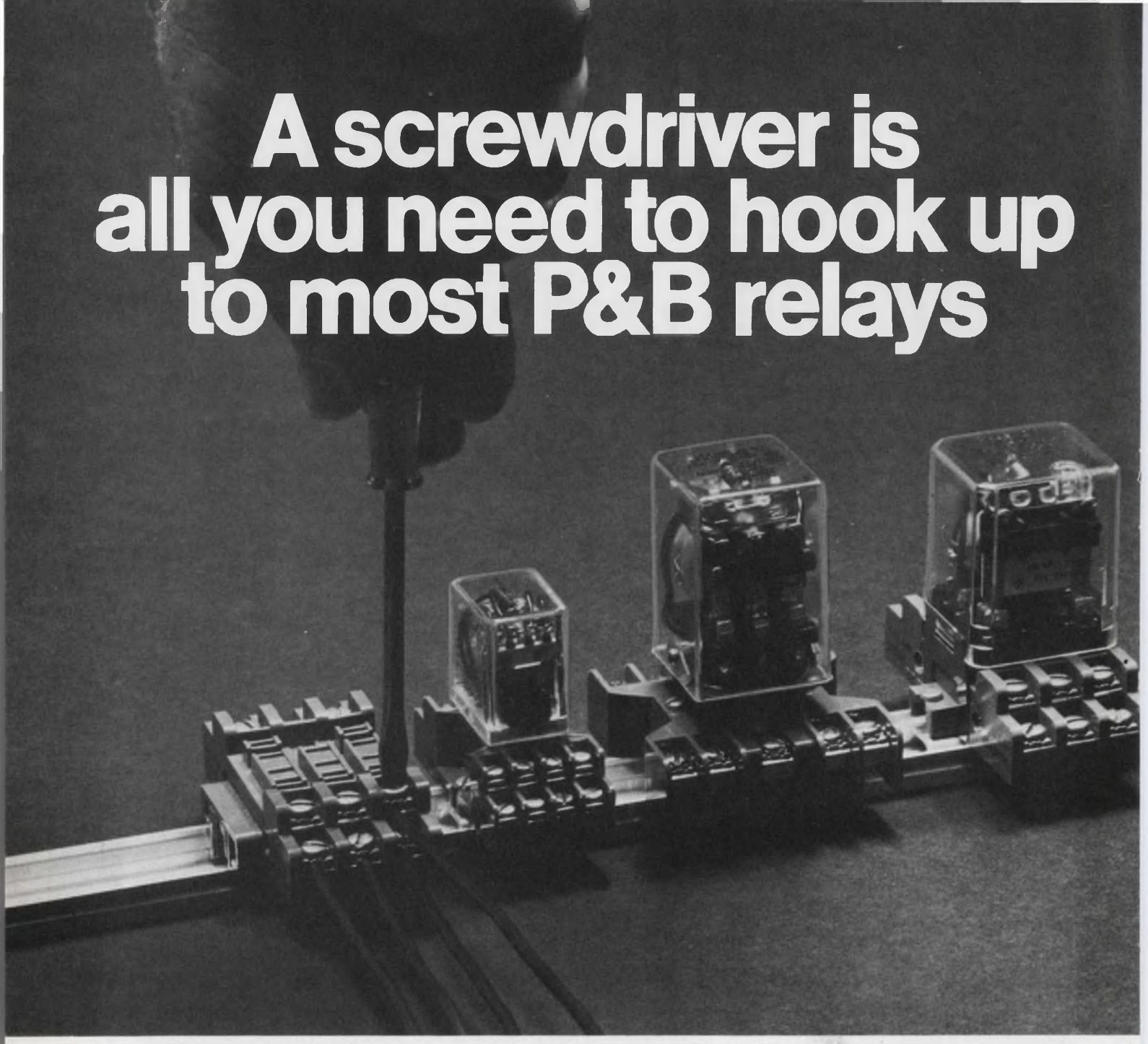

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INFORMATION RETRIEVAL NUMBER 34

editorial

The economic outlook is beginning to brighten

President Nixon's new economic policy provides the U.S. electronics industry with a unique opportunity it hasn't had in years. First, it should enable U.S. products to compete on equal terms with foreign imports—particularly from Japan. Secondly, the expected upward revaluation of foreign currencies will mean opportunities for manufacturers to sell overseas.

These policies along with the investment tax credit and the increase in personal tax exemption should help get the industry out of the doldrums its been in during the past 18 months. Many economists are now forecasting real growth next year of 6% or better for the whole economy. This rate of growth would be at least twice the slow rate for 1971 and significantly higher than was indicated by forecasts before the President's speech.

To further add to the bullish outlook, a survey of the electronic original equipment market (see page 28) was completed by ELECTRONIC DESIGN just before the President's new policies were outlined. The study revealed that more than 70% of the top executives of leading EOEM companies surveyed expect both sales and profits to increase in the latter half of 1971. For 1972, over 90% expect sales increases and over 80% look for a profit increase. It's likely that another survey planned for later this year will reveal an even more optimistic business outlook for the months ahead.

These cheery predictions are, of course, much welcome in an industry that has been pretty much steeped in pessimism but there is a qualification. The electronic industry has got to watch its costs. While the President has indicated that there will probably be an increase in the flexibility of wage-price restraints after the 90-day freeze expires, it's still up to business and labor to restrain itself. Costs must be kept in line with productivity, otherwise the industry will in a short time be right back in its present predicament.

Ralph Dobriner

RALPH DOBRINER

While a few dozen vendors compete vigorously for what may one day become a huge IC-memories market, it can prove fruitful to examine their product specs and delivery promises with more than usual caution. For young technologies don't lend themselves to early standardization. And vendors, under pressure to announce new products, may often announce ICs before they are fully characterized—or even manufactured.

"Hope," said Alexander Pope, "springs eternal in the human breast," and even, one might add, in the breast of the man who prays that production quantities of his new memory will show the performance he found in one good chip.

Problems

It can prove valuable to hang some warning signs at a few pitfalls and roadblocks. Of these, the most typical is "typical." One vendor, whose data sheets abound in "typical" specs, warns: "Never read a typical spec; always insist on minimum-maximum specs. You can't design with typs."

And yet, they have their value. For they demonstrate a product's capabilities. A vendor can screen devices to meet a particular spec—but not all specs. For a price penalty, he may guarantee a maximum access time *or* a maximum power dissipation—but not both in the same device.

Or a manufacturer may modify a device to meet a particular spec. But "O! that way madness lies," said Shakespeare's King Lear—and many a memory vendor. But it happens. A customer samples a device, likes it, then asks for a small modification. So does another customer. And another. Pretty soon the vendor is selling a device his manufacturing people can't make.

In the heat of competition, a vendor may prepare a spec sheet with apparently guaranteed "min-max" specs. But the sheet may be headlined, "Tentative" or "Preliminary"—which may be variants of "We hope we can make this part." Unfortunately "tentative" specs, like "projected" prices for a brand new device, are invariably more attractive than firm specs and market prices for an established device.

Prices deserve almost as much attention as specs. For the best price may come from the vendor who can't make the device. And he may have the best specs. Further, the IC-memory business has some peculiarities: In many cases the laws of supply and demand are completely abandoned. Prices can plummet for a memory that everybody wants and nobody can make.

Because memories are complex devices, their data sheets can be awesomely complicated. The man feeling secret shame because he can't understand some spec sheets is not alone. When a vendor writes, for example, that a device is *also* available for different voltage levels, a user may need more than clairvoyance to know what *else* changes.

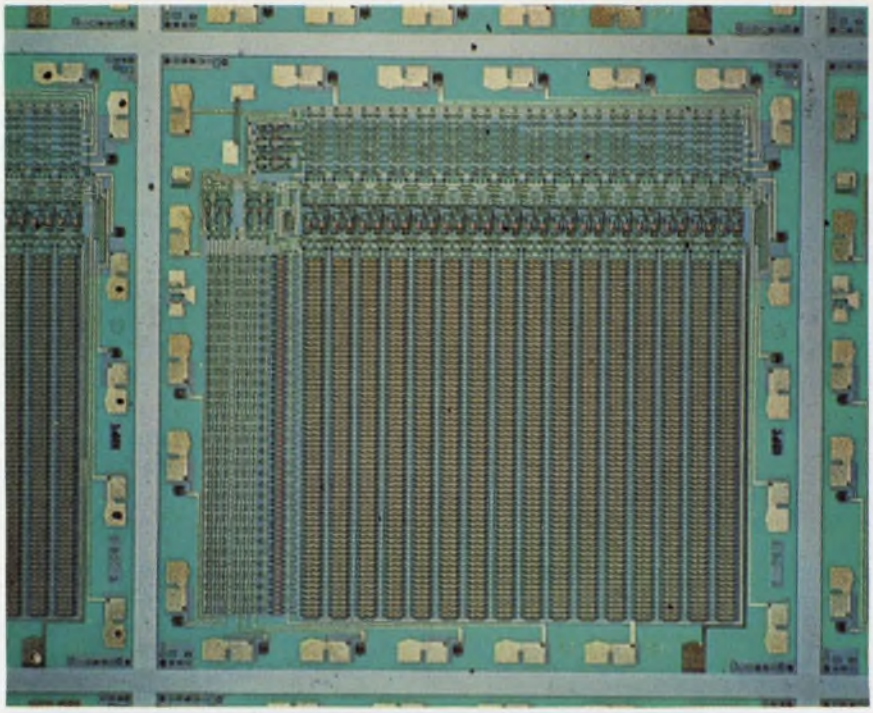
That crucial question, "What else changes?" must be raised often. Vendors are always pushing the edge of the state of the art. With admirable frequency, they break through. But not on all fronts. They advance one spec—or two. Not all.

The one or two selected specs are important milestones and thus form the bulk of this report. But it's necessary to ask, "What else changes? What sacrifices were made? What tradeoffs?"

It's necessary, too, to determine if a particular advance is useful in a specific application. A de-

George Rostky
Special-Projects Editor

sign approach that may be fine in a small terminal may prove ridiculous in a central processor.



The first one-transistor memory cell provides high density in General Instrument's RA9-2048, a silicon-gate 2048 X 1-bit dynamic RAM on a 138 X 143-mil chip only slightly larger than most 1024-bit chips.

Nothing is free

A vendor may hail the fact that his RAM or ROM has full decoding on the chip. But in a given system it may be more economical, in nanoseconds and dollars, to have undecoded storage chips share a decoder/driver.

One MOS array may boast its compatibility with TTL, perhaps forgetting its need for external pullup resistors. Resistors are cheap but they eat board space. So another MOS array boasts *full* compatibility with TTL. Yet a particular system may find it better to use level translators external to the MOS memory chips.

To an enormous extent, memory specs influence each other. So it's formidably difficult to characterize a device fully, even for an extremely conscientious vendor with time on his hands, and even for a well-established device. So a user must be particularly aware of his own requirements, and amply prepared to ask lots of questions.

An unwary user could assume that if a device can work well with a 3-MHz clock rate, it ought to be fabulous at 10 kHz. But dynamic shift registers, for example, have *minimum* clock rates, too. They would be better characterized if specs were to read: "Clock rate must be no greater than x MHz and no less than y kHz."

Further, data rates in shift registers and access times in RAMs and ROMs depend on voltage and temperature. So does power consumption. So a spec sheet that calls out access time for a high voltage and power for a low voltage is less than useful.

Those chip shots

Some engineers feel they can learn a lot about a device by studying what's inside the package. Magazine editors help by publishing pictures of memory dice. But the main reason editors publish chip shots is a simple one: They're pretty.

It's certainly true that chip shots (or the chips themselves) can convey information. A hawk-eyed observer might detect metal necking (variations in line width) which could suggest process difficulties. Using the die-bonding pads (usually four mils on a side) as size references, he might try to determine if the chip is too large for reasonable yield or too small to permit adequate control of practical tolerances.

In a packaged device (before encapsulation or lid-attach), he might look for cross bonding—wires going over others. He could look for leads that might touch. And he could check that wire bonds are centered in the pads. Many vendors would be happy to help him. Others could say he's wasting his time.

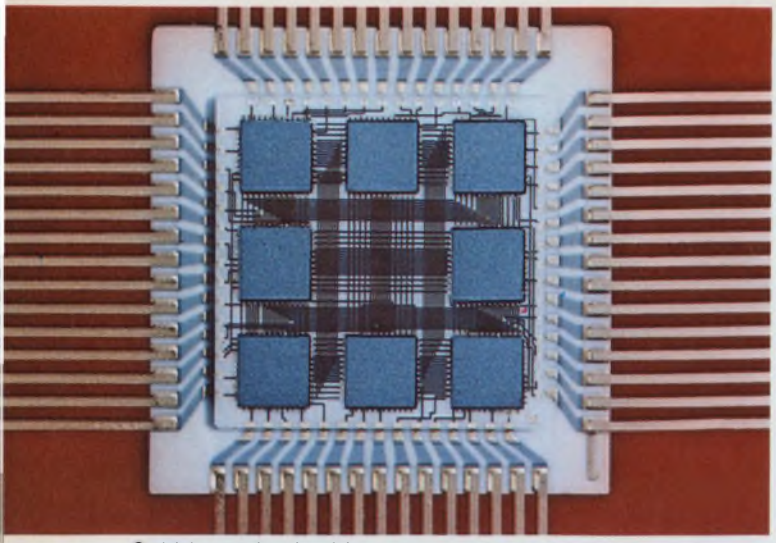
Vendors in the second school maintain that an engineer needs to know only the black-box parameters of a memory. He doesn't have to know if it's MOS or bipolar, or if it uses metal gate or silicon gate, n- or p-channel transistors, 111 or 100 crystal orientation, Schottky clamping or none.

He shouldn't care, these vendors feel, if there's a small man in the package, as long as the device can store and retrieve data at the proper speed, with the proper voltage levels, with proper power consumption and heat dissipation and with adequate longevity.

Unfortunately, it's difficult to generate instant reliability data. And engineers want some assurance that a vendor won't discontinue a product next year because its yield is too poor. So most engineers take a mid-stream course. They want to learn something about the chip, but not everything.

Those processes

For bipolar memories, the attention-getting process is Schottky clamping. This uses reverse-polarity aluminum-silicon diodes shunting base-



Gold-beam-lead chips on a ceramic substrate form a 2048 X 1-bit static MOS RAM from Texas Instruments.

collector junctions to enhance speed. The diodes turn on before the collector-base junctions can saturate, holding the transistors out of saturation so they can be driven hard, thus fast.

They provide high speed without saturation, because there's almost no charge storage, and without gold doping, which can contaminate wafers and processing equipment.

Opponents of the process (and those who aren't using it now) may argue that Schottky is an excuse for people who don't know how to gold-dope. Nevertheless, it allows the use of high-gain pnp transistors with high speed npns. And it cuts power dissipation. Intel was first to use the process in production.

In MOS memories, the silicon-gate process (also pioneered in production by Intel) has caught on to a great extent. In this process the gate electrode, of polycrystalline silicon rather than aluminum, serves as the diffusion mask that defines the edges of the source and drain regions of a FET. So the gate is automatically aligned, making overlap unnecessary.

This cuts gate and Miller capacitances while allowing FETs to be smaller, giving better chip density. A layer of silicon dioxide and glass over the entire chip (except for bonding areas) is impervious to ion and other surface contamination, so the device can be packaged in low-cost plastic—an important merit. And the technology lowers threshold voltage, making for easier interface with bipolar devices.

Another important process, ion implantation, was pioneered by Hughes. Involving ion bombardment of the chip surface, the process is used by Hughes and others to obtain self-aligned gates. It's used by Mostek and others to lower threshold voltage for bipolar compatibility and even for developing depletion-mode devices on the same chip with enhancement-mode transistors.

In bipolar memories, the newest offering is Fairchild's Isoplanar process, which uses silicon-nitride masking to permit oxide isolation instead of diode isolation, allowing substantial reduction in cell size. Fairchild hopes the process will give the high bit density that's common with MOS, along with bipolar speeds.

There are other processes, but these are the most significant today. Newer processes, like almost everything else in IC memories, are often subject to dispute.

If an engineer were to chat with key men at IC houses, he would likely find a wide range of views. Speaking in turn to experts A, B, C, D, E, F, G and H, he might find, for example:

A. "The process we use is best. It's inherently simple. The other fellow's process isn't practical; it's too difficult to use in production; it's too expensive."

B. "The other fellows think our process is too difficult. But that's only because they lack experience with it. When they learn how to control the process, as we have, they'll change their tune."

C. "When we come out with a product (or process) *before* the other fellow does, we have an advantage because, by the time he starts, we'll be at a more advanced point on the learning curve."

D. "When we come out with a product (or process) *after* the other fellow does, we have an advantage because we have learned from his mistake. We won't repeat them."

E. "His specs may look better than ours, but his process has never been proven. Nobody knows its long-term effects. The device is only experimental. His tolerances are too tight. He'll never be able to make it in production."

F. "The other fellow simply doesn't know how to control his process and work to close tolerances. We know we'll be able to use our process to make 10,000 circuits a month by next June. That's definitely achievable."

G. "Our process is inherently better because it reduces cell size."

H. "Cell size doesn't matter. Everything depends on smart circuit design and the number of metalization lines going to each cell."

In all these views, there is some truth. But there is almost no universal truth. Some generalizations have acquired such widespread acceptance that they're often accepted as fundamental truths. Yet they may be wrong.

Myths, pitfalls, tradeoffs

It is widely held, for example, that while bipolar memories are best for speed, MOS memories offer lowest power consumption and highest bit density, thus most storage per chip. But at the end of May, the largest single-chip memory for sale was

bipolar—it was not MOS.

In keeping with sanctified tradition, competitors praised the device, but said it was experimental and not really in production. The manufacturer, Monolithic Memories, insisted it was definitely in production and, in fact, being manufactured with good yields and sold in quantities normal for a new device.

ROMs

A read-only memory storing 1024 8-bit words, the unit, the MM6280, has the access time one might expect from bipolars—150 ns maximum. But its maximum power consumption, 60 μW/bit, matches that of MOS memories. Though output current is a full 16 mA, which is typical of TTL, address-line current is a mere 160 μA, one tenth that of TTL.

In quantities of 100 to 249, the MM6280 (for 0 to 70 C) costs \$60 (0.73¢/bit). It includes four chip-enable lines and is available with open-collector output, so it's easily expanded from 8192 to 16,384 words or, to use industry parlance, from 8 k to 16 k. All decode and sense circuits are on the chip.

Nobody holds records long

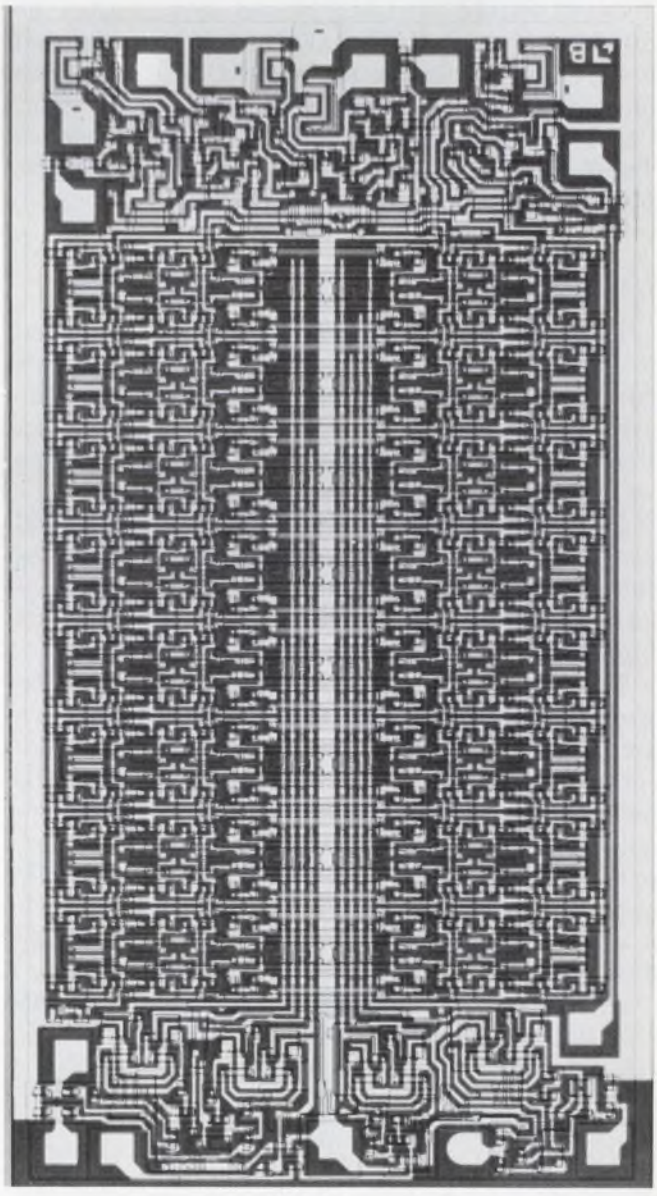
Before Monolithic Memories introduced its bipolar ROM in May, the record for the largest single-chip memory belonged to Electronic Arrays, for a static MOS ROM introduced in November 1970. Part of the EA4000 series, the device stores 512 10-bit words on a 93 by 100-mil chip that includes all decode and sense circuitry.

Total power consumption is only 325 mW (about 60 μW/bit). Though selected devices are faster, maximum access is 700 ns for units rated at 0 to +70 C and −55 to +85 C. Full Mil versions, for −55 to +125 C, have 800-ns max access. In 100-up quantities, the units cost \$34, (0.67¢/bit), \$40 (0.78¢/bit) and \$50 (0.98¢/bit), depending on temperature range.

Having lost the "largest memory" record in May, Electronic Arrays regained it in June with a slow, but big, dynamic MOS ROM on one chip. The EA5027, with 1024 12-bit words, has a maximum access of a rather leisurely 2 μs. But maximum power consumption is a mere 250 mW (20.4 μW/bit). A unit for 0 to +70 C operation costs \$40 (0.33¢/bit) in quantities of 100 to 249.

While these ROMs from Electronic Arrays and Monolithic Memories are the largest available at the moment, earlier ROMs are still noteworthy from the viewpoints of size, speed or power consumption.

Monolithic Memories, for example, has a 4096-



Schottky-clamped Am3101, a 64 X 1-bit bipolar RAM from Advanced Micro Devices, offers 30-ns access.

bit bipolar ROM. Fairchild has a 4096-bit MOS ROM and a 1240-bit character generator with on-chip counter/decoder. Texas Instruments has the TMS 4400 static MOS ROM, organized as 1024 × 4 or 512 × 8, at $16.25 in 100 to 249. Signetics has static MOS ROMs or character generators with up to 3072 bits. Unisem has a 4096-bit dynamic ROM. And American Micro-systems will soon offer a fully decoded 11,648-bit dynamic ROM with 800-ns access.

The earliest large MOS ROM was the American Micro-systems MA51, introduced in 1969 with 256 10-bit words and 1-μs maximum access. Several MOS ROMs with similar size have been introduced since then. These include circuits from Collins, Intersil, ITT, MOS Technology, Solitron and Teledyne, with densities of 2048, 2240 or 2560 bits.

Most of these companies also have smaller MOS ROMs, with about 1000 bits. At that size, there are some very fast bipolar ROMs.

Computer Microtechnology, for example, has 1024-bit ROMs, the CM2800 and 2805, with 50-ns maximum access. Intel has the Schottky-clamped 3301, the first bipolar 1024-bit ROM. It has 90-ns maximum access. And Kenics has a 1536-bit Schottky-clamped ROM with 60-ns typical access. These circuits—slow and fast, small and large, MOS and bipolar—all use transistors.

Why transistors?

Is the choice of semiconductor ROM restricted to bipolar and MOS transistors? Perhaps there's no need for any kind of transistor. Perhaps diode arrays can make a good ROM. North American Rockwell Microelectronics Co. (NRMEC) thinks so.

In its Model 15900 diode-array ROM, NRMEC uses silicon-on-sapphire construction and takes full advantage of the benefits of SOS—great isolation and very low junction capacitance—thus high speed and low power consumption.

The SOS ROM stores 3328 bits, organized in word lengths from one to 32 bits. The passive array, with a total of 5120 diodes, has on-chip decoding. The input is fully compatible with TTL but the output, which provides 150 μA, would require sense amplifiers for high-speed-TTL compatibility. The array, in a 42-pin flat pack or DIP is powered from a single 5-V supply, from which it takes no more than 60 μW/bit. Access time over 0 to +70 C is no more than 20 ns. That's quick.

In 100-to-999 quantities, the price is $45 (1.35¢/bit). That price includes encoding, which NRMEC can provide very fast—in 24 hours if a user furnishes a properly coded IBM card. For small quantities, NRMEC programs the ROM with a laser beam that opens silicon links between diode rows and columns. For larger quantities, the company uses mask programming. But there is no added mask charge tacked on.

While some manufacturers include the mask (or coding) charge in the price of the ROM, others separate the charge. They generally charge $200 to $2000 (depending on complexity) when fewer than 100 circuits are purchased. Beyond a specified quantity, generally 100, they invariably waive the mask charge.

Dodging the mask cost

It's apparent that one way to avoid the mask charge for coding ROMs is to buy them in sufficient quantity. A second way is to buy pre-coded ROMs. Most vendors offer several ROMs with fixed program patterns that they hope will have wide market acceptance.

These circuits—code converters, character generators, lookup tables, microprograms and keyboard encoders—are off-the-shelf, standard products, generally available from distributors.

Almost always these fixed-pattern ROMs stem from uncoded ROMs in the manufacturer's line. For example: Teledyne's TM5423BO Hollerith-to-ASCII converter comes from its 256 × 8-bit TM5423. Similarly derived standard, off-the-shelf ROMs include the Collins CRC3003 (1024-bit sine-lookup table), CRC3502 (2560-bit ASCII-to-EBCDIC converter) and the CRC3503 (2560-bit EBCDIC-to-ASCII converter). Still another is the ITT3257, with 64 5 × 7 dot-matrix characters encoded in ASCII or EBCDIC.

pROMs

There's still another way to avoid mask charges. One can do his own ROM coding with electrically alterable, field-programmable ROMs —pROMs— which can be fine solutions for those who need few ROMs with any single code. (See, also, ED 17, Aug. 16, 1971, "A new era in digital design: program-it-yourself memories," p. 22.)

They can purchase pROMs in large quantities, then electrically code (or program) them singly or in small groups with as many different codes as they like. Then if the volume of devices required for a particular code should grow large enough, they can go back to the pROM vendor and order mask-programmed ROMs at a lower unit price. Maybe.

While some pROMs are backed up by pin-for-pin equivalent mask-programmed ROMs, some are not. There may be no mask-programmed ROMs behind the pROM or a mask-programmed version may have different specs.

The first important pROMs were introduced in 1966 by the Microelectrics Div. of Radiation, Inc.

(now Harris Semiconductor), who owns the "PROM" trademark. They were small (but fast) diode matrices with 25 to 48 diodes having reverse recovery ranging from 10 to 100 ns. Not much later, Texas Instruments offered similar arrays, the TIDM1 and TIDM2, with reverse recoveries of 10 and 25 ns.

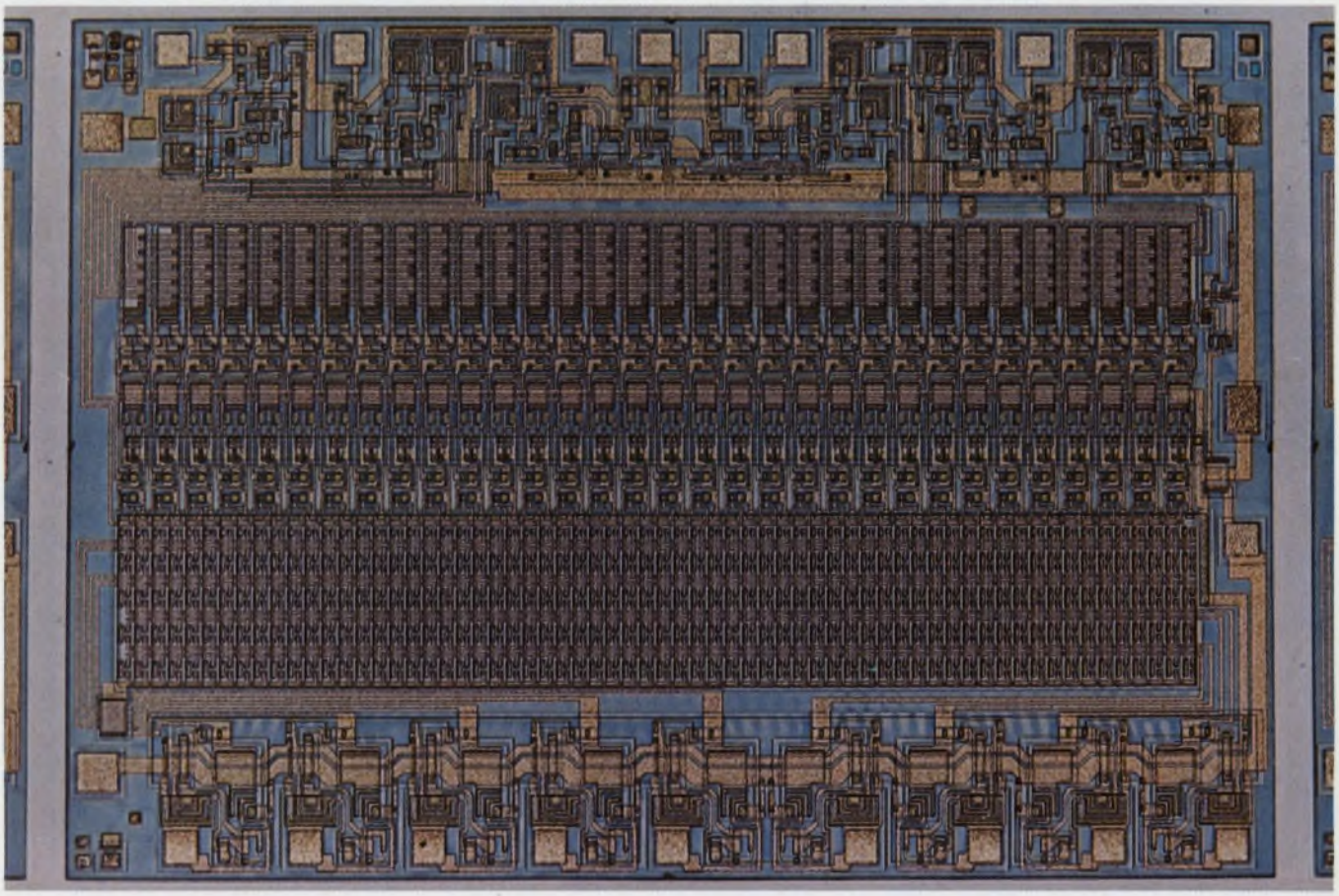
Zap programming for most pROMs

These pROMs have narrow aluminum strips connecting each diode to the matrix. To program the device, a user opens (or "fuses" or "zaps") appropriate aluminum links by briefly passing relatively high currents through them.

Some vendors argue that fusing links is a bad approach. They feel that fused links may re-form and that zapped metal particles may splatter over the circuit (despite the protective glass coat) and cause shorts. Harris disagrees. By June 1971 the company had accumulated more than 120-million fuse hours on the HROM-0512 without a single failure.

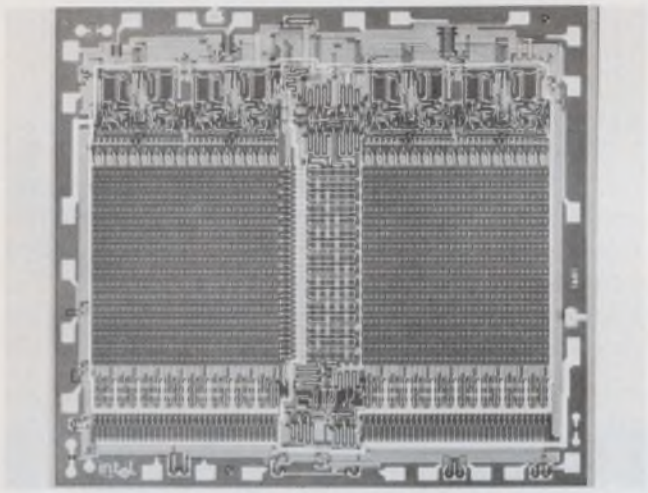
Introduced in April 1970, the HROM-0512 uses nichrome instead of aluminum links. It was the first large pROM, with 64 8-bit words. The company now has a 256 × 1 HR1256 at $23.50 in 100 to 999 and a 32 × 8-bit pROM and plans to introduce a 1024-bit pROM with a performance-equivalent ROM within a few months.

Nichrome-resistor links are also used in pROMs from Monolithic Memories, Motorola and Signetics. But Intersil, a company that doesn't like to zap metal, effectively creates links by shorting base-emitter transistor junctions instead. The company feels there's an advantage here because link forming takes place under the chip surface.

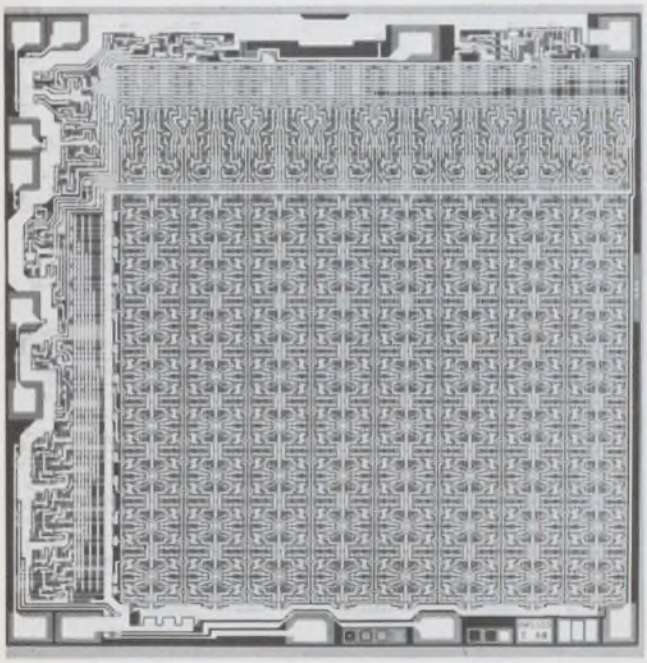


Ninth bits in Motorola's MCM5003 permit testing a pROM that's sold as a 64 × 8-bit memory.

Designed for code conversion, this American Microsystems 128 X 12-bit ROM with full decoding and TTL compatibility is one of the early products to use ion implantation for lowering threshold voltage.



The first erasable field-programmable ROM, Intel's 1601 on a 147 X 161-mil chip, can be erased by exposure to ultraviolet light, then reprogrammed.



One of the first 256 X 1-bit bipolar RAMs, Intersil's 5503, fits on a 120 X 120-fil chip.

By April 1971 Intersil had accumulated 250,000 device hours (40-million programmed bit hours) of high-temperature operating and storage life without a failure.

Intersil has four pROMs—the 32 × 8-bit IM-5600 and IM5610 (at $25.70 in 100 to 999) and the 256 × 4-bit IM5603 and IM5613 (at $51.20 in 100 to 999). The 5610 and 5613 are board-programmable versions of the 5600 and 5603. Twenty units can be programmed simultaneously.

Though Intersil has MOS ROMs to follow these bipolar pROMs, the MOS units don't have the same specs. The company feels it doesn't matter. It disagrees with the assumption that mask-programmed ROMs are necessarily more economical in large volume than electrically programmed pROMs.

For small quantities, Intersil or any of its distributors can deliver a programmed pROM in 24 hours. For large quantities, the user can do his own programming quickly, especially with board-programmable devices. Intersil sells a programmer for $700, but the price drops to $500 when an engineer buys 100 pROMs. The programmer is free when a man buys 1000 pROMs.

Taking the other point of view, Monolithic Memories offer bipolar ROMs that are direct replacements for its fusible-link, bipolar pROMs. The MM6200 ROM (at $21 in 100 to 249) has the same performance as the 256 × 4-bit MM6300 pROM (at $70 in 100 to 249). And the MM6205 ROM ($70) has the same specs as the 512 × 4-bit MM6305 pROM (at $100).

Programmers are available from Monolithic Memories at ($1400) or from programmer specialist Spectrum Dynamics. But Monolithic Memories says that no special equipment is required. Any test equipment that can deliver 90 mA can blow the links.

Does the pROM work?

There can be another problem with pROMs. When all links are intact—when a device is still unprogrammed—a unit can show zeros all over. A user cannot know—yet—if his address decoders, word-line drivers, inverters and buffers are working or if the pROM simply has a giant metal short or even missing metal paths. Further, he can't measure dynamic performance.

Motorola addresses these problems with the MCM5003 pROM which the company prefers to call a ROMP (Read-Only Memory, Programmable). By adding ninth bits to the device (sold as a 64 × 8) and a "T" to the acronym, Motorola gets a TROMP (Testable Read-Only Memory, Programmable), thus showing the world, among other things, how acronyms are developed.

The company programs ones in about half the ninth-bit locations. About 16 ones are mask pro-

grammed, allowing wafer-probe tests, while another 16 are electrically programmed (as a user might program them) during final test.

The zapped nichrome links are in locations that enable a user to measure worst-cast propagation delay (less than 75 ns). If he likes he can blow some of the remaining ninth bits to check his programming circuitry. Or he can get the MCM5003 with no links zapped, as a 64 × 9-bit pROM. In 100-to-999 quantities, the device costs $45. To follow the pROM, Motorola is about to introduce a mask-programmed version, the MCM4003. Both devices use Schottky clamping.

Unprogramming programmed pROMs

The testing problem could be alleviated and other advantages could accrue if a programmed pROM could be erased, then programmed again. That's obviously impossible in devices that use any form of zapping to destroy or create links. Two devices use radically different approaches to make this possible.

The first, a 256-bit "Read-Mostly Memory" from Energy Conversion Devices, is a 16 × 16-bit matrix of amorphous glass and silicon diodes. The "Ovonic Memory Switch" (named after company founder and chairman Stanford Ovshinsky) at each matrix cross-point can be switched from a resistance of 300 kΩ to 500 ohms and back again—so a program is easily changed.

The RM-256 Read-Mostly Memory differs from conventional pROMs in that a program can be changed. It differs from conventional read/write random-access memories in that the "write" or "programming" current must be applied for a relatively long time.

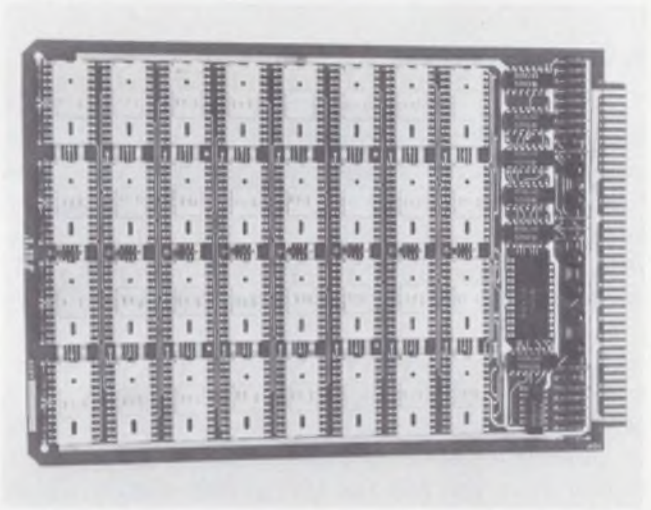
A 15-ms current of 7.5 mA from a 25-V source changes the RMM from its high to its low-resistance state. A 6-μs current of 150 mA from 25 V reverses the structure. Read access is only 150 ns, including the delay in an external decoder. At 100-up levels, the unit costs $45 (25-199).

The first MOS pROM

Another approach to a reversible pROM appears in Intel's 1601, a 256 × 8-bit memory that embodies a challenging new concept, and the first pROM using MOS devices. Like many other MOS products, the 1601 depends on charge storage at the gate. But unlike any other, its gate (a silicon gate) has no electrical connection; it floats.

It gets its charge by avalanche injection of electrons from source or drain, which induces a conductive channel. The amount of charge on the gate of this "Floating-gate Avalanche-injection Metal Oxide Semiconductor," or FAMOS, depends on the amplitude and duration of applied junction voltage. Once the programming voltage is removed, there's no discharge path for the accumulated charge and a zero has been written to replace the initial-condition one.

Semiconductor memories



Modular memory card from Advanced Memory Systems uses 1024 X 1-bit MOS RAM chips with 350-ns access to provide 4096 eight-bit words.

But don't charges leak? How stable is the programmed zero. Very stable, says Intel. Extrapolation of charge-decay measurements made at high temperatures (125 C and 300 C) suggest that the charge should be retained for at least 10 years at 125 C and for perhaps 100 years at normal ambients—unless the FAMOS is exposed to X rays. They erase all zeros and return the device to the initial, unprogrammed, all-ones condition.

But X rays aren't recommended for erasing. They can increase leakage and may adversely affect other parameters. The device is erased, safely, when the chip is exposed to ultraviolet light. In fact, Intel programs each 1601 with a magnetically held lid on the package, then tests each bit, then removes the lid and erases with ultraviolet,

then attaches the normal solder lid.

If a user wants to erase and reprogram a device, he must ship it back to Intel to have the lid removed. This may not be necessary for long. Intel just introduced a new FAMOS unit, the 1701 (at $200 in 1 to 999) with a quartz lid that permits a user to erase with his own UV source, without removing the lid.

Intel and its distributors can ship programmed 1601s in 24 hours if a user sends a properly coded TWX or telex or tape. Or a user can buy a programmer, the 7600, from Intel for a rather rich $5000. Or he can design his own from instructions provided by Intel.

The 1601 can expect some early competition from National Semiconductor's MM5203 which, too, will take UV erasure. The National device will offer full decoding, bipolar compatibility and 1-μs maximum access. In addition, it will include National's Tri-State output, which offers OR-tieable outputs without requiring pullup resistors.

Is it really available?

Like many other impressive devices, the 1601 has met with some competitors' challenges. The standard-repertoire argument, in this case, has been: "Can Intel really make it?" With barely suppressed enthusiasm, competitors pointed to Intel's May 10, 1971 price list which, for the 1601, quoted: "Not available until further notice."

Intel contends that, in May, demand so far exceeded supply that it would have been too disappointing to continue quoting. The June 25, 1971 price list, however, does give the base price—$100 in quantities of 1 to 999—which is quite a bit higher than the $58 (in 100 to 999) figure which was quoted in a January 1971 product-information sheet.

While mask-programmed ROMs and electrically programmed pROMs get their share of attention, the major battle against the dominant memory—cores—takes place on a different front. The bastion of cores is being battered by the semiconductor RAM.

RAMs

In technical articles, seminars and lofty discussions, the battle between core and IC RAM (which should, more properly, be called a Read/Write RAM, since ROMs and pROMs are also random-access memories), is fought in terms of speed, volatility, power consumption, power requirements, space consumption, sensitivity to unpleasant environments, reliability, system simplicity and other factors. In the last analysis, however, the battle will in all likelihood be won by dollars. And availability.

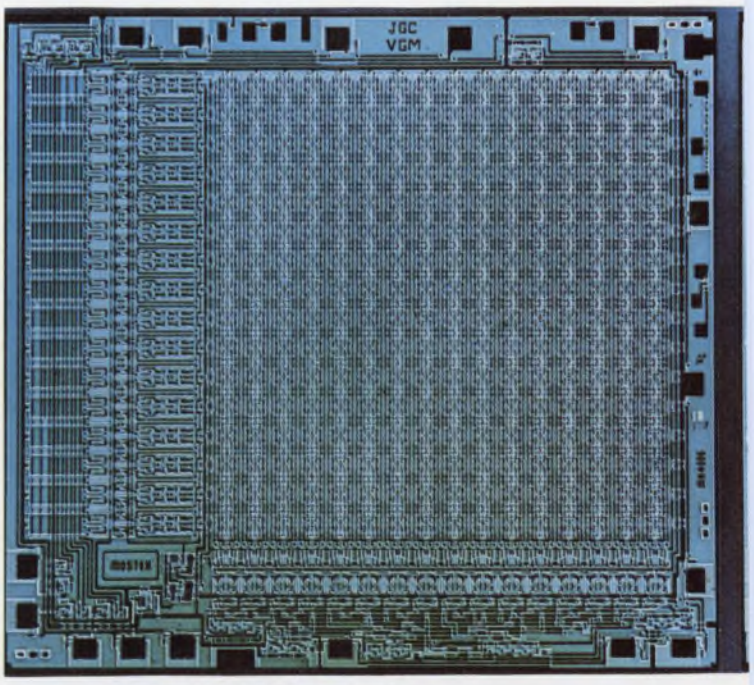
Everyone's the only one shipping

The two most widely discussed and probably most widely sold RAMs today are from Intel. Both are silicon-gate MOS devices; both are fully decoded on chip; both have chip-enable inputs and OR-tieable outputs to simplify system expansion. And both are extensively second-sourced (though second sources prefer "alternate source").

The 1103 is a 1024 $\times$ 1-bit dynamic RAM and the 1101 is a 256 $\times$ 1-bit static RAM. By late June, a dozen vendors were "the only one actually shipping" the 1103.

While many alternate sources (like American Micro-systems, General Electric, General Instrument, ITT, Microsystems International, Motorola, North American Rockwell, Signetics, Solid State Scientific, Solitron, Texas Instruments and Unisem) offer (or will soon offer) direct, almost-identical replacements for 1103s, several companies have (or will soon have) somewhat similar 1024-bit or larger memories with important departures from the 1103.

By year-end, for example, Computer Microtechnology hopes to introduce a 1024-bit bipolar RAM with 90-ns access and full decoding. The company already has prototype 2048-bit dynamic MOS RAMs. Signetics developed a 2048-bit dynamic RAM for Honeywell Information Systems and dynamic 2048-bit RAMs are now available, albeit in limited quantities, from Texas Instruments. Fur-



Dynamic 1024 X 1-bit MOS RAM, Mostek's MK4006, uses ion implantation to adjust threshold and provide depletion- and enhancement-mode transistors on one chip.

ther Mostek is working on a 4096-bit and General Instrument already has a 2048-bit dynamic RAM using—and this is dramatic—one transistor per cell.

A brief look at some circuits that compete more directly with the 1103 can be worth while. One advantage cited for silicon-gate technology is higher speed due to reduced capacitance. But Advanced Memory Systems uses conventional aluminum gates and gets higher speeds than does Intel's 1103.

The 1024 × 1-bit AMS 6002 boasts worst-case access of 150 ns while the 1103's access is 300 ns. The 6002, in a 22-pin ceramic DIP, costs $45 in 100-up quantities while the plastic-packaged version of Intel's 18-pin 1103 costs $38.40.

For compatibility with DTL or TTL devices, the 1103 needs external level shifters and sense amplifiers (which can increase access time and board-space consumption). National Semiconductor's MM4260 doesn't need them. Its input and output data levels are directly compatible with DTL/TTL. Level translation and low-level sensing take place on the chip.

Further, the 18-pin 1103 uses a separate bus for input and output, while National's MM4260 uses a common I/O bus—a feature whose merits can be disputed. But the common I/O bus allows National to package the RAM in a 16-pin DIP, the largest that can be handled by automatic-insertion machinery.

Another unusual 1024-bit dynamic RAM comes from Mostek, whose MK4006B uses ion implantation. While others (like Hughes) use ion implantation mainly to get self-aligned gates, Mostek uses II to lower threshold voltage of conventional, enhancement-mode p-channel transistors from about −4 to −1.5 V. A further II step lowers threshold through zero to +5 V, providing depletion-mode transistors on the same chip with the enhancement-mode devices.

The MK4006P uses depletion-mode transistors as constant-current sources, giving high speed-power product and low standby power (50 mW). In addition, the device—with static decoding and sensing—requires no precharging or clock input—so it fits in a 16-pin DIP. Further, the device can be ordered with on-chip pullup resistors to provide full input compatibility with TTL.

Varadyne's VO-18 is another 1024-bit RAM, this one with TTL compatibility at the input and output. The VO-18, too, requires no clocks. Access time is typically 200 ns. Price, in quantities of 100 to 499, is $50.

An extremely significant 1103 replacement is the SCL-5710 from Solid State Scientific. Like the 1103, this is a 1024 × 1-bit silicon-gate dynamic RAM. Unlike any other, however, it uses n-channel transistors instead of p-channel devices. With a +15-V supply it offers typical access of 150 ns.

The company expects to follow this in early 1972 with a similar RAM and a 2048-bit unit, both with on-chip complementary-MOS decoding for ultra-low power consumption.

The first one-transistor memory cell

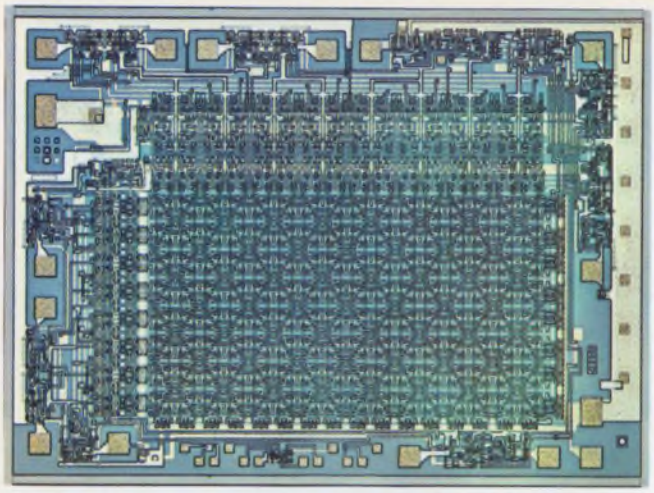
The basic cell in all dynamic MOS memories—but one— requires three transistors—one to read, one to refresh old data or write new data, and one to store data as a charge in the gate capacitance. Now General Instrument has a large memory that uses a single-transistor storage cell.

The silicon-gate transistor serves as a bi-directional switch to write, refresh or read data stored as a charge in a source-to-substrate thin-oxide capacitor. Using this revolutionary development, GI has built and is now sampling the RA9-2048, a 2048 × 1-bit dynamic RAM.

On a 138 × 143-mil chip, not much larger than the 114 × 140-mil chip used in Intel's 1103, GI has twice as many data bits. The RA9-2048 offers 250-ns access and 400-ns cycle times, compared to the 1103's 300 ns and 580 ns; 300 nW dissipation instead of 400 mW; and a startling output of 10 mA at 70 C instead of 400 μA.

Who makes larger memories?

It's a rare system that uses only a single memory chip—however large. For larger memories, somebody has to organize the memory chips and their "overhead" circuits (like row and column decoders, refresh amplifiers, clock generators, sense amplifiers and level shifters), package them, power them, and get data to them and from them. Who?



Bipolar RAM with 256 one-bit words, the 93410, is the first product to use Fairchild's Isoplanar oxide-isolation process to boost on-chip bit density.

Sometimes the design engineer assumes the entire responsibility, even to designing and manufacturing the chips. Such was the case, for example, with Four-Phase Systems.

The company designed its own 1024-bit dynamic RAM and additional logic on a rather large, 165 × 165-mil chip in a 28-pin DIP. It went on to develop an 8096-bit, then an 18,432-bit dynamic ROM for use in its computer systems.

While design engineers sometimes assume complete responsibility for memory-system design, they more often shift some responsibility to vendors who specialize in building larger memories.

North American Rockwell, for example, offers 11 × 12-inch cards with 4096 × 16, 17 or 18 bits. These are multi-package, not multi-chip, cards.

Texas Instruments favors multi-chip arrays, with gold-beam-lead chips. TI now has two static 14-chip MOS RAM arrays, the SMA2001 (2048 × 1 bit) and the SMA2002 (1024 × 2 bits), both at $143 in 100-to-499 quantities, both with 125-ns access, and both decoded and fully compatible with TTL. They're in 1.6 × 1.2-inch 28-pin DIPs.

Another approach is taken by Semiconductor Electronic Memories Inc., who uses 0.4-inch square modules with 32 rigid pins emerging from the surface. SEMI separates the storage and support functions. It flow solders two 128-bit bipolar RAM flip chips in one module. A second module, with a single chip, has address registers, input and output buffers and read/write drivers.

The company mounts the modules on 5-1/2 × 7-inch cards. The RAM289B 1024 × 9-bit card, for example, contains 36 storage modules and six support modules with 180-ns maximum access and 0.8 nW/bit consumption. This card costs $553 in 100 to 499. A 300-ns card costs $369.

Another chip manufacturer making modules is Computer Microtechnology, who prefers beam leads of aluminum. The company mounts almost two dozen chips in a 1-1/2 inch square package to provide a 4096-bit static RAM with all support circuitry. Storage and decoding are MOS while driving and sensing are bipolar. The entire memory with 400-ns access and 400 μW/bit dissipation, costs about 6¢/bit at the 100-up level. This month, the company plans to introduce an 8192-bit module with 250-ns access.

Another company, Advanced Memory Systems, goes even further. It covers all levels from chips to complete memory systems. At one end, AMS provides superspeed, but small, ECL memories with worst-case access times of 8 ns for 16 × 1 to 15 ns for a 128 × 1-bit memory.

In addition, the company offers TTL and MOS chips; memory cards, in bipolar or MOS, with capacities from 32 × 8 to 4096 × 9; and full systems, up to 32 k × 64, for use as add-on memories for IBM 360 computers.

Who makes smaller memories?

In larger memories, many vendors have been busy matching or beating Intel's 1103. In smaller memories, there's similar activity in second-sourcing the Intel 1101 and its variations, but not to the same extent. For the 1101, a 256 × 1-bit static MOS RAM, has bipolar competition.

Despite its following, the 1101 is not the largest static RAM. That honor belongs to Fairchild's 3532, a 512 × 1-bit RAM with full DTL/TTL compatibility, on-chip decoding, 600-ns typical access, 20-mW standby power, 150-mW operating power and a price of $20 in 100-999 quantities.

While there are several alternate sources for the 1101—including Computer Microtechnology, General Instrument, Mostek, National Semiconductor, Signetics, Solitron, Texas Instruments and Unisem—there can be substantial differences among them in speed, power dissipation, voltage requirements and price.

Mostek's MK4007P, for example, uses ion-implanted depletion-mode loads to provide the widest voltage range for V_{DD} and V_{D}—6.5 to −15 V. Power dissipation doesn't vary rapidly with supply-voltage variation; it changes linearly.

For another example, National Semiconductor has a family of five 1101 equivalents. One, the MM1101A2, has a maximum access time of 500 ns—just half of that available in the fastest traditional 1101. In 100-up quantities, prices range from $15.40 to $23.10. In the same quantities, Intel's 1101A costs $12.80, the 1101A1 $15.40.

Since RAM chips with 256 bits or less are often intended for cache or scratchpad memories, there's a great deal of emphasis on speed, hence on bipolar designs. In some earlier designs, speed was achieved, in part, by excluding decode, drive and sense circuitry, then assigning their delays to another chip. This can make sense.

For example, Intel quotes access time as a total

of 120 ns for the partially decoded 256 × 1-bit 3102 static bipolar RAM and the 3202 3-out-of-6 decoder-driver. But the 3202 can drive 32 3102 chips. Both units were introduced in August 1970.

A month later, Intersil announced the first 256 × 1-bit static bipolar RAMs with on-chip sense and decode—the IM5503. This was followed by the 5523 and 5533, all with 65-ns typical access.

A more recent bipolar RAM, the 256 × 1-bit Am2700 from Advanced Micro Devices, has similar speed—60 ns—as well as full decoding, three-state output and three chip-select inputs, all of which are available with Intersil's IM5523.

Two very recent 256 × 1-bit static RAMs deserve special attention—the MM6510 from Monolithic Memories (introduced in May) and the Fairchild 93410 (to be offered this month). The MM-6510, with 70-ns typical access, uses cross-coupled silicon-controlled rectifiers for storage.

As a result, it has astonishingly low power consumption—10 μW/bit in the standby (storage-only) mode, 900 μW/bit during read or write—and a degree of nonvolatility. The device retains data indefinitely if the supply drops from +5 to +2 V. And if the supply fails completely, the memory retains data for 5 ms—which may be enough to permit switching to standby power.

The Fairchild 93410 deserves notice, not so much for what it does, but for what it promises. It is, in fact, very fast, having address access of 40 ns and chip-select access of 20 ns. More important, however, is the fact that it's the first product to use the Isoplanar process, which Fairchild announced in February.

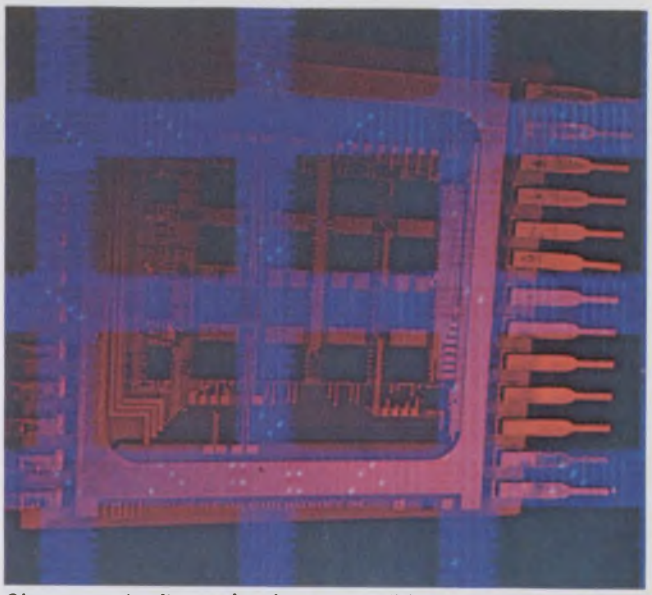
The 256-bit RAM, with full decoding, three chip selects and OR-tieable output, demonstrates feasibility of the high-density, low-capacitance Isoplanar process. The dramatic contribution, however, should appear when Fairchild announces the first 1024-bit Isoplanar RAM—in early 1972.

Though most activity in smaller memories is aimed at trimming nanoseconds, an important process—complementary-symmetry MOS—is aimed at chopping milliwatts. Several vendors like RCA, Intersil, Motorola and Solid State Scientific, use CMOS for logic and timing circuits, but the two leading ones using it for memories are RCA (who calls it COS/MOS) and Motorola (who, with a penchant for initial Ms, calls it McMOS, which a few people pronounce like the name of a Walt Disney character).

The basic CMOS structure uses enhancement-mode p-channel and n-channel transistors in series, forming inverters that are cross coupled to form flip-flops in memories. Since one transistor is always off, the circuit consumes very little quiescent (or "standby" or "storage only") power. CMOS RAMs have two principal disadvantages —lower bit density and higher cost due to the additional processing required.

But they have compensating advantages — in addition to low power consumption. They operate from a single supply voltage (unlike other MOS memories); they can be designed for a wide range of supply voltages, so they can be operated from batteries and can interface easily with bipolar; they can have high noise immunity; and because of high input impedance, they have high fanout.

RCA has two CMOS RAMs to be offered for sale this month — the TA6042 with 200-ns access, and the TA5974 with 500-ns access. In standby, both 256 × 1-bit memories consume a mere 1.2



Close-up (red) and closer-up (blue) photos, superimposed, of CM2400 module from Computer Microtechnology, show 16 256 × 1-bit MOS storage chips in the center, five bipolar sense amplifiers and decoders around the periphery of this TTL-compatible 4096 × 1-bit, 2048 × 2-bit or 1024 × 4-bit static RAM. Combination of MOS and bipolar chips, all using aluminum beam leads, provides high speed with low dissipation.

μW/bit (about 300 μW total) with a 10-V supply. Both devices are fully decoded, the former with current sensing and the latter with voltage sensing. Both are compatible with TTL.

Since June, Motorola has been selling a smaller CMOS RAM, the 64 × 1-bit MCM 14505L, with full on-chip decoding, TTL output compatibility, and input compatibility if pullup resistors are used. The device operates from −55 to +125 C and costs $25 in quantities of 100 to 999.

With a 10-V supply, total standby consumption is 1 μW (about 16 nW/bit), making this the lowest-power RAM available. The unit has typical access of 200 ns and a supply-voltage range of 4.5 to 18 V, but 3-to-18-V units are available on special order. With a 5-V supply the RAM can operate with 1-MHz data rates and have a dynamic power consumption less than 4 mW.

RCA's 64-bit CMOS TA5577 consumes more standby power than does the Motorola unit, 450 nW/bit, and it has no decoding. But it's four times as fast, with 50-ns access.

Speed isn't everything. There are applications where speed is limited by mechanical devices like card readers, printers or other peripherals. There are applications where the memory is to be synchronized to relatively slow circuits — like those in CRT-display terminals. And there are applications where computation and memory can be very slow, as in calculators, because of the intervention of very slow devices — humans.

In these applications, the optimum memory is often a sequential-access device with very low cost — the shift register.

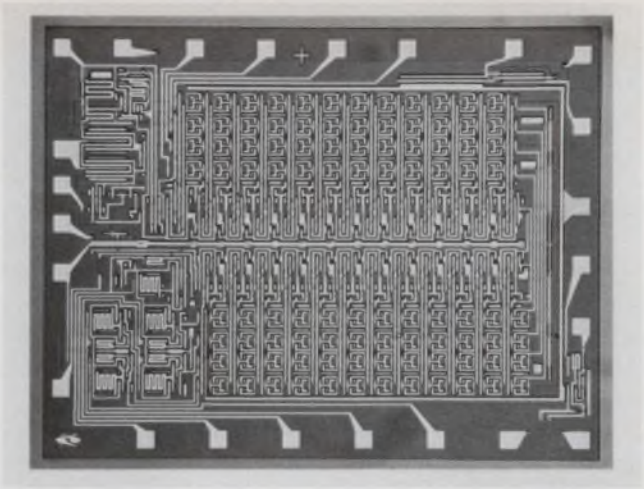
SRs

Like ROMs and RAMs, shift registers can be designed for static operation (which does not require clocking to retain data) or dynamic operation. The static SR can retain data forever, but it requires a bigger chip for the same number of bits and it consumes more power.

Many new SRs use silicon-gate technology. With the exception of those using CMOS, almost every one uses standard p-channel transistors with 111 crystal orientation. But not all.

Intersil hopes to be first with commercially available n-channel silicon-gate SRs. Since the carriers (electrons) in n-doped crystals have twice the mobility of p-doped carriers (holes), n-channel devices can be twice as fast with the same power consumption. But n-channel devices are far more susceptible to sodium-ion contamination — a problem Intersil feels it has whipped.

Taking a different tack, National Semiconductor used 100 crystal orientation, rather than silicon gates and 111 orientation, to achieve low threshold voltages in its new 1024-bit dynamic shift register, the MM4013.



The fastest static shift register, Ragen's 64-bit MS612, can operate at 25 MHz. It uses complementary MOS transistors to slash standby current to 1 microampere.

Many manufacturers feel that 100-cut crystals reduce power consumption, but cut speed, too. National's 1024-bit dynamic MM5013 does, indeed, cut power. Maximum current drain at 2.5 MHz is 15 mA, compared to the usual 50 mA. But the device can still operate at a 2.5-MHz clock rate and that's the rate offered by many competitive devices. The unit offers internal recirculation, as do other 1024-bit shift registers, full TTL compatibility and active wired-OR output, requiring no external pullup resistor. In quantities of 100 to 999, the full-Mil version costs $24.

Though National is willing to pay a penalty in clock-line capacitance — 160 pF compared to 140 pF in many competitive 1024-bit SRs using silicon-gate technology, that capacitance is important enough so that most data sheets precede the clock-capacitance spec with the same adjective — "low." For clock power costs money. And that power equals fCV^2.

So a company has an advantage if it cuts capacitance, and an added advantage if it cuts the clock-voltage requirement. Fairchild has done both in a line of 500-bit (Model 3331), 480-bit (3330), and 512-bit (3329) dynamic SRs. Capacitance is down to 45 pF (compared to competitive 80 pF) and clock voltage is 10 V instead of 17 V, slashing clock power by 80 per cent. In quantities of 100 to 999, the devices, which can take a 2-MHz clock, cost $4.90.

Clock-line capacitance is even lower, at 40 pF, for two phases of a four-phase 1024-bit dynamic register, the Collins CRC1501. The other two phases, however, have 110-pF input capacitance.

Dynamic shift registers of 1024-bit length are available from many vendors, often as dual 512-bit or quad 256-bit units. Data rates in some can be as high as 10 MHz (with 5-MHz clocks and two-

chip multiplexing).

Static registers are shorter. The Signetics 2511A, a dual 200-bit static SR, is the longest. In quantities of 100 to 999 it costs $5, complete with built-in logic, internal clock, TTL compatibility and wired-OR output requiring no external pull-up. The silicon-gate device can operate at 3 MHz.

The fastest shift register is the Ragen Semiconductor MS612, a 64-bit static CMOS device. At 16 V and 25 C it can operate at 25 MHz. At 5 V it can operate at 5 MHz across the entire Mil temperature range.

In standby the device draws no more than 1 μA from supplies of 5 to 16 V. Units can be designed for 2 to 10 V or 1.5 to 5 V, sacrificing speed. In 100 to 999, the MS612 costs $32. Almost as fast, Solid State Scientific's 128-bit CMOS static register, the SCL-5170, has a 20-MHz rate at +15 V.

The most unusual shift register may well be Ragen's MS618, a quad-24 CMOS device. It's a variable-length static register that stores one to 24 four-bit words and, within limits, allows simultaneous insertion and extraction of data at different clock rates.

When words are loaded into the SR, they automatically advance to the last "empty" stage, an empty stage being one with a flip-flop at an intermediate "not-1, not-0, no-data" level.

So the unit, at $60 in 100 to 999, serves handsomely as a short buffer between systems with different clocks. ■■

Need more information?

Products cited in this report have, of necessity, received only cursory coverage. They've been selected for outstanding or unique qualities, though other specifications, not discussed, may limit or enhance their value in specific applications. Readers may wish to consult the manufacturers, listed here, for further details.

ELECTRONIC DESIGN is deeply grateful to many individuals who generously gave time and patience to provide information for this report. To some of these men, listed here, we extend our special thanks for very special help.

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Advanced Micro Devices Inc., 901 Thompson Place, Sunnyvale, Calif. 94086. (408) 732-2400. (Clive Ghest, Digital Appl. Mgr.)

American Micro-systems, Inc., 3800 Homestead Rd., Santa Clara, Calif. 95051. (408) 246-0330. (Glenn Dumas, Vice President Engrg; John Ryan Davis, Mgr. Mkt. Planning)

Computer Microtechnology Inc., 610 N. Pastoria, Sunnyvale, Calif. 94086. (408) 736-0300. (David Conrad, Vice President Mktg.)

Collins Radio Co., Newport Beach, Calif. 92663. (714) 833-0600.

Electronic Arrays, Inc., 501 Ellis St., Mountain View, Calif. 94040. (415) 964-4321. (Richard Eiler, Prod. Mktg. Mgr.)

Energy Conversion Devices, Inc., 1675 W. Maple Rd., Troy, Mich. 48084. (313) 549-7300.

Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. 94040. (415) 962-5011. (Bernard Marren, MOS Prod. Mktg. Mgr; Jack Balleto MOS/LSI Subsystems Prod. Mktg. Mgr; Robert Ulrickson, Digital IC Prod. Mktg. Mgr.)

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General Instrument Corp., 600 W. John St., Hicksville, N.Y. 11802. (516) 733-3353. (Lewis Solomon, Vice President Mktg. Semiconductors; Leo Cohen, Mgr. Advanced Development Engrg. Microelectronics Div.)

Hughes Microelectronics Div., 500 Superior Ave., Newport Beach, Calif. 92663. (714) 548-0671.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051. (408) 246-7501. (Armas "Mike" Markkula, Mktg. Mgr. North America).

Intersil Inc., 10900 N. Tantau Ave., Cupertino, Calif. 95014. (408) 257-5450. (Marshall Cox, Executive Vice President; Murray Siegel, Mgr. Prod. Mktg.).

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Kenics Systems Corp., 125 Harvard St., Cambridge, Mass. 02139. (617) 868-5100.

Microsystems International, Box 3529, Station C, Ottawa 3, Ontario. (613) 828-9191.

Monolithic Memories, Inc. 1165 E. Arques Ave., Sunnyvale, Calif. 94086. (408) 739-3535. (Zev Drori, President; Robert Schwartz, Vice President Operations).

MOS Technology, Inc., Valley Forge, Pa. 19481. (215) 666-7950.

Mostek Corp., 1400 Upfield Dr., Carrollton, Tex. 75006. (214) 242-1494. (Gordon Hoffman, Mktg. Mgr.).

Motorola Semiconductor Products Inc., 5005 E. McDowell, Phoenix, Ariz. 85036. (602) 273-4441. (B.D. "Bud" Broeker, Jr., Mgr. Memory and Interface Systems Section).

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. (408) 732-5000. (Gene Carter, Microcircuit Prod. Mktg. Mgr; Dale Mrazek, Digital Appl. Eng; Jon Stemples. MOS Standard Prod. Mfg. Mgr.).

North American Rockwell Microelectronics Co., P.O. Box 3669, Anaheim, Calif. 92803. (714) 632-2321. (Robert L. Koppel, Prod. Mktg. Mgr. for Memories).

Ragen Semiconductor, Inc., 53 S. Jefferson Rd., Whippany, N.J. 07981. (201) 887-4141. (Dale Wilde, Ch. Engr.).

RCA Solid State Div., Route 202, Somerville, N.J. 08876. (201) 722-3200. (George Waas, Mgr. Technical Planning).

Semiconductor Electronic Memories, Inc., 3883 N. 28th Ave., Phoenix, Ariz. 85017. (602) 263-0202. (Bernard Kute, Sr. Appl. Engr.).

Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif. 94086. (408) 739-7700. (William Sanderson, MOS Prod. Mktg; George Vashel, Mgr. MOS Mfg. and Engrg.).

Solid State Scientific Inc., Montgomeryville, Pa. 18936. (215) 855-8400.

Solitron Devices, Inc., 8808 Balboa Ave., San Diego, Calif. 92123. (714) 278-8780.

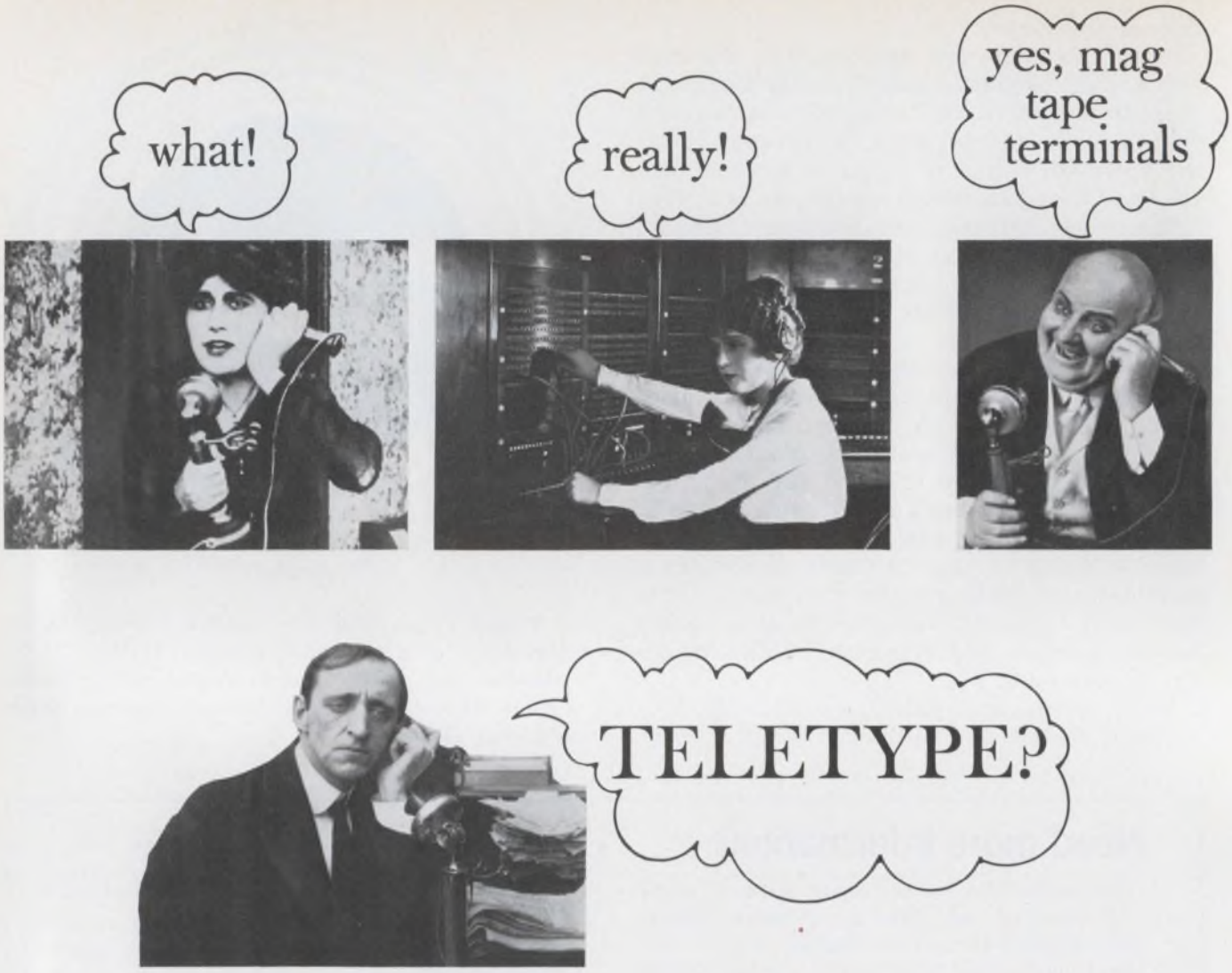
Spectrum Dynamics, Inc., P.O. Box 23699, Fort Lauderdale, Fla. 33307. (305) 566-4467.

Teledyne Semiconductor, 1300 Terra Bella Ave., Mountain View, Calif. 94040. (415) 968-9241. (William Maxwell, MOS Prod. Mktg. Mgr.).

Texas Instruments Inc., Components Group, 12201 Southwest Freeway, Houston, Tex. 77006. (713) 494-5115. (Robert Kressler, Mktg. Mgr. Logic and Memory Functions).

Unisem Corp., P.O. Box 11569, Philadelphia, Pa. 19116. (215) 355-5000.

Varadyne, 1805 Colorado Ave., Santa Monica, Calif. (213) 870-9094.



It's true.

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

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

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

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

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

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

It contains 100 feet of ½″ precision magnetic tape.

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

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

Teletype is a trademark registered in the U.S. Pat. Office.

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

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

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

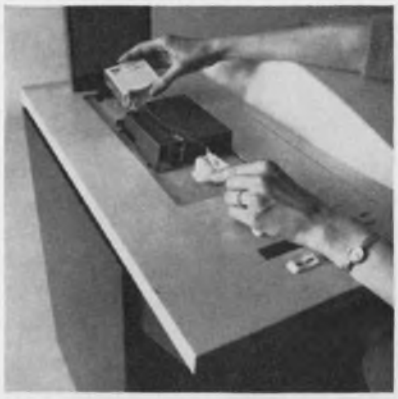
Also magnetic tape adds high speed on-line capability to low speed data terminals.

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

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

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

These new modular magnetic tape data terminals offered by Teletype are perfectly compatible with model 33, model 35, model 37 and model 38 keyboard send-receive equipment.



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

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

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

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

TELETYPE

machines that make data move

INFORMATION RETRIEVAL NUMBER 35

Guarantee signal timing relationships

with one of these three methods. You can eliminate spikes, fix pulse widths and clock signals.

Controlling pulse edges in digital systems becomes difficult when the problem is attacked circuit by circuit. The designer must have a systematic approach. Otherwise arbitrary decisions made with each signal at various points in the system can lead to significant over-all system errors.

Likewise when it's necessary to eliminate spikes and to clock signals, the timing relationships must be guaranteed.

You can achieve such guaranteed timing relationships efficiently and systematically with one of three methods. Let's examine them.

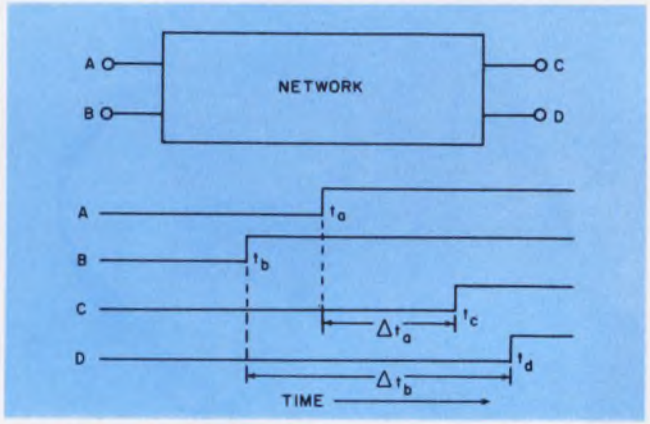
The basic terms used to explain these methods are defined in Fig. 1. Inputs A, initiated at t_a, and B, initiated at t_b, give rise to outputs C, at time t_c, and D, at time t_d. Time delays $\Delta t_a = (t_c - t_a)$ and $\Delta t_b = (t_d - t_b)$ are delays encountered by inputs A and B, respectively, through the network. In terms of these parameters, the basic problem in guaranteeing the correct time relations is stated as follows: How does one guarantee $t_d \geq t_c$ while minimizing the time delay to outputs C and D?

Method 1: Add a delay

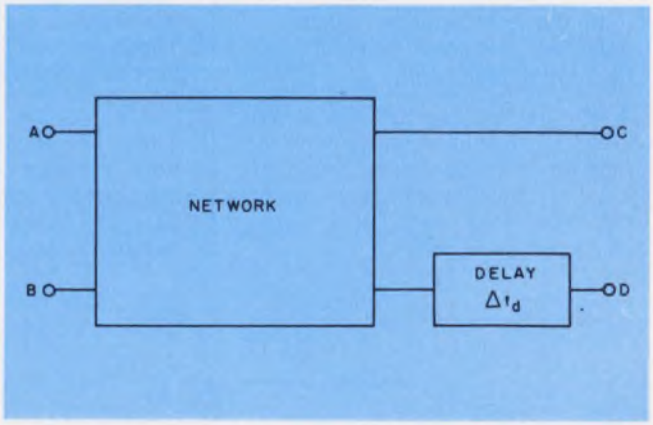
The easiest solution is to introduce another delay whose value is chosen to satisfy the condition $t_d \geq t_c$ (see Fig. 2). There are three ways to obtain the value of this delay.

(a) Worst case time delays are assumed and the delay Δt_d is picked so that $(\Delta t_d)_{min} \geq [(\Delta t_a)_{max} - (\Delta t_b)_{min} - t_b + t_a]$. This potentially adds $[(\Delta t_d)_{max} + (\Delta t_a)_{max} - (\Delta t_b)_{min}]$ to the delay of D. This technique allows one to pick a value for the delay that accounts for all possible variations in the tolerances of the network. No tuning of individual systems is required.

(b) One path is tuned, and Δt_d is set so that $(\Delta t_d)_{min} \geq [(\Delta t_a)_{max} - (t_b + \Delta t_b)_{meas} + t_a]$. It is assumed that worst-case delays exist in the path not being tuned. Then the D path is tuned to account for the actual delays in the D path. This method is particularly useful when the C path may be a group of data lines and the D path is a strobe pulse. With this technique, one has only to measure one path to determine the value of the delay, and this value is sensitive only to changes in its own path. This delay, however, must be determined for each individual system. This method could add as much as $[(\Delta t_d)_{max} + (\Delta t_a)_{max} - (\Delta t_b)_{min}]$ to the delay of D, reducing the delay of



1. **Obtaining $t_d \geq t_c$ while minimizing time delays** at the output is the objective in guaranteeing signal timing relationships. The required timing relationships are defined for output signals C and D, which are responses to inputs A and B, respectively.



2. **Introducing a delay in one path** is the easiest way to obtain the $t_d \geq t_c$ criteria. The delay can be determined by assuming a worst-case delay, tuning one path or tuning both paths. The last option provides the least delay to signal D.

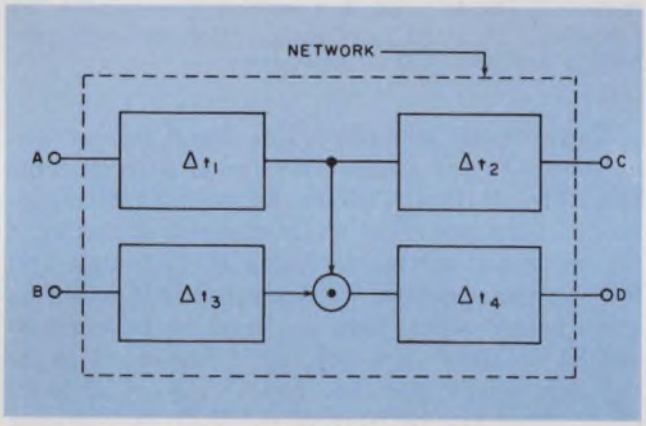
W. W. Farr Jr., Honeywell Information Systems, Framingham, Mass. 01701

the D signal by $[(\Delta t_b)_{meas} - (\Delta t_b)_{min}]$ over the delay introduced by the worst-case technique of 1a.

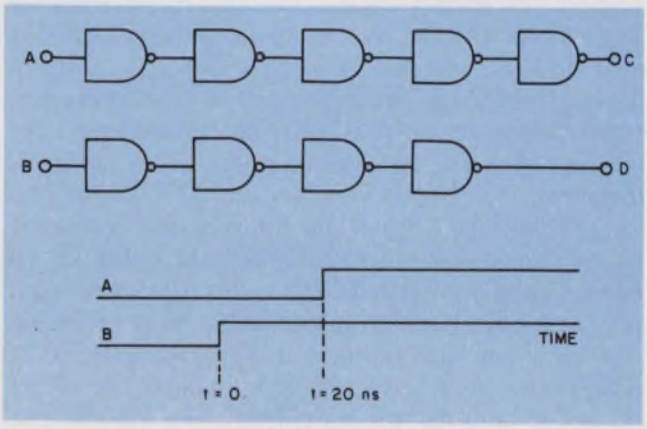
(c) Both paths are tuned, and Δt_d is set so that $(\Delta t_d)_{min} \geq (\Delta t_a - \Delta t_b - t_b + t_a)_{meas}$. The delay Δt_d is adjusted so that $t_d = t_c$ by measurement. The adjustment must somewhat overcompensate to allow for aging and drift. This technique is useful when there are only a few lines involved and their relationships are well-defined. Generally this technique adds less delay to D than technique 1b does. It could add as much as $(\Delta t_d)_{max} + (\Delta t_a - \Delta t_b)_{meas}$ to the delay of D.

Comparing the three techniques of method 1:

- Method 1a is the easiest to specify, set up and maintain. It does, however, introduce the most delay to D.
- Method 1b is easier to implement than technique 1c, since it is dependent only on the components in its own path. When the other path is actually many paths, such as data lines, method 1b will add very little more delay to path D than technique 1c will. This is because some of the measured delays in the multiple path have a high probability of being close to the worst case (maximum delay).
- Method 1c achieves the least total delay. It is generally not useful for systems that are mass-produced or systems where paths C or D are multiple, parallel paths. The degree of improvement to be expected depends on the statistical distribution of the elemental delays in the network. This technique can be used, however, to obtain the least possible delay in a highly tuned system.



3. **A logic interlock also fixes the required time relationships.** With the logic connection, both inputs must be present before there is any output. To optimize the system with this method it is required that $(\Delta t_4)_{min} \geq (\Delta t_2)_{max}$ and $(\Delta t_1 + \Delta t_4)_{max}$ be minimized.



4. **A simple example requiring a guaranteed timing relation** of $t_d \geq t_c$, the basic network consists of NAND gates. Gate delays are 10 ns to 20 ns; delay lines have ±10% tolerances. The minimum delay to be added to D, neglecting tolerances, is 80 ns.

Method 2: Logically interlock C and D

Paths C and D can be logically interlocked as shown in Fig. 3 with a logic AND condition. To satisfy the requirement that

$$t_d \geq t_c, \quad \left\{ \begin{array}{c} t_a + \Delta t_1 \\ \text{or} \\ t_b + \Delta t_3 \end{array} \right\} + \Delta t_4 \geq t_a + \Delta t_1 + \Delta t_2$$

Either of the terms in the brackets can satisfy the inequality. However, if $(t_b + \Delta t_3)$ satisfies the inequality, then the logic connection is not needed, and the equation reduces to that of method 1. If $(t_a + \Delta t_1)$ alone satisfies the inequality, it reduces to $(t_a + \Delta t_1 + \Delta t_4) \geq (t_a + \Delta t_1 + \Delta t_2)$, or $\Delta t_4 \geq \Delta t_2$. This adds to the delay of D as much as $[t_a + (\Delta t_1)_{max} + (\Delta t_4)_{max} - t_b]$.

Thus two conditions are required to optimize the system using this method:

1. $(\Delta t_4)_{min} \geq (\Delta t_2)_{max}$.
2. $(\Delta t_1 + \Delta t_4)_{max}$ must be minimized.

Method 3: Combine the first two methods

The number of places in a given system where one can perform the logic AND of method 2 are limited, and therefore so are the values of the time delays. By combining methods 1 and 2—adding an adjustable delay, Δt_5, into Δt_4 of method 2—you can compensate for the quantum nature of a sum of gate maximums and minimums, or the measured circuit delays in a given system, and further reduce the delay of the D path.

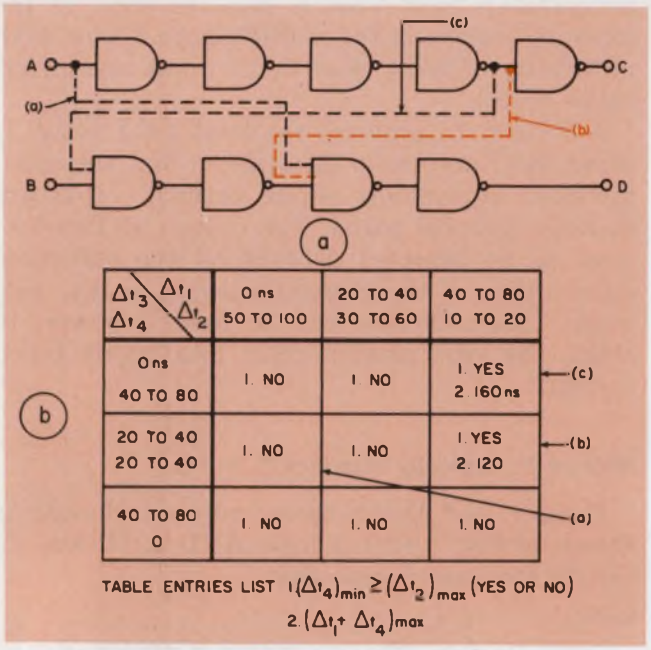
The two optimizing equations of method 2 then become:

1. $(\Delta t_4 + \Delta t_5)_{min} \geq (\Delta t_2)_{max}$.
2. Minimize $[(\Delta t_1 + \Delta t_4)_{max} + (\Delta t_5)_{max}]$.

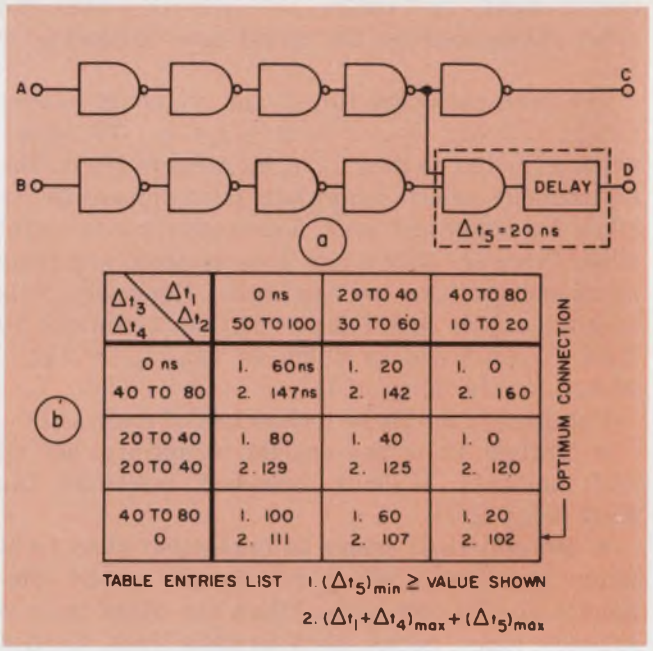
This could add to the delay of D as much as $[t_a + (\Delta t_1)_{max} + (\Delta t_4)_{max} + (\Delta t_5)_{max} - t_b]$.

Now let's consider a practical example to demonstrate how the methods are applied.

Two input signals, A and B, are defined in the worst case as shown in Fig. 4a. The network is a series of NAND gates (Fig. 4b). The gate delays are defined to be 10 ns minimum and 20 ns maximum. All delay lines are assumed to have a ± 10% tolerance. The requirement is that $t_d \geq t_c$.



5. **The optimum connection using logic interlock** is shown, along with two other possible connections out of a total of nine (a). The optimum connection satisfies the required timing relationship, while providing minimal delay to C and D. A "truth table" (b) compares the possible connections.



6. **The hybrid technique of method 3** results in the optimum connection shown (a). A table giving all possible connections (b) lists each in terms of the criteria of method 3. The delay Δt_5 is a variable used to solve the inequality $[\Delta t_4 + \Delta t_5]_{min} \geq (\Delta t_2)_{max}$. The optimum connection has least over-all time delay.

With no compensation to the network, $\Delta t_{a\ max} = 100$ ns, $(\Delta t_b)_{min} = 40$ ns, $t_a = 20$ ns, $t_b = 0$ ns and $[(\Delta t_a)_{max} - (\Delta t_b)_{min}] \leq (t_b - t_a)$ yields 60 on the left and −20 on the right. Therefore D must be delayed by at least 80 ns to satisfy the requirement.

Using method 1a, we find that $(\Delta t_d)_{min} \geq 80$ ns. If the delay line has a tolerance of ± 10%, then Δt_d is chosen to be 89 ns, and D could be delayed by as much as 158 ns.

In method 1b, the actual delay of D may be tuned to achieve a lower delay than that found by method 1a. Assume that the actual delays of the gates in the D path are measured to be a total of 60 ns. Using method 1b, we still assume the worst case delays in the C path, so that $(\Delta t_d)_{min} \geq 60$ ns, without tolerances taken into account. With tolerances $\Delta t_d = 67$ ns and D can be delayed by as much as 134 ns.

With method 1c, the measured delays of both C and D paths are tuned, and a further reduction in the delay of D can be achieved. Assume the measured delay of the D path is 60 ns, as in method 1b, and the delay of the C path is 85 ns. Then $(\Delta t_d)_{min} \geq 45$ ns without tolerances. With tolerances $\Delta t_d = 50$ ns, and D can be delayed by as much as 80 ns.

Using method 2 one could—without adding any logic elements other than input nodes to the existing NAND gates—interconnect paths C and D. There are nine different ways to interconnect these paths. Three possible connections are shown in Fig. 5a.

A systematic way of finding the optimum connection is to use a chart similar to a truth table (Fig. 5b). With the chart, all possible interconnections are described and evaluated in terms of the criteria of method 2. Using this example and the worst-case delays, we observe that if $\Delta t_1 = 0$ ns (zero gate delays), then Δt_2 must be between 40 and 80 ns (four gate delays). Likewise if Δt_1 is two gate delays, and thus has a value of 20 to 40 ns, Δt_2 must also be 20 to 40 ns. If Δt_1 is four gate delays, and thus 40 to 80 ns, then Δt_2 must be 0 ns. These are the only sets of values that Δt_1 and Δt_2 may have in this example. Likewise Δt_3 and Δt_4 are related in the same manner.

The axes explicitly show all of these possible values. The entries inside the table show whether $(\Delta t_1)_{min} \geq (\Delta t_2)_{max}$ (item 1) is satisfied (YES) or not (NO), and the value of $(\Delta t_1 + \Delta t_4)_{max}$ (item 2) is given. Thus the table shows that there are two configurations that provide the correct timing and that the "b" interconnection is the optimum one.

You can also choose the interconnection based on measured delays. Assume a gate delay of 10 ns in C and 15 ns in D. Then the optimum connection would have an added delay to D of 70 ns.

A table can also be used in applying method 3. Assuming the worst-case gate delays of 10 ns minimum and 20 ns maximum, we obtain the table shown in Fig. 6b. The optimum configuration is shown in Fig. 6a. One could also measure the element delays and use the measured values of Δt_5. ■■

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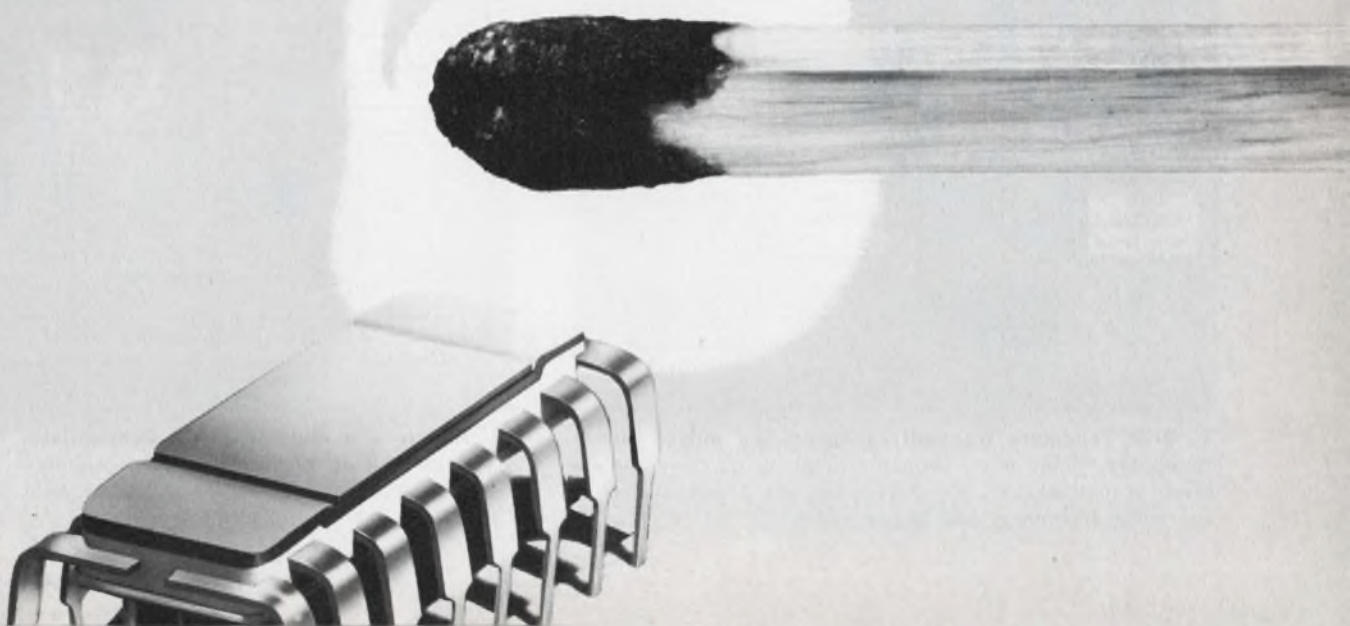

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A unique new modulation technique, based upon the principle of locked oscillators, can add a great degree of flexibility to data communications systems. With the new technique, all of the stations in the system use the same frequency channel, thus eliminating the necessity for complex frequency assignments. The stations are all identical in every respect—including crystal frequency—reducing costs and making maintenance easier.

Phase locking—the key to success

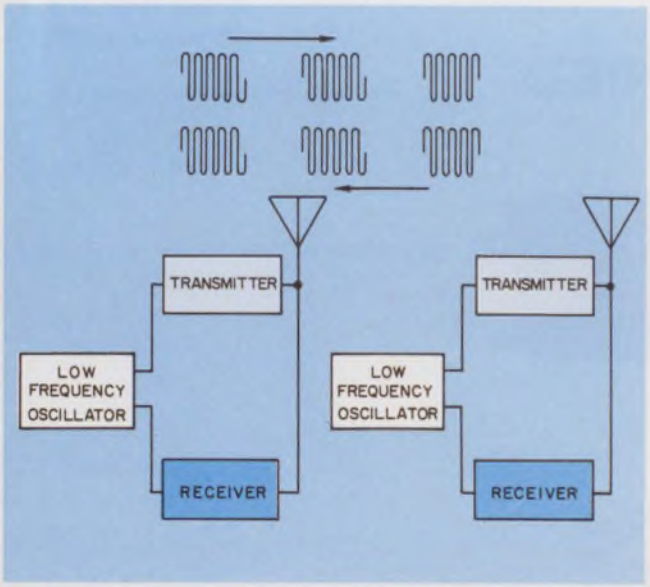
The heart of each station in the system is an electronically tunable low-frequency oscillator. In normal operation, synchronizing signals are transmitted simultaneously by all stations, causing the oscillators to become phase locked (Fig. 1). Each cycle of the low-frequency oscillator causes the transmitter to send a pulse of rf. A practical pulse length is about one fifth of the repetition time, the optimum repetition time being determined largely by the expected data rate.

Since phase-lock is maintained at all times, all the low-frequency oscillators will assume the the same frequency and phase. If the frequency of any of the oscillators is changed, the others in the system will also change to maintain the phase-locked relationship.

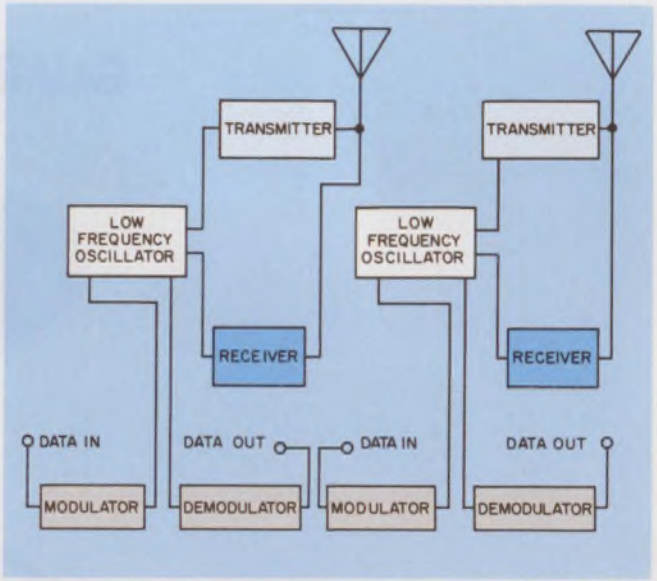
Communications between stations are provided by frequency modulating and demodulating the various low-frequency oscillators. All of the stations can receive and transmit simultaneously and each acts as a same-channel repeater.

As illustrated in Fig. 1, the transmitter and receiver at each station are connected to the same antenna. If a station is operating all by itself, its transmitter will send out pulses at a rate determined by the free-running frequency of the low-frequency oscillator. These pulses will be radiated by the antenna, and they will also be received by the station's own receiver. If a sec-

John M. Tewksbury, Principal Engineer, The Bendix Corp., Communications Div., East Joppa Rd., Baltimore, Md., 21204.



1. **Both repeaters transmit synchronizing pulses simultaneously.** Since each repeater receives its own and all other transmissions, the oscillators are phase locked at the same frequency and phase angle.



2. **Adding a modulator and a demodulator** to the basic repeater allows each station to originate and receive data as well as relay it. Data can be sent between any and all of the stations in the network.

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ond station is put into operation, it will send its pulses in a similar manner.

If the two stations are not in exact synchronism, then each will receive an early or late signal with respect to its own transmission. Early or late reception causes the low-frequency oscillators to speed up or slow down so the transmitted pulses from the two stations will be coincident.

The same principles apply when more than two stations are working in the system.

Since the output of the transmitter is connected directly to the receiver, the receiver must have a very short overload recovery time. This, of course, means that agc cannot be used, and all interstage coupling components should be made as small as possible.

Sending data over the system

To transmit data over this system, it is merely necessary to deliberately change the frequency of one of the low-frequency oscillators; the others will follow. So, the addition of a frequency modulator and a demodulator to each repeater station converts it into a complete send/receive unit (Fig. 2).

With this system, it is possible to send and receive data simultaneously between any or all stations in the network. When several stations are transmitting at the same time, all of the low-frequency oscillators remain phase locked and their frequency-vs-time contours will contain the vector sum of all the data inputs.

This, of course, means that the demodulators will put out several signals at once. In voice communications this isn't much of a problem, because the listener can usually pick out the voice he wants to hear. In data communications, on the other hand, something must be done to prevent confusion.

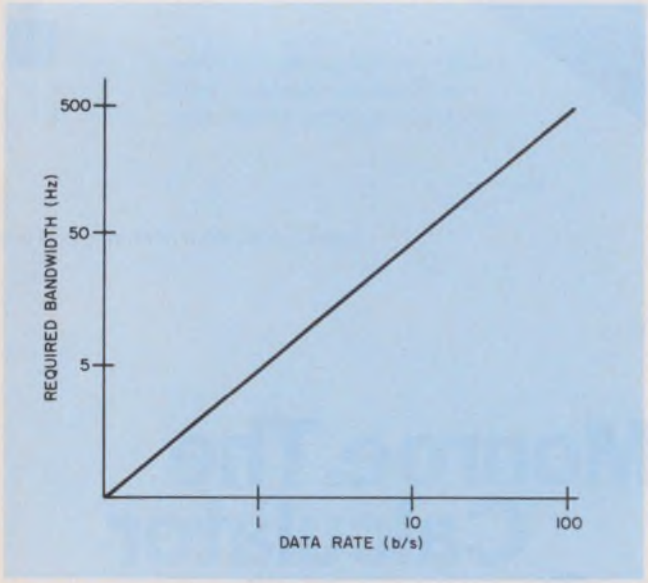
The most straightforward approach is simply to send one message at a time. Alternatively, a system of subcarriers can be used, with each transmitter working on a different subcarrier frequency.

Of course, it is not always necessary to have a modulator and a demodulator at every station. If it is only necessary to transmit data in one direction, the sending unit is provided with a modulator and the receiving unit has a demodulator. Similarly, if a station is only required to act as a repeater, then it doesn't need a modulator or a demodulator.

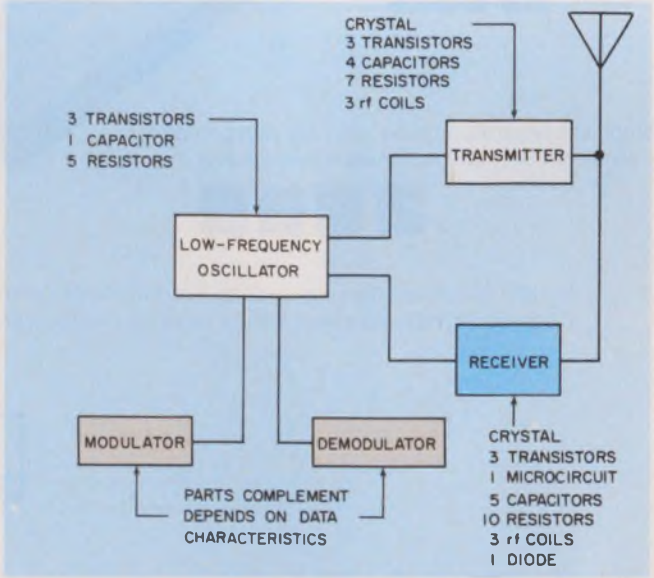
A significant point to bear in mind when this new modulation technique is used is that each station in the system can have a relatively low power output, because it needs only to transmit as far as the station or stations adjacent to it in the network. Power output can be kept to a minimum to conserve the batteries. All transmitters may be turned off during periods when there is no data to be transmitted or relayed.

The required system bandwidth is dependent upon the data rate to be transmitted. The graph of Fig. 3 is based on practical considerations involving equipment size, weight, complexity and cost. For most data systems the ultimate bandwidth is dictated by crystal oscillator drift rather than by data rate.

In large quantities, data stations may be produced at low cost. In Fig. 4 the major components in each sub-section are called out. It is clear that the locked-oscillator principle lends itself to low-cost station design. ■■



3. **Practical, rather than theoretical, considerations** led to this graph of required bandwidth vs data rate. These figures pertain to equipment for which size, weight, complexity and cost are kept at a low level.



4. **Station design is uncomplicated and inexpensive.** The design details will vary with the system designer, but the parts complement should be approximately as indicated in this typical-system example.

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If your document release system is sick,

this guide will be helpful. It tells how to diagnose the strengths and weaknesses of your system, and improve its health.

When was the last time your engineering document release system had a complete check-up? The health of your release system should be evaluated as often as your own—if it's below par it can undermine the best laid plans of management, engineering, and manufacturing.

Because of the wide-ranging impact of the engineering document, or as it is often called—data release system, managers and design engineers alike should know what, how, and when engineering data is released to manufacturing and procurement. Implicit in that knowledge is:

- what defects reflect a sick system and how to correct them.
- who's responsible for the system.
- how to improve the system.

The telltale signs of illness

Several defects characterize an unhealthy release system. One of the more recurrent ones is the use of *multiple release desks and records.* Any time more than one group controls the issuance of data, the risk of having different and even contradictory descriptions of the product is high. Thus, two different drawings may be used by assemblers on the production line, causing the manufacture of supposedly identical items with different configurations. In addition, if multiple records are used, they must be continuously reconciled with each other to assure uniformity. This process increases the chances for errors and adds clerical labor charges to the project.

Cure? Use one release desk and one set of records.

Another sign of illness is *uncontrolled access to released vellums.* In order for vellums to represent the authorized configuration, they must be untouched after release unless authorization is obtained to change them. While this may seem self-evident, some companies still have such an informal system of operation that a draftsman can enter the release facility, remove a vellum, make changes, and return it to the file—all without the designer's cognizance and approval. It is not surprising that the final product is sometimes different from what is wanted and that wrong parts are ordered.

To assure the integrity of the approved design, no one—including the project engineer—should be permitted to make changes to a released document without following a required procedure.

The *lack of written procedures* is another major obstacle to a smoothly operating system. Without them, staff members will have trouble finding out how the release system works. Changes will also run rampant and a firm operating system will be hard to maintain. And evaluation of engineering and quality control recommendations for improving the system will be difficult to do. Thus, the practical needs of other groups and the ideal requirements for an effective system cannot be merged to achieve the best system possible for company operations and requirements without written procedures.

Still another major deficiency is *failure to control engineering data released for manufacture, procurement, or testing operations.* A controlled document is one that is (a) stamped with unique identifiers, (b) issued only to manufacturing, testing, procurement, and quality assurance, and (c) retrieved when a revised document is issued. (Sometimes these documents are printed on pink paper for easier identification.) Superseded controlled documents must be destroyed to prevent their inadvertent use, except for one copy that is filed in the product's history file.

Who's who in the system

Who is responsible for the release system? Usually a data control supervisor designs the system, organizes the facilities, selects and trains personnel, writes procedures, and makes sure that the system is working as planned. However, the release system cannot work effectively without the cooperation and support of other organizations, especially the design, quality assurance, and configuration management groups. The designers should know the basic rules and follow them, and quality assurance engineers should

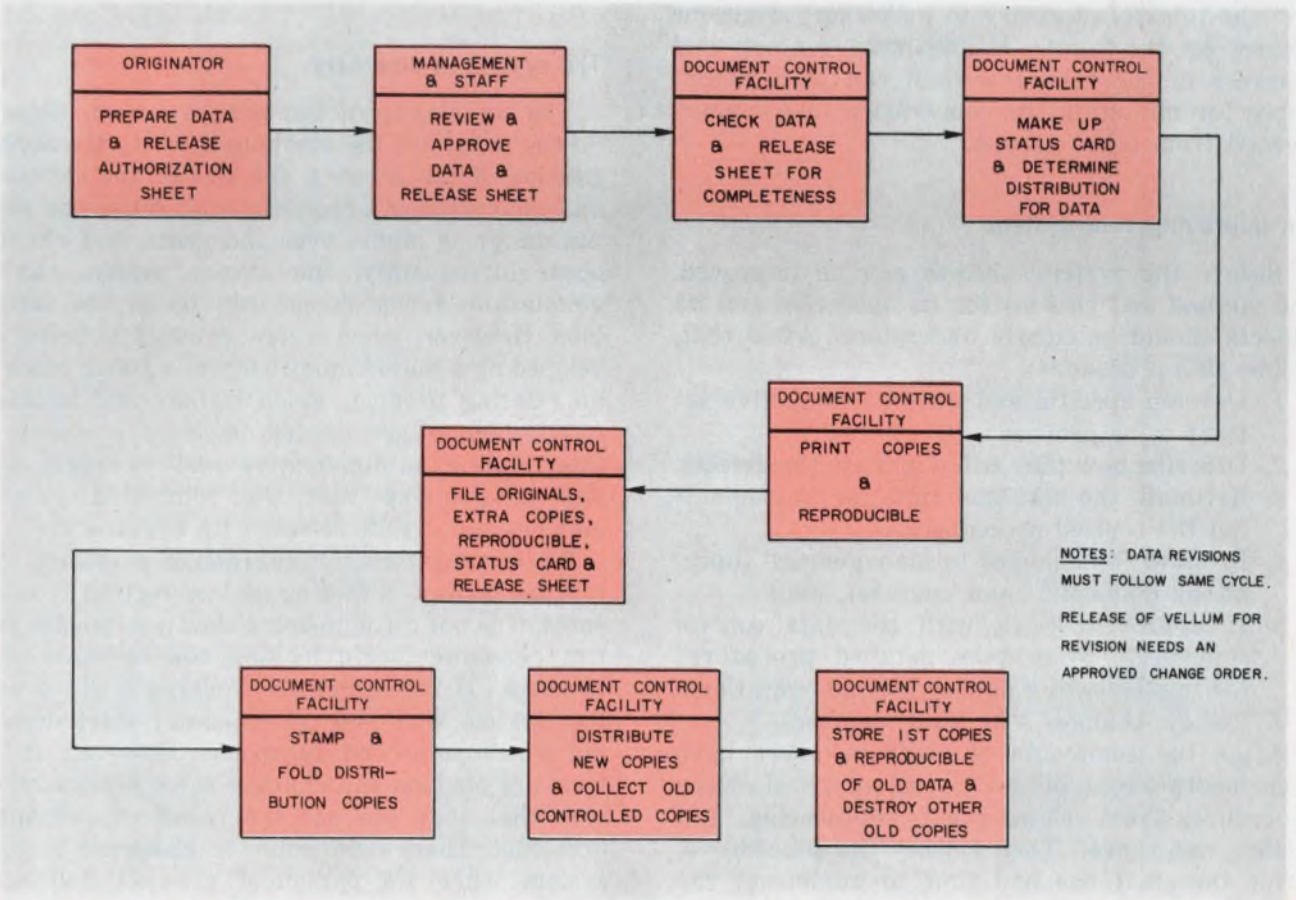
Thomas T. Samaras, Configuration Management Consultant, Universal Monitor, 2361 E. Foothill Blvd., Pasadena, Calif. 91107

Changes are minimized with system cycles like this.

Below is a sample release system cycle. Note that proper review and approval of engineering documents before release is a key step, one that can save the company a lot of money by reducing the number of changes made in production.

This can provide bigger savings than many people realize. A large California company, for example, made a study of the efforts required to make engineering changes after production drawings have been released and work is in progress. It found that each design change required 82 distinct operations to rework the product so that it matched the new design. Poor review and checking, which may leave errors in new documents undiscovered, can have disasterously expensive effects in a system like this.

Another critical step in any release cycle is the proper control and implementation of changes. It is essential that engineering changes be reviewed and approved at an adequate level to assure control over the product's configuration, cost, and schedule. In addition, everyone who needs copies of the revised data must get them. Therefore, a formal system is required to ensure that (a) the responsible engineer and designer approve the change for technical accuracy and compatibility with customer requirements and (b) the project manager reviews the change for its impact on other project elements such as spare parts, manuals, work in progress, budget, and schedule. To assure that this process is being followed, the data control clerk should not release any vellums from the facility without written authorization from the project manager. Also, the release of revised data or supplements (engineering orders) must follow the same procedures as followed during the original document release to assure the integrity of the product's configuration. The change procedure can be involved for some products, especially large systems, and may require a configuration manager to implement it properly.



Use this list to check the health of your system.

This checklist will help you determine the state of health of your data release system. If your system is in good shape, the following information should be available from an inspection of records and released data.

1. Can you find out what part numbers are used in a particular component, subassembly, etc? (This capability is usually not needed for standard parts.)
2. Can you determine the parts composition (by part and serial numbers) of each product built?
3. Can you determine the next higher assembly part numbers for a particular item? (This capability is usually not needed for parts assembled into standard parts.)
4. Can you identify the end product or model in which any lower level part is used?
5. Can you find out what change identification numbers were released for each product built?
6. Can you determine the effectivity (product serial numbers) for each change identification number?
7. Can you determine the change identification numbers released for each part in the product?
8. Can you find the company specification document numbers for parts built by other companies?
9. Can you determine the standard specification numbers or standard part numbers for parts used within any non-standard item?
10. Can you find the part numbers of items built by other companies to your specifications?
11. Can you find the product's specification number?
12. Can you find the manufacturer's code identification number for all vendor and subcontractor supplied parts?

audit the entire system, covering manufacturing, engineering, testing, and procurement operations.

Configuration and project managers must apply the muscle necessary to make sure everyone abides by the rules. Management concern and interest in the release system can be a potent force for obtaining the cooperation and support needed from other groups.

On improving your system

Before the system's health can be improved, the method and reasons for its operation and its defects should be clearly understood. After that, follow this procedure:

1. Develop specific and detailed corrective actions to be proposed.
2. Describe how they will eliminate the defects.
3. Estimate the cost and time for implementing the revised procedures.
4. Propose the changes to management (operations manager, chief engineer, etc.).
5. If approved, work with the data control supervisor to prepare detailed procedures for implementing new or revised operations.
6. Review changes with staff members.

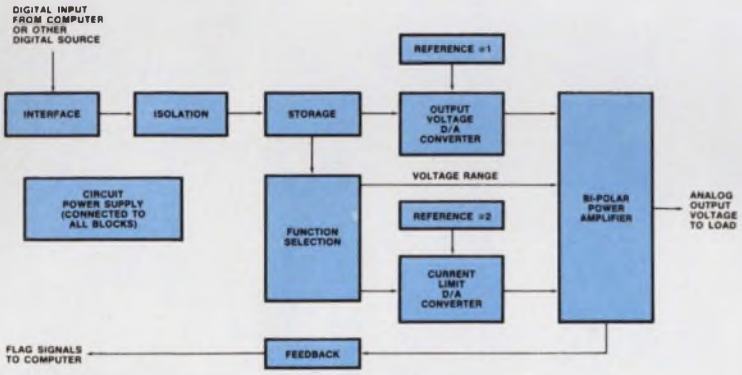
After the comments of staff members have been incorporated, obtain formal approval of the procedures from management, engineering, and quality assurance. Then release the procedures. After the staff has had time to implement the new requirements, follow-up the revised system to make sure that it is working as planned and that it has not introduced new defects. Minor changes may be necessary to tune the system.

The system in summary

The complexity of the release system depends on the nature of the company's work, the sophistication of the product, the size of the company, and the customer's requirements. When the product design is stable over the years and changes occur infrequently, the release system can be simple and fewer people can be in the release loop. However, when a new product is being developed or a major modification is being made to an existing product, much tighter and sophisticated controls are needed to avoid problems in interrelating administrative and technical data and in assuring that the completed product matches the design released by engineering.

While guidelines for appraising a release system are helpful in finding and correcting trouble-spots, it is not recommended that non-release system personnel begin looking for improvements to make. If the system is working well—a perfect system won't be found—don't start designing a new improved approach. However, if defects are obvious and changes seem necessary, be sure that they are not the result of personnel problems. There's no point in changing a good system when its personnel are not following it. ■■

all this



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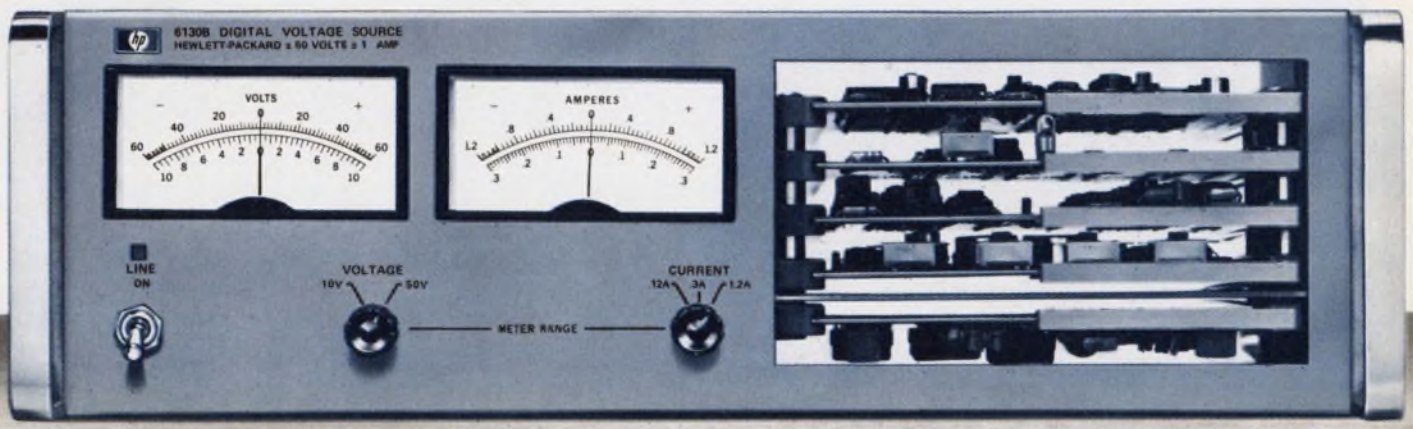

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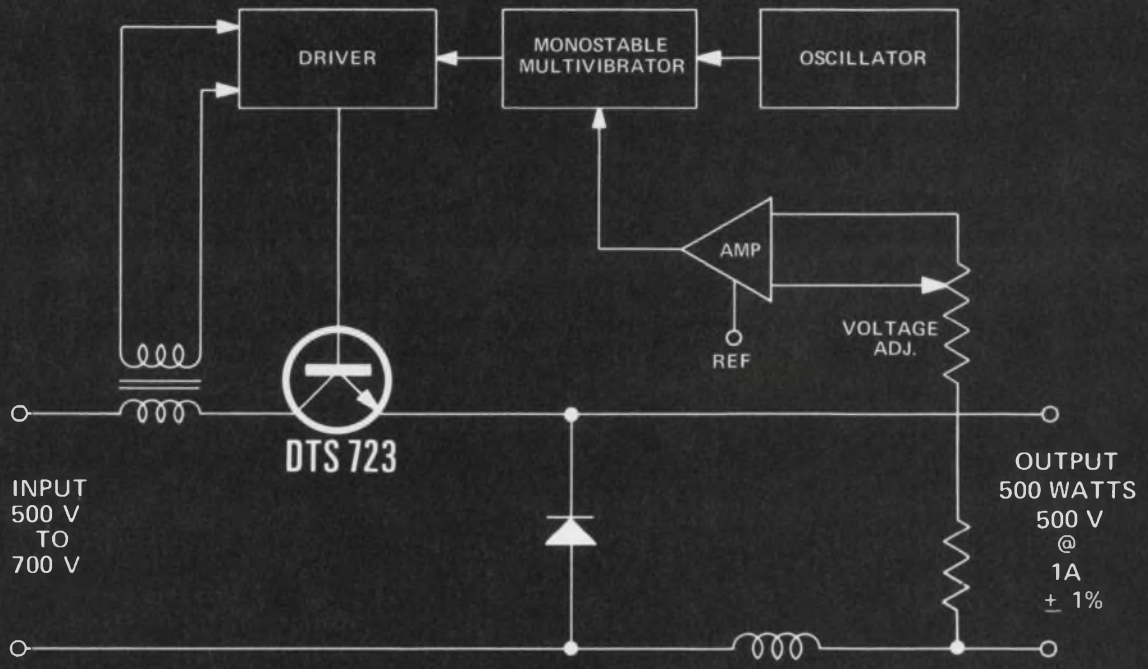

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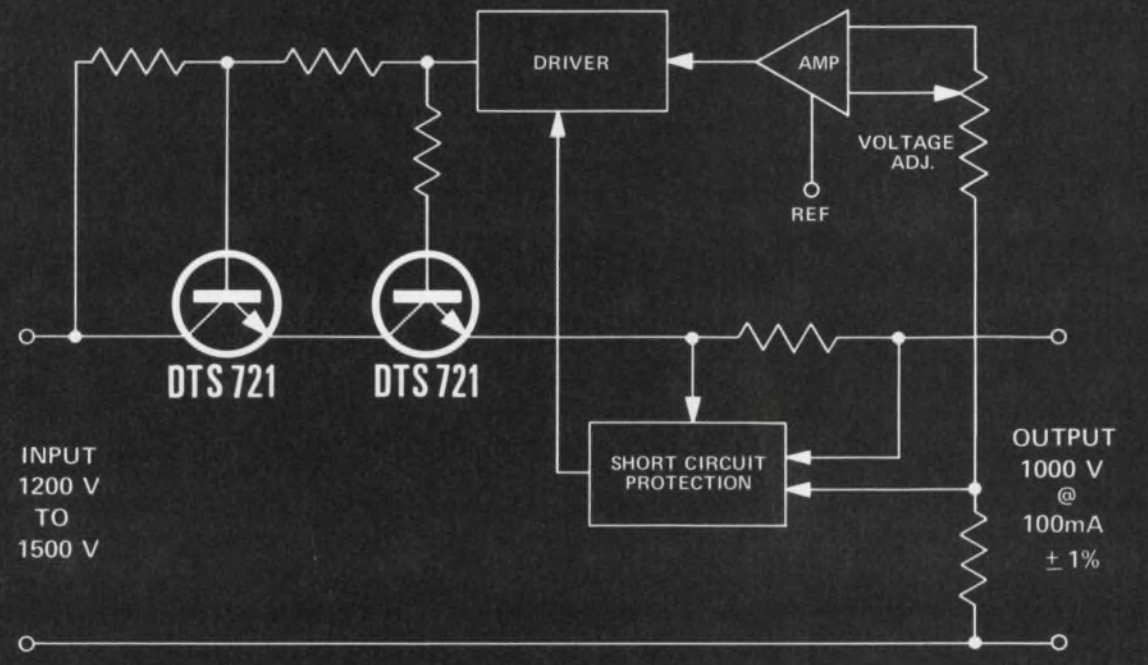

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INFORMATION RETRIEVAL NUMBER 41

ideas for design

Photomultiplier amplifier subtracts logarithms

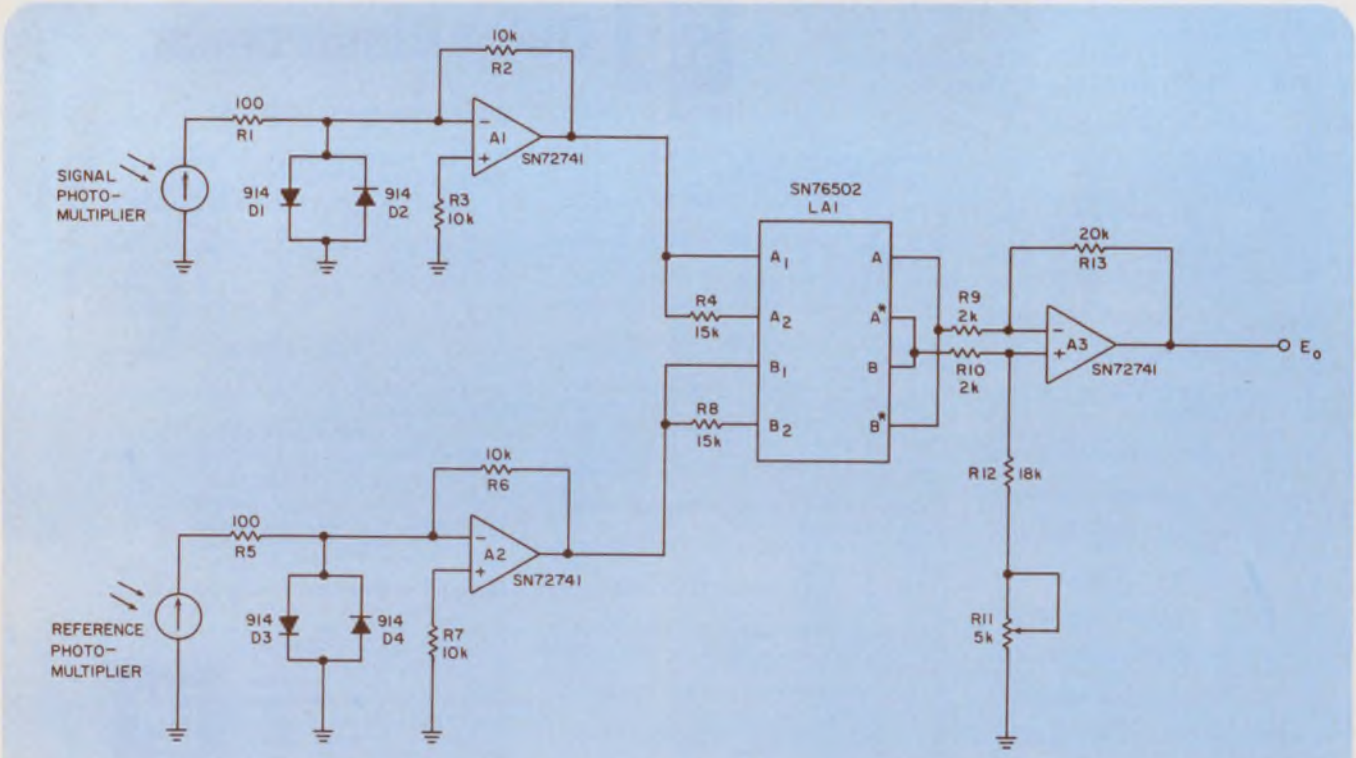
In many electro-optic scanning applications, a more accurate synthesis of the required signal can be obtained by comparing the ratio of two photomultiplier currents, a reference channel and the signal channel. In this way common-mode noise, such as variations in the scanning intensity (phosphor noise or CRT beam-current variations) or ambient-light are canceled out.

A circuit performing these functions is shown in the diagram. The ratio of two signals is determined by subtracting their logarithms and then taking the antilog of this difference. Using the log difference instead of the ratio provides a compressed version of the true ratio and lessens the dynamic-range requirements of the processing circuits.

The output current of the signal photomultiplier (PM) is applied to the summing junction of op-amp A1 through a transient suppressor. A range of PM signal currents of 3 to 300 μA is amplified by A1 to a voltage output of 0.03 to 3.0 V, which falls in the center of the linear portion of the logarithmic characteristics of log amp LA1. The reference PM current follows a similar path through the second channel. The two log-amp channel outputs are cross-coupled (A to B* and B to A*) to yield a difference signal output. Op-amp A3 provides a closed-loop gain of 10 to raise the log difference signal to a usable level.

Charles A. Herbst, 39 Lucille Ave., Dumont, N.J. 07628

VOTE FOR 311



A low-cost, wideband (40 MHz) log amp (LAI) enables the circuit to achieve a faster and more accurate response than the usual design employing the nonlinear characteristics of diodes or transistors. The output voltage is proportional to log A—log B. Resistor R11 zero sets op amp A3.

Our new analog gates switch even faster! What's more, there are no design compromises. And we deliver.

All other junction FET switch drivers trade one or more performance characteristics to gain a preferred characteristic.

Now there's no need to compromise. The DG180 analog switch/driver series from Siliconix exhibits all the features junction FET switches can offer:

- <150 ns switching times
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- <1 nA leakage from signal channel in both ON and OFF conditions
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- −60 dB crosstalk at 10 MHz (100 Ω load)
- ±15 V power supply
- Direct TTL, DTL, RTL compatibility

All at the same time!

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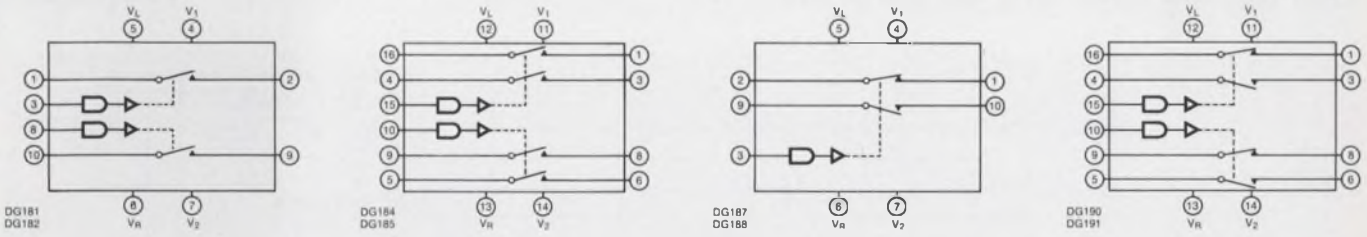
Overseas sales offices. Siliconix Limited, Saunders Way, Sketty, Swansea, Great Britain/Siliconix GmbH, 7024 Bernhausen, Postfach 1340, W. Germany/Siliconix S.A.R.L., 94-Saint-Maur, France. Tel. 283-57.90.



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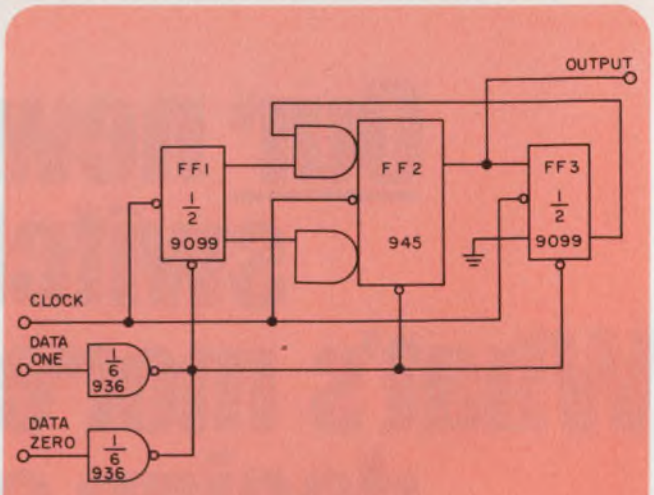
Blank detector checks data ONE/ZERO message gaps

When data is transmitted so that a pulse on one line means a data ONE and a pulse on another line a data ZERO, it's often necessary to detect gaps between messages. A simple circuit can perform this function. The register resets whenever a pulse occurs on either data line. Flip-flop FF 1 sets a maximum of one clock pulse later. If there is a message gap, FF 2 sets on the next clock pulse, causing an output pulse of one clock-time duration. This indicates that a gap is detected. FF2 resets on the following pulse.

Flip flop 3 sets on the third clock pulse and inhibits FF2 from setting again until additional data is received.

Frank Nesbitt, Senior Engineer, McDonnell Douglas Electronics Co., Box 426, St. Charles, Mo. 63301

VOTE FOR 312



Three flip-flops form the basis of a blank detector. The circuit requires additional flip-flops when the external clock rate is significantly different from that of the internal clock.

Circuit inhibits transmission on busy digital party line

A design requirement for digital party-line systems is to prevent data transmission when the line is busy. A simple way to do this is to use the circuit shown in the diagram. It detects the busy condition of the line when a remote driver is using the line and does not allow the local driver to transmit until the line is free.

A sense amplifier (SN7524) detects zero crossings on the line during data transmission from a remote driver. Each zero crossing retriggers the multivibrator (SN74123), maintaining the inhibit low on the local driver (SN75109 or SN75110). Data transmission is thus prevented from the local driver until the line is free.

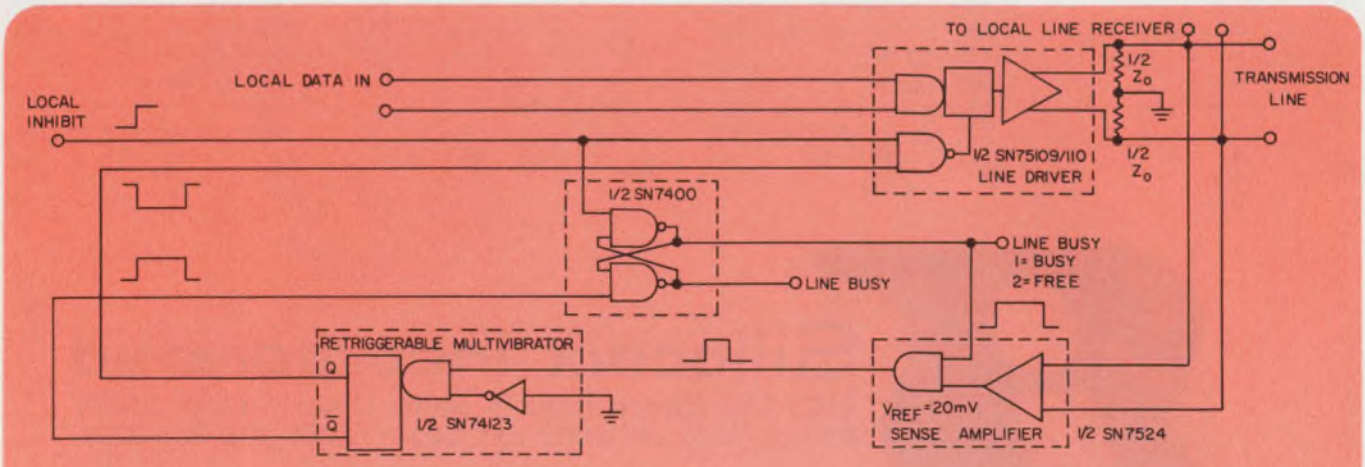
The driver (SN75109 or SN75110), receiver (SN75107 or SN75108) and sense amplifier (SN7524) have common-mode signal ranges of ±3 V on the line and differential-mode ranges up to ±5 V.

The transmission line is terminated only at its ends. Drivers and receivers may be located at any point along the transmission line.

Once the line is free and "acquired" by the local driver, the latch (SN7400) maintains acquisition until the inhibit of the driver goes low. The "line busy" signal can be used to prevent the dumping of data into the driver from a local data storage register.

James Talley, Texas Instruments, Inc., 13500 N. Central Expressway, P.O. Box 5012, Dallas, Tex. 75222.

VOTE FOR 313



The local driver is prevented from transmitting in this party-line control until the line is free. The sense-amplifier voltage reference is less than the minimum differential data signal.

Lowest distortion

and low cost in PIN diodes

If you are designing a VHF or UHF system with strict harmonic or intermodulation product requirements, Unitrode PIN diodes, with industry's longest carrier lifetime (1-10 μsec typical) will put your mind at ease.

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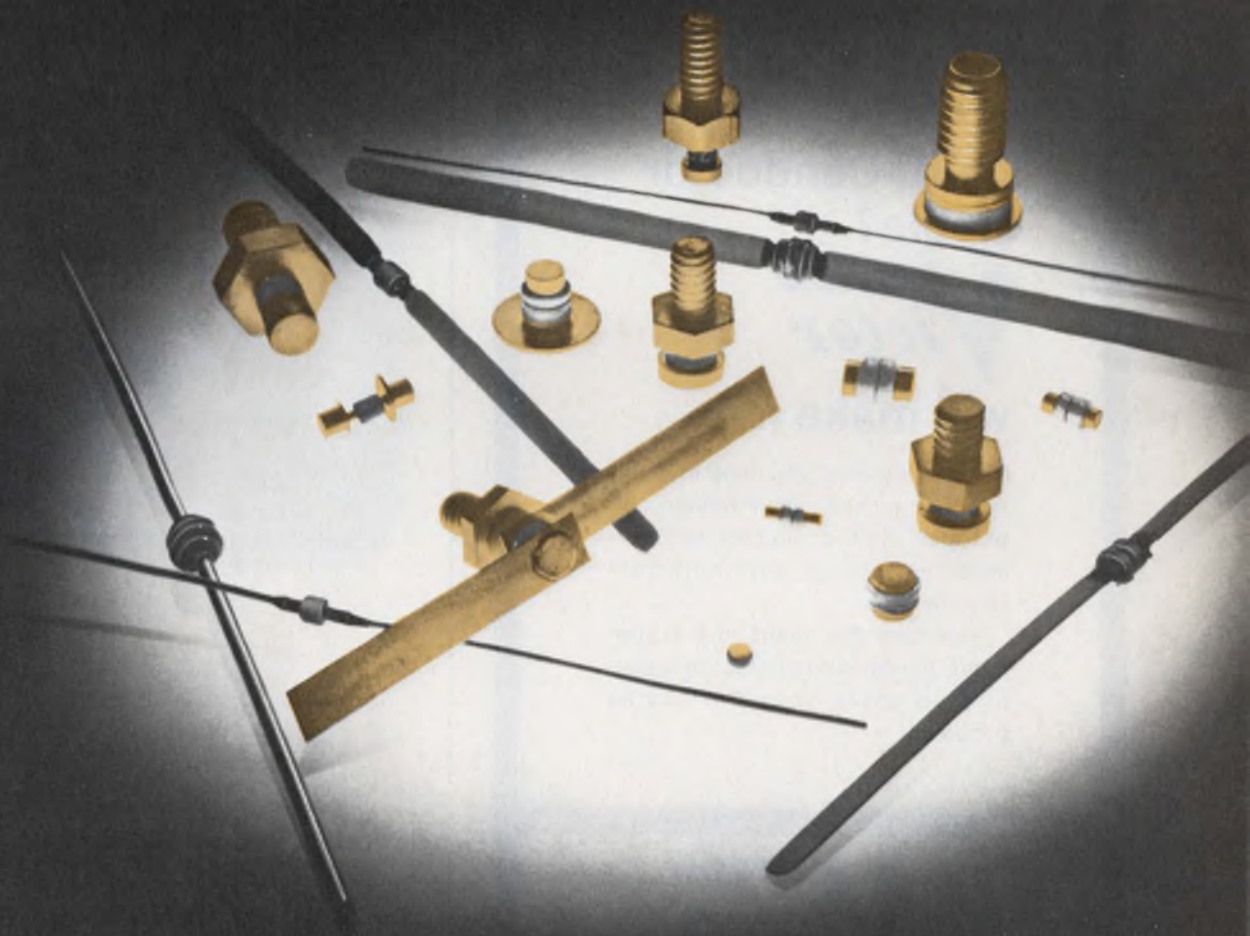
Applications from HF through UHF include TR switches, duplexers and receiver protectors in military and commercial two-way communications systems. They also reduce distortion in AGC loops and tunable filters in CATV systems.

For further information, samples and applications assistance, call Bob Tremblay at (617) 926-0404 or write Unitrode Corporation, Dept. 9B 580 Pleasant Street, Watertown, Mass. 02172



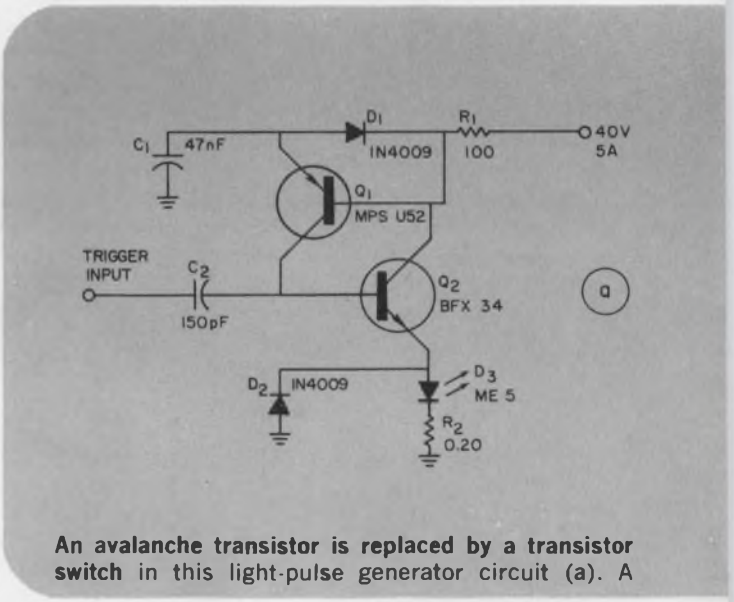
UNITRODE

Light-pulse generator works on variable supply voltage

The high current pulses for LEDs are usually generated with avalanche transistors requiring precise supply voltage. But with the circuit shown in the diagram (a), the supply voltage can be chosen between 5 V and 40 V.

The current-pulse amplitude depends on supply voltage as plotted in b. Rise time is 10 ns and the maximum PRF with the values shown is 100 kHz. Capacitor C_1 determines the duration of the pulse, and standby power is not required.

Both Q_1 and Q_2 are normally OFF. Capacitor



An avalanche transistor is replaced by a transistor switch in this light-pulse generator circuit (a). A

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

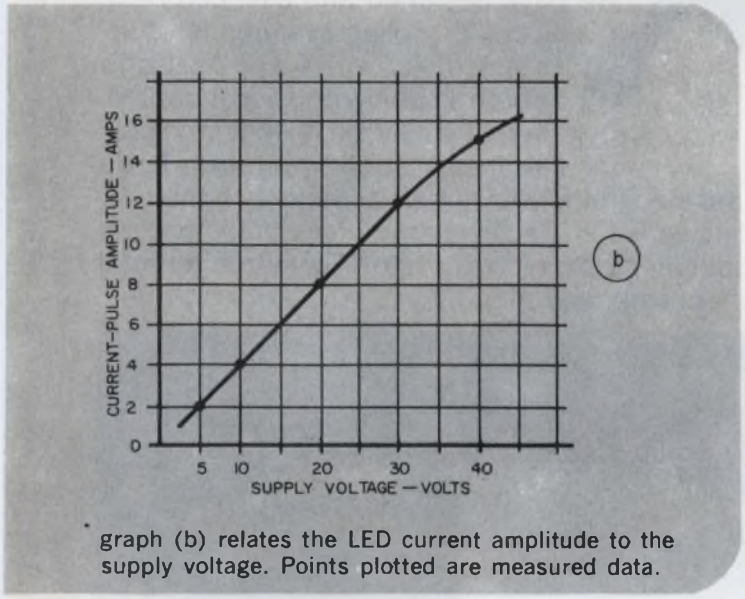
SEND US YOUR IDEAS FOR DESIGN. You may win a grand total of $1050 (cash)! Here's how. Submit your IFD describing a new or important circuit or design technique, the clever use of a new component or test equipment, packaging tips, cost-saving ideas to our Ideas-for-Design editor. You will receive $20 for each accepted idea, $30 more if it is voted best-of-issue by our readers. The best-of-issue winners become eligible for the Idea Of the Year award of $1000.

C_1 charges almost to the supply voltage, through D_1. A positive trigger turns Q_2 ON. Then V_{b1} decreases, D_1 is reverse-biased and Q_1 turns ON and keeps Q_2 ON. The transistors drive each other into saturation so that C_1 discharges through the LED.

Resistor R_2 aids in measuring the current. Diode D_2 protects the LED in case of backswing. When the exponentially decaying discharge current drops below the hold current, Q_1 and Q_2 stop conducting and C_1 is charged again via R_1 and D_1.

C. A. J. van der Geer, FOM-Inst. Plasmafysika, Jutphaas, Holland.

VOTE FOR 314



graph (b) relates the LED current amplitude to the supply voltage. Points plotted are measured data.

IFD Winner for May 27, 1971

Peter Stasz, Electronics Engineer, Medtronic, Inc., 3055 Old Highway 8, Minneapolis, Minn. 55418. His idea "Clean up switch closures with a fast UJT pulse" has been voted the Most Valuable of Issue award.

Vote for the Best Idea in this Issue.

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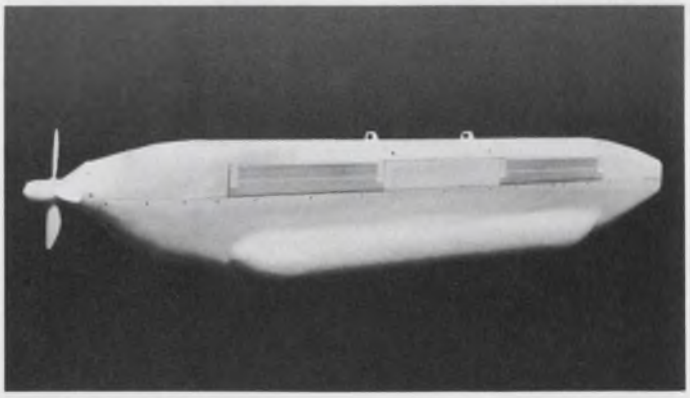
We have designed and built complete electronic cooling systems for hundreds of airborne applications—both on board and pod mounted. In fact, a Garrett AiResearch built electronic cooling system is on board the Grumman F-14 air-superiority fighter. □ Whatever your specific airborne electronic cooling requirement, come to Garrett AiResearch for total system optimization.



Garrett AiResearch enclosures are also cooling the pod mounted ALQ-76 and ALQ-99 electronic countermeasures systems. The enclosure in the ALQ-99 pod (shown above) for the EA-6B utilizes surface heat exchangers as the ultimate heat sink.

GARRETT

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INFORMATION RETRIEVAL NUMBER 45

700V Planar

HI-VOLTAGE SILICON POWER TRANSISTORS

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First, Solitron announced the high voltage silicon power SDT 1050 Series. Next, Solitron announced the high voltage SDT 400 Replacement Series offering higher gain and reliability. Now Solitron has gone a giant step further and developed the new and unique high voltage SDT 500 Series with sustained breakdown voltages (V_{CEO}) from 200 to 700 V. All transistors in this series utilize hi-rel planar construction and are SiO_2 passivated. Yet, there is no reduction of $I_{s/b}$ and $E_{s/b}$ ratings.

These new devices are ideal for power supplies, all CRT deflection circuits, converters, inverters, relay drivers and series regulators And, you'll pay no more for the SDT 500 Series than the price you've been paying for other high voltage NPN silicon power devices.

FEATURING:

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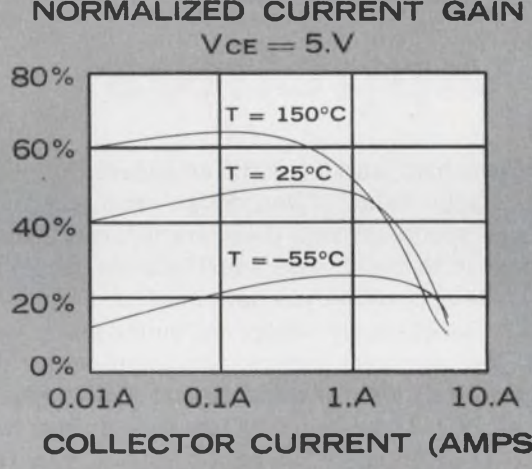

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INFORMATION RETRIEVAL NUMBER 46

LM351 AUDIO AMPLIFIER

- low cost
- 1.8W at 9V and 4Ω
- 6-12V supply voltage
- 68 dB gain (open loop)
- 1 mA quiescent current
- 0.75 MΩ input impedance (open loop)

PRICE	1-24	25 up	100 up
LM351	$3.00	2.70	2.00

LM361 FM AMPLIFIER AND DETECTOR

- low cost
- 60 dB gain at 6.0 MHz
- 5 kHz to 60 MHz frequency range
- 100 μV threshold limiting voltage at 5.5 MHz
- 1.4V rms audio output voltage (THD=1%)

PRICE	1-24	25 up	100 up
LM361	$1.76	1.60	1.17

LM352 AUDIO AMPLIFIER

- 2.1W at 12V and 8Ω
- 6-15V supply voltage
- 1.2 mA quiescent current
- Gain (open loop): 70 dB at 12V

PRICE	1-24	25 up	100 up
LM352	$3.15	2.80	2.10

LM353 AUDIO AMPLIFIER

- 3W at 15V and 8Ω
- 6-16V supply voltage
- 1.8 mA quiescent current
- 72 dB gain at 15V
- Heat sink package with low thermal resistance

PRICE	1-24	25 up	100 up
LM353	$4.40	4.00	2.90

EEP has amplifiers (and applications data) for audio appetites

LM354 AUDIO AMPLIFIER

- 4W at 24V and 16Ω
- 6-24V supply voltage
- 3 mA quiescent current
- 74 dB gain at 24V
- 52 dB SVRR
- heat sink package with low thermal resistance

PRICE	1-24	25 up	100 up
LM354	$4.50	4.05	3.00

Here are five new hard working audio amplifiers from EEP. Which one best satisfies your needs? If you design radio receivers, phonographs, TV sets or sound systems these are naturals. But the world of audio is more than that and these amplifiers can handle just about any general purpose application you have in mind.

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The details provided here are only appetizers, intended, of course, to get your applications juices and the orders flowing. Send us an order and we'll send you our 32-page audio applications appetite appeaser. Write or call today.

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INFORMATION RETRIEVAL NUMBER 47

new products

Universal field programmer programs all types of ROMs

Spectrum Dynamics, Inc., 2300 E. Oakland Park Blvd., Fort Lauderdale, Fla. Phone: (305) 566-4467. P&A: see text; fall 1971.

Designed to automatically or manually program read-only memories in the field, a new universal programmer can program all types of available ROMs—fusible-link, diode junction-shorting, electrochemical-fusing and floating-gate avalanche-injection types.

Known as the model 500, this handy instrument will automatically verify a ROM's "0" and "1" logic levels. Its present address capacity is 4096 words, however future plug-in cards will be available to easily modify the instrument, in the field, to a capacity up to 65,536 words.

Programming a ROM with the 500 is very simple. Data can be entered manually through 9 program switches (into a RAM within the model 500 programmer), which makes it possible to set up and check an entire word before a ROM is programmed.

If one desires automatic programming this can be done in one of several ways: from a master ROM, with an optional optical scanner, with an optional interface for punched paper tape or with optional interfaces for any other equipment.

The ROMs are addressed in binary code, but the word numbers are displayed decimally on a seven-segment four-digit readout.

Satellite units will become available for the model 500 programmer for programming several ROMs simultaneously.

A universal adapter module is available to verify programmed ROMs and mask-made ROMs for logic levels. The adapter will also permit the checking of access times.

The model 500 is constructed using circuit modules on plug-in cards to allow flexibility for simple word capacity expansion. It is designed to accommodate future programming techniques, as far as possible, through minor modifications.

The basic instrument costs $1500. Modules are available, for the different programming techniques, at prices ranging from $360 to $450 each.

A lower-cost programmer version (model 300) is available to program all fusible-link ROMs. It costs $280 (plus $95 for an adapter).

CIRCLE NO. 250

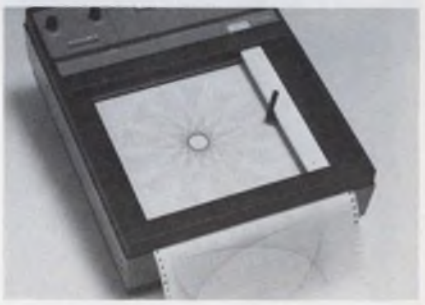
Test generator unit gives offline messages

General Instrument Corp., Andrews Rd., Hicksville, N.Y. Phone: (516) 681-4300.

A new economical offline message generator simplifies troubleshooting problems in telecommunications equipment. The device, the model 723 message generator, eliminates all online testing by producing off-line data messages. The operator can select standard Fox Test, Short Line or Composite messages, discrete characters, a checkerboard test pattern or a binary progression of codes in ITA-2 and USASCII.

CIRCLE NO. 251

Software-less terminal makes hard-copy graphs



Valtec Corp., 17751 Sky Park Circle, Irvine, Calif. Phone: (714) 540-9591. Availability: stock to 30 days.

A new self-contained interface option (model 121) for the series 2000 digital plotters allows plug-compatible operation from TTY or CRT terminals for hard-copy graphic plots. An exclusive data protocol, hard-wired into the plotter, allows the plotter to bring its own software to the terminal.

CIRCLE NO. 252

CRT display terminal costs down to $2750

Delta Data Systems Corp., Cornwells Heights, Pa. Phone: (215) 639-9400. P&A: $2750; 30 days.

A new inexpensive display terminal is the model TelTerm 33 which is aimed at the teletypewriter replacement market. The visual-display system handles up to 80 characters/line and 27 lines of data. It blinks information on the screen so that important data can be called to the operator's attention. The TelTerm 33 has a numeric pad in addition to a standard teletypewriter keyboard.

CIRCLE NO. 253

Benchtop tester checks keyboards

Controls Research Corp., 2100 S. Fairview, Santa Ana, Calif. Phone: (714) 557-7161. P&A: $890; 4 to 6 wks.

A new tester provides laboratory and/or production testing capabilities for any size encoded electronic keyboard with up to 20-bit lines and either a positive or negative strobe. It also accommodates up to 12 non-encoded function keys. Designated the model 800, the unit compares a known standard keyboard against one under test or displays a bit line readout.

CIRCLE NO. 254

1-Megabyte memory speeds cycle to 2.5 μs

Core Memories, Inc., 2525 Charleston Rd., Mountain View, Calif. Phone: (415) 964-4080.

Cycle time has been decreased to 2.5 μs for the 1-million byte Large Core Store (LCS) memory. Compatible with IBM's system/360 model 50, its cycle time for the 2-million byte model has been decreased to 3 μs from 4 μs. Both models do not have price increases. A 524,288-byte 2.5 μs model compatible with the IBM system 360/50 has also been developed.

CIRCLE NO. 255

Optical ROM system uses fiber optics

Quadri Corp., 2950 W. Fairmont, Phoenix, Ariz. Phone: (602) 263-9555.

A new optical ROM system, the model 401-22, uses fiber optics rather than complex and delicate lens systems of conventional optical memories. This eliminates the need and expense of peripheral mask-making equipment. It also offers such features as user programmability, rapid and simple field alterability and elimination of costly and time-consuming mechanical alignment.

CIRCLE NO. 256

Impact print mechanism types out 30 char./s

Typagraph Corp., 7547 Convoy Court, San Diego, Calif. Phone: (714) 279-5690. P&A: $750; 30 days.

A new 30-character/s impact printer mechanism features all 94 standard USASCII characters including upper and lower-case alphabet, numerals, symbols and space. The DPM-30 accepts standard fan-fold, sprocket-fed paper in widths from 4 to 15 in. It can handle single or multiple copies providing up to four carbon copies.

CIRCLE NO. 257

Compact data modem is for wall mounting

RFL Industries, Inc., Boonton, N. J. Phone: (201) 334-3100. P&A: $180 (without carrier detect); 30 to 60 days.

A PC card OEM modem designed for desk or wall mounting is housed in a 5-3/4 by 2-7/8 by 12-1/2-in. package. Model 5220 modem is a low-cost, compact, originate or answer-only unit with power supply and indicating lights. It is compatible with the Bell 101, 103 and 113 series and will operate full-duplex at up to 300 bits/s.

CIRCLE NO. 258

7-in.-reel transport works at 18.75 in./s

Peripheral Equipment Corp., 9600 Irondale Ave., Chatsworth, Calif. Phone: (213) 882-0030. Price: from $2630.

A new 7-in.-reel, low-cost tape transport achieves a high speed of 18.75 in./s of tape velocity. An addition to the 7000/series of synchronous digital transports, it provides the OEM user with high data density to 30,000 characters/s. Its 8-3/4-in. rack height makes it ideal for minicomputer and data terminal applications.

CIRCLE NO. 259

Amperex high quality trimmer pots priced to help you beat inflation.

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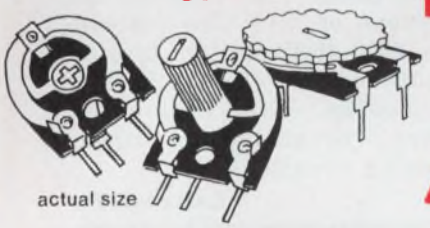
SMALL



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Available for horizontal or vertical mounting on printed circuit boards with pitch of 0.200 inch. The slider is equipped with a central screwdriver slot or plastic knob to facilitate adjustments. Designed for radio and television receivers and industrial applications.

MINIATURE

actual size

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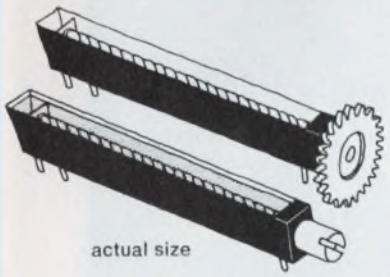
IN PRODUCTION LOTS

Resistance range: 100Ω to 1megΩ; **Tolerance:** ±20%; **Dissipation:** 0.1 watt.
Completely new design. No price penalty for miniaturization of our standard trimmer. Height: 0.4", Width: 0.4". Available for horizontal or vertical mounting on printed circuit boards with pitch of 0.100 inch. Adjustment by a central screwdriver slot or a plastic knurled wheel. Designed for new products in which small size is a necessity . . . transceivers, portable TV's, etc.

20-TURN PRESET



actual size

33¢ TO 41¢ each

IN PRODUCTION LOTS

Resistance range: 100Ω to 2.2megΩ; **Tolerance:** ±20%; **Dissipation:** 0.125 watt. **Adjustment range:** 20 turns full-scale; linear or non-linear resistance curve.
Brand new in concept. They break the "dollar apiece" barrier without yielding an inch in performance.
Available with knurled thumbwheel or with screwdriver slot in shaft. (Thumbwheel is actually a spur gear to allow indirect drive where desired.) Dust cover of unique design can also be supplied; seals carbon track and slider against contamination. These 20-turn pots are suitable for use in TV and radio fine tuning, precision instruments, tape recorders, servomechanisms, etc.

Write for detailed data sheets on these three examples of Amperex quality and pricing and for our catalog on the complete Amperex line of components . . . carbon film resistors, non-linear resistors, electrolytic capacitors, film dielectric capacitors . . . and much more. Amperex Electronic Corporation, Component Division, Hauppauge, New York 11787.

Amperex®

TOMORROW'S THINKING IN TODAY'S PRODUCTS

A NORTH AMERICAN PHILIPS COMPANY

Low-cost synthesizers raise spectral purity

Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. Phone: (415) 493-1501. P&A: $1900, $2400; Oct. 1971.

Two new low-cost frequency synthesizers with a range of 0.01 Hz to 13 MHz feature high spectral purity. These fully programmable instruments include the model 3320A with a 1-V-rms output into 50 Ω and a continuous 0 to +13-dBm amplitude vernier. The more expensive 3320B has a four-digit leveling loop with 0.01-dB level resolution. Both 10 and 100-Hz optional ranges are available.

CIRCLE NO. 260

Sweep/mark generator covers 2 to 100 MHz

Kay Elemetrics Corp., 12 Maple Ave., Pine Brook, N.J. Phone: (201) 227-2000. P&A: $1495; 3 to 4 wks.

The model 162A sweep and marker generator covers a frequency range of 2 to 1000 MHz in a wide and flat (±0.5 dB) sweep. It features a digital readout of center frequency and a selection of variable birdie or harmonic comb marker systems. Swept output is 0.5 V rms into 50 or 75 Ω, with harmonic or spurious response down by 30 dB. Other features include 0 to 80-dB attenuators in 1-dB steps.

CIRCLE NO. 261

Digital thermometers optimize performance

Newport Laboratories, Inc., 630 E. Young St., Santa Ana, Calif. Phone: (714) 540-4914. Price: $750.

A new series of wide-range digital thermometers provide a wide choice of temperature measurements with readings for most thermocouple types made directly in Fahrenheit or Centigrade at resolutions of 0.1°. The low-cost series 2600 thermometers provide readouts for type J,K,T,S, R or E thermocouples. They feature 58-segment "break-point" digital linearizing circuits.

CIRCLE NO. 262

Look how our family tree has grown

It started with a seed of microwave technology.

The first fruits were tunnel diode amplifiers. Then came mixers, detectors, transistor amplifiers, solid state sources, and YIG and ferrite devices. From this component base, we branched in both directions — to semiconductor chips and modules and to subsystems.

Now Aertech is a leading producer of a wide variety of microwave products. In our catalog you will find standard products that will satisfy most of your needs. But if you need something really special, our broad line proves that we have the experience to design to your specs.

Many of our products have been "space qualified"; they have undergone as rugged a reliability program as you'll find anywhere. Much of what we learned in earning this rating is incorporated into our standard products. And to maintain this high standard, quality assurance is an independent project review function at Aertech.

Our facilities are described in a comprehensive brochure — yours for the asking; a lab full of microwave engineers is available to provide applications assistance; a nationwide network of representatives is ready to serve you.

For standard UHF/microwave products or custom devices and subsystems, call Aertech, 825 Stewart Drive, Sunnyvale, CA 94086; 408/732-0880. You won't have a complete bid package without word from us.

Aertech

Dynamic curve tracer tests most devices

Tektronix, Inc., Box 500, Beaverton, Ore. Phone: (503) 644-0161. P&A: $795; 7 wks.

The new Telequipment CT71 curve tracer is a dynamic tester designed for displaying the characteristic curves of a wide range of transistor, FET and diode devices on its 10 by 10-cm CRT. It has a collector supply voltage of 0 to ±1 kV, 2 A of peak current and series resistances from 0 to 1.7 MΩ in 11 steps.

CIRCLE NO. 263

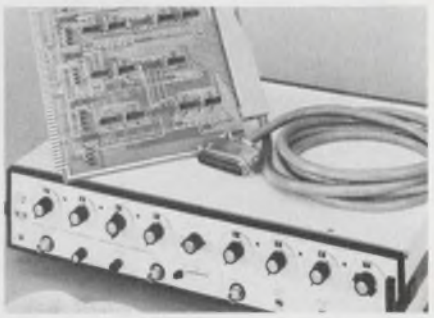
50-MHz pulse generator has variable rise/fall

Systron-Donner Corp., 10150 W. Jefferson Blvd., Culver City, Calif. Phone: (213) 871-0410. P&A: $850; 90 days.

Model 116 pulse generator features repetition rates from 1 Hz to 50 MHz with a continuous vernier adjustment through all ranges. Its rise and fall times are linear and independently variable from 5 ns to 0.5 s in eight ranges. Baseline offset is variable from 100 mV to 5 V into 50 Ω. Repetition rate, delay and width jitter is less than 0.1% of setting or 50 ps, whichever is greater.

CIRCLE NO. 264

Interface package drives many instruments



Exact Electronics, Inc., Box 160, Hillsboro, Ore. Phone: (503) 648-6661. P&A: $450; stock.

A new computer interface package can drive programmable waveform generators and other programmable instruments. The model 67 interface package includes an interface card that fits any 1/0 slot of Hewlett-Packard and other compatible computers, cable, connectors and software (paper tape). It can be adapted for other instruments by different software.

CIRCLE NO. 265

Simpson® has the world's largest selection of PANEL METERS and METER RELAYS

with famous Simpson STAY-ACCURATE QUALITY

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- THE ABOVE PANEL METERS ARE AVAILABLE IN AC/DC VOLTMETERS, AMMETERS, MILLIAMMETERS, MICROAMMETERS . . . DC MILLIVOLTMETERS AND GALVANOMETERS . . . RF AMMETERS AND MILLIAMMETERS.
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- SIMPSON CAN MAKE CUSTOM PANEL METERS AND METER RELAYS TO YOUR SPECIFICATIONS. ANY PRACTICAL RANGE CAN BE SUPPLIED. SEND US YOUR REQUIREMENTS.

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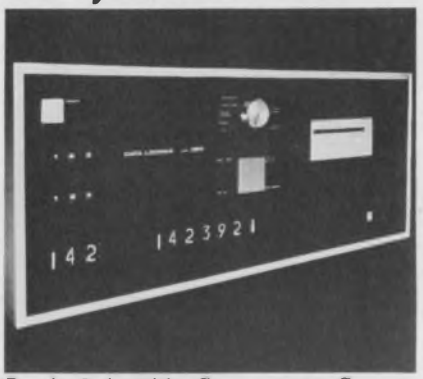
INFORMATION RETRIEVAL NUMBER 54

AGM DIVISION

MANUFACTURERS OF THE WORLD FAMOUS SIMPSON 260®

Digital data logger is a system in a case



Doric Scientific Corp., 7601 Convoy Court, San Diego, Calif. Phone: (714) 277-8421. Price: $2000.

Digitrend 210 is a low-cost and complete instrument system for scanning, conditioning, measuring, displaying and digitally recording multiple low-level dc signals from thermocouples, transmitters and millivolt transducers. Reference junctions, FET scanning, automatic zero drift correction and digital linearization are built into the 210.

CIRCLE NO. 266

5-digit time-interval meter costs $450

Eldorado Electrodata Corp., 601 Chalomar Rd., Concord, Calif. Phone: (415) 686-4200. Price: see text.

The model 355 is a low-cost 1-μs time-interval meter with five digits of display, separate input channels and input signal conditioning. The meter can measure the time interval between two electrical events, and can time a single input cycle. Switch-selectable resolutions of 1-μs and 1-ms allow readout of the five-digit display ranging from 1 μs through 99.999.

CIRCLE NO. 267

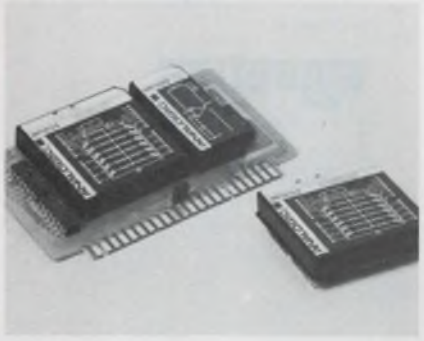
Fast pulse generators offer 1-ns rise/fall

Philips Electronic Instruments, 760 S. Fulton Ave., Mount Vernon, N. Y. Phone: (914) 664-4500.

PM5775 and PM5776 pulse generators offer repetition rates from 1 Hz to 100 MHz in nine ranges and adjustable 0.3-to-3-V output pulses with rise/fall times under 1 ns. A single positive or negative output is provided with the PM-5775, while two outputs are available with the PM5776. The generators are suited for testing digital computer and control systems.

CIRCLE NO. 268

12-bit d/a converters settle in 5 μs



Analogic Corp., Audubon Rd., Wakefield, Mass. Phone: (617) 246-0300. Price: $89, $114.

DTL/TTL-compatible MP1812A and AN1812M 0.01% accurate 12-bit d/a converters offer 5-μs settling times. Their typical TC and offsets are 10 ppm/°C and 50 μV/°C, respectively. A dc reference is built-in. The basic MP-1812A is a standard Modupac module with a 10-mA output. The AN1812M consists of an MP1812A mounted on a plug-in PC card.

CIRCLE NO. 269

Digital display panel is only 0.6-in. deep

Durgin & Browne, Inc., 80 Allen Rd., S. Burlington, Vt. Phone: (802) 863-6873. Price: from $59.

A breakthrough in digital panel display design is achieved with a new slim-line model which requires less than 0.6 in. of rear-panel space. Ideal for auxiliary and remote, continuous-slave indicator applications, the DPD-100 features low-voltage, flatpack segmented displays providing maximum viewing angle through a polarized front filter.

CIRCLE NO. 270

Here are seven super-useful examples:

Dual 50-bit (Three-State) 2509
Dual 100-bit (Three-State) 2510
Dual 200-bit (Three-State) 2511
Hex 32-bit 2518
Hex 40-bit 2519
Dual 128-bit 2521
Dual 132-bit 2522

Here's what makes them tick:

1. Single TTL level clock (0 to +5v).
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4. TTL compatible inputs; drive direct from TTL.
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6. Static operation.
7. Silicone DIP packages.
8. Lowest cost system implementation.
9. Availability; off-the-shelf. Now.

And here's how you get them all together.

All the user-oriented benefits: the remarkable adaptability, application-ease and versatility. Together in the static shift registers from Signetics Silicon Gate MOS series. Call your nearest Signetics salesman, rep or distributor for the new MOS handbook, price list and samples.

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The more usable static shift register.

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INFORMATION RETRIEVAL NUMBER 59

Total capability. Price competitive. Available for fast delivery. Just ask your nearest Signetics distributor.

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MICHIGAN
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Seattle: Hamilton/Avnet Electronics (206) 624-5930

MODULES & SUBASSEMBLIES

Modular supplies are 80% efficient

Aaron-Davis Co., 1150 S. Beverly Dr., Los Angeles, Calif. Phone: (213) 553-8121. P&A: $170 for 25-W units; stock to 3 wks.

The M-5-20 is only one model (5 V at 20 A) in a new line of 80% efficient power supplies. The M series is designed for both foreign and domestic use, or for any application where wide line voltage excursions are common. All models operate from 90 to 150 V ac, 45 to 1000 Hz, and from 90 to 240 V dc, interchangeably.

CIRCLE NO. 271

Low-cost power amps are quite miniature

Epitek Electronics, Ltd., 19 Grenfell Crescent, Ottawa, Ontario, Canada. Phone: (613) 825-3911. Price: $6.50, $7.25 (100 quantities).

Models 525 and 1040 5 and 10-W thick-film low-cost power amplifiers —only 1.68 by 1.16 by 0.3 in.—are designed to drive 4 to 16-Ω speaker systems. They offer a response from 20 Hz to 200 kHz and need only either +25 or +40-V supplies to operate. They continuously operate at rated outputs without heat-sinking.

CIRCLE NO. 272

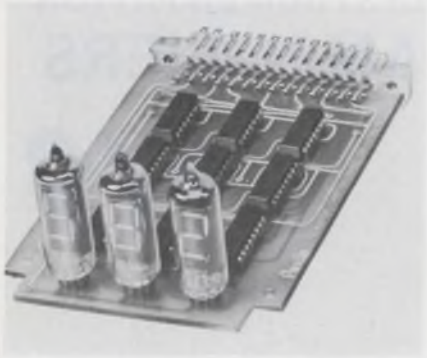
Indexing drive/steppers ease kinematics design

Machine Components Corp., 53 Werman Court, Plainview, N. Y. Phone: (516) MY4-7222.

A new line of cyclic drives and indexing steppers provides the mechanism designer with the important option of selecting the precise kinematics to match a particular requirement. These may pertain to the length of the index dwell angle from 0 to 240 degrees of input, the shape of the acceleration and velocity profiles and the kinematic mechanization of a prescribed mathematical or empirical function.

CIRCLE NO. 273

Three-tube display operates from 5 V



Apollo Corp., 5-1, Togoshi 6-chome, Shinagawa-Ku, Tokyo, Japan. P&A: $45 (1000 quantities); 50 to 60 days.

The new pulse-driven DN-3130 display unit may operate at a low voltage level of 5 V. It is suited for high-speed decimal counting and storage display and consists of three seven-segment, incandescent, digital readout tubes, decoder/driver, quadruple bistable latch and decade counter. Its dimensions are 2.95 by 1.57 by 4.72 in.

CIRCLE NO. 274

Fast-settling op amps drive 5000-pF loads

Dynamic Measurement Corp., 6 Lowell Ave., Winchester, Mass. Phone: (617) 729-7870. P&A: from $40; stock.

Two new fast-settling op amps, models FST-158A/B and FST-159A/B, are capable of driving 5000-pF loads. Both have 7-MHz bandwidths, settle to 0.01% in 1 μs, gain 500,000 and have input impedances of 10^{12} Ω.

CIRCLE NO. 275

Multi-deck switches can handle 6000 V rms

Shallco, Inc., Highway 301 at Holt Lake, Smithfield, N.C. Phone: (919) 934-3135.

High-voltage switches are available on a custom-design basis to withstand 6000 V rms to ground. Switches are 4-in. square, employ silver alloy contacts and include 1 pole/deck and 24 positions/pole. Multi-deck models are possible.

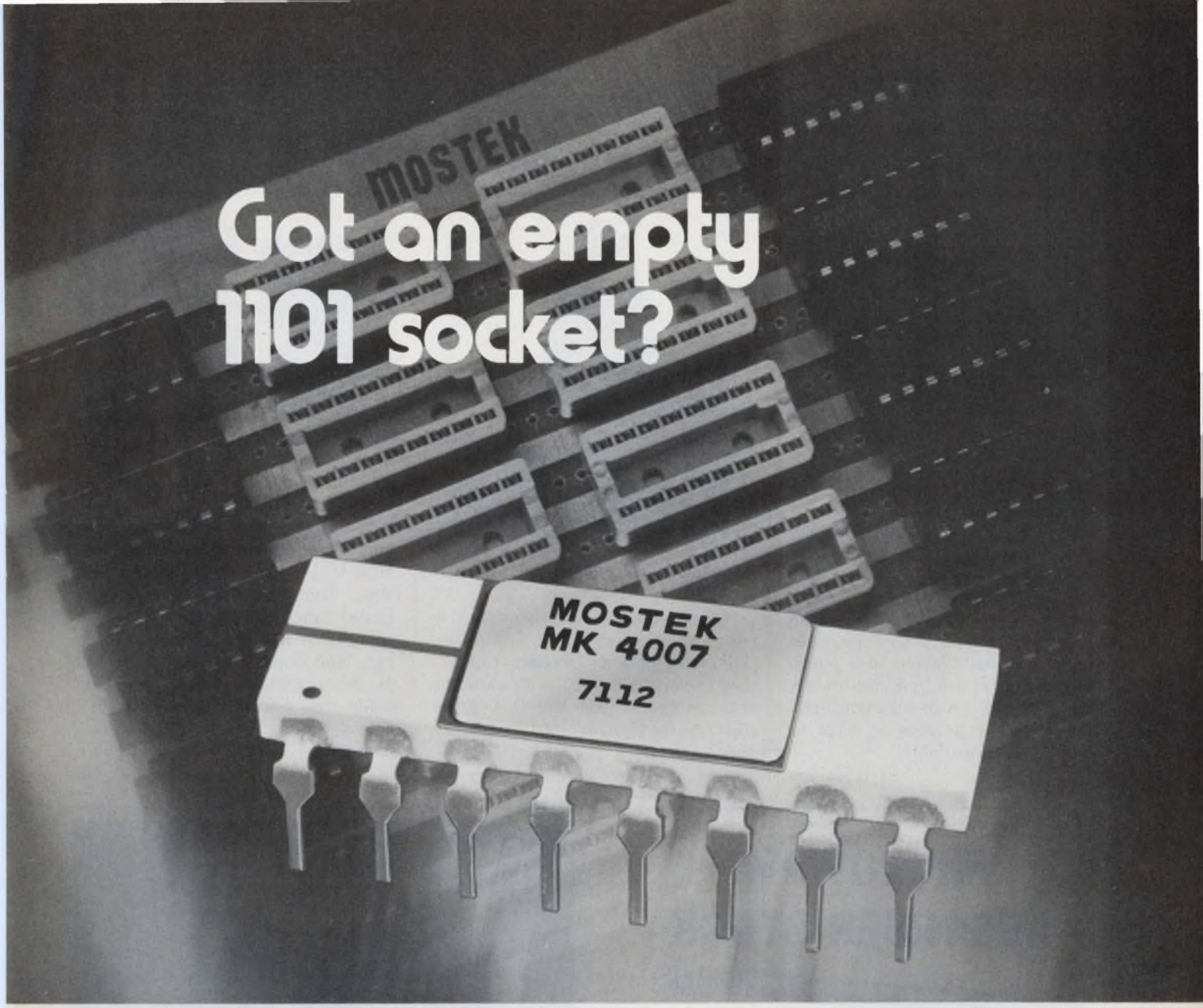
CIRCLE NO. 276

PC-board supply delivers 5 W

Computer Products, Inc., 1400 Gateway Dr., Fort Lauderdale, Fla. Phone: (305) 974-5500. P&A: $58.95; 1 to 5 days.

The PM572 encapsulated modular power supply is designed for mounting on PC boards. Measuring 3.5 by 2.5 by 1.25 in., it has an output of 5 V dc at 1000 mA. The supply is load regulated at ±0.4% and line regulated at ±0.2%. Its ripple and noise is 1 mV rms. Temperature coefficient is 0.03%/°C and input frequency is 47 to 440 Hz.

CIRCLE NO. 277



Fill it with the coolest 256-bit RAM around... from MOSTEK

Whether you've already got an empty 1101 socket—or just considering a replacement—you'll find MOSTEK's new MK 4007 P your ideal choice in 256 x 1-bit RAMs. Here's why:

Low power: 250 mW!

Wide voltage range: + 5V; —7 to —15V, fully covers the range of any other existing part.

Full DTL/TTL compatibility including the outputs which have a fan-out of 2 with tightly controlled sink currents.

High performance: This exceptional combination of low power/high performance is made possible for the first time by ion-implanted constant current (depletion) devices.

Speed: All 4007s operate at less than 1 μ sec access time up to + 75° C...ambient.

16-pin ceramic package: You get ceramic hermeticity at plastic prices!

Now, add-up these key benefits and compare them with what you get in any other 1101 replacement. Wouldn't it be smart to switch **now** rather than try to fix? Find out for yourself how MOSTEK makes it easy to use MOS by calling Gordon Hoffman or Dave West at (214) 242-1494. Or contact your nearest Sprague Electric Company representative or distributor.

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The Calculator-on-a-Chip Company

INFORMATION RETRIEVAL NUMBER 63

LED readout assembly has 2 character heights

Dialight Corp., 60 Stewart Ave., Brooklyn, N. Y. Phone: (212) 497-7600. P&A: $32 (3-digit unit in 100 quantities); 2 to 3 wks.

Designed for electronic thermometers, keyboards, clocks and counters, the series 749 assembly contains groups of Diode-Lite readouts, decoder-drivers and a stylish black bezel assembly that provides for ease of installation in a panel. The readout is a 6-by-8 dot matrix connected for seven-segment driving. Character heights of 0.125 or 0.205 in. are available.

CIRCLE NO. 278

Alphanumeric displays feature 2-ft characters

Power Technology, Box 4403, Little Rock, Ark. Phone: (501) 565-1750.

Giant numeric and alphanumeric displays feature 6, 12 and 24-in. character heights in either 7 or 13-bar configurations. Readability ranges from over 200 ft for the 6-in. units to over 1000 ft for the 24-in. ones.

CIRCLE NO. 279

Fast-settling op amp slews at 1000 V/μs

Analog Devices, Inc., Route 1 Industrial Park, Norwood, Mass. Phone: (617) 329-4700. P&A: $75; stock.

Model 46 FET differential op amp offers a unique combination of 1000-V/μs slew rate, 300-ns settling time to 0.01% (inverting mode) and ±100 mA of output current. It has the same high slew rate and settles to 0.05% in 150 ns in a unity-gain non-inverting mode. The amplifier handles ±10-V comomn-mode inputs in the non-inverting mode.

CIRCLE NO. 280

IC voltage regulator controls over 10 A

Advanced Micro Devices, Inc., 901 Thompson Pl., Sunnyvale, Calif. Phone: (408) 732-2400. Price: $12 (100 quantities).

A new voltage-regulator IC features an adjustable output of 4.5 to 40 V and controls output currents in excess of 10 A. The second-source Am105 can be operated as a series or as an efficient switching regulator. It offers 1% temperature stability over −55 to +125° and 1% load regulation.

CIRCLE NO. 281

Color processor IC simplifies TV design

Motorola Semiconductor Products, Inc., Box 20924, Pheonix, Ariz. Phone: (602) 273-6900. Price: $1.98 (1000 quantities).

The MC1398P TV color processor, a single IC, is a chroma i-f amplifier with automatic chroma control, color killer, and an injection-lock reference system that generates the required chroma subcarrier reference signal. It's internal-feedback oscillator locks into phase above 200 μV. DC control is used for hue and chroma amplitude adjustments.

CIRCLE NO. 282

BCD decoder/driver has high noise immunity

Teledyne Semiconductor, 1300 Terra Bella Ave., Mountain View, Calif. Phone: (415) 968-9241. Price: $6 (100 quantities).

A new BCD-to-decade decoder/driver features over 4 V of typical noise immunity and has a guaranteed 70-V output. The 382 decodes BCD 1-2-4-8 code and drives gas-filled cold-cathode indicator tubes requiring 7 mA or less of cathode current. The 382 operates from 12 to 15-V power supplies.

CIRCLE NO. 283

Monolithic dual JFETs drop input current to femto-amps

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. Phone: (408) 732-5000. P&A: $3.50 to $21 (100 to 999 quantities); stock.

A new family of monolithic dual junction field-effect transistors features devices with the lowest input currents available—currents down in the femto-ampere region (a femto-ampere is 10^{-15} A).

This makes these dual transistors ideal for such applications as instrumentation and op amp signal-handling circuits where high input impedances are necessary.

Specifically, typical input offset currents of the new FM1100A family of JFET duals are only 20 femto-amperes at 25°C. Maximum input offset currents at 25° C are only 100 femto-amperes.

Intput bias currents are also quite low—typically less than 20 femto-amperes and a maximum of 1 pA at 25°C.

At room temperatures, the new monolithic JFET duals compete with electrometer tubes.

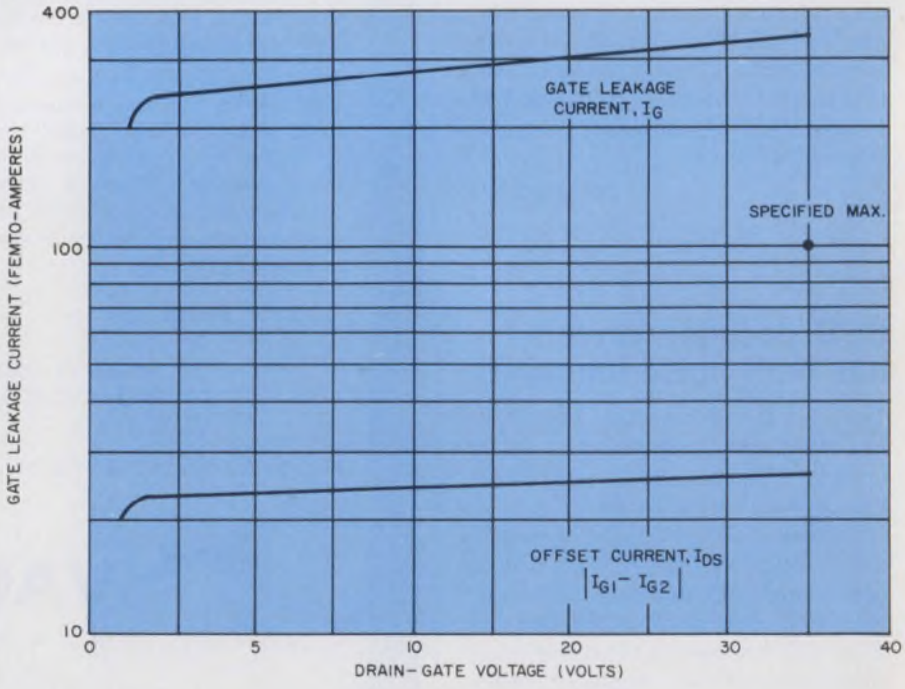
Even at temperatures as high as +125°C input currents are approximately an order of magnitude better than those of super-beta monolithic transistors. Most transistors in the FM1100A family exhibit about 40 femto-amperes of input offset current at this high temperature.

Voltage offset and drift characteristics of the new JFET duals are better than MOSFETS. They offer offset voltages as low as 2 mV and drift only 5 μV/°C.

The FM1100A transistors can be used over the normal op amp power supply range of ±15 V, with drain-gate voltages as high as 35 V, without any worry about input current degradation.

Another advantage of the new devices is a forward admittance, Y_{fs}, of 100 μmhos minimum. This is ten times the usual rating for low-leakage JFET pairs. And common-mode rejection is 100 dB.

CIRCLE NO. 284



A new family of monolithic JFET duals features devices with ulta-low leakage and offset currents down in the femto-amperes region. These new JFETs can handle drain-gate voltages as high as 35 V with no input current degradation. Drain current for the above curves was set at 100 μA.

GaAsLITES for your panel

or circuit board, or anywhere else you need lasting light

Panel indication is a SNAP with the MV5020 series of Gallium Arsenide Phosphide LED's. This bright, long lasting light can be easily seen in most ambient light situations. It emits 750 footlamberts at only 20 mA.

The easy-mount bezel supplied with this unit makes it ideal for 1/16 or 1/8 inch panels. Just pop the mount through your panel and SNAP in the light.

You also have a wide choice of lens types to give you the exact effect you need. There are clear, clear red, diffused and diffused red plus the new diffused red flooded lens.

And now Monsanto offers two variations of the MV5020 with shorter lenses for use on circuit boards. These are: the MV5010 series with a .212 inch lens in clear, clear red, diffused and red diffused epoxy and the MV5030 series in clear and red diffused epoxy.

Both of these units offer the same reliability and low power requirements as the MV5020.

Remember, when your thinking about light, think Monsanto. GaAsLITES are available through your major distributor or from

Monsanto - Electronic Special Products - 10131 Bubb Road - Cupertino, California 95014 - (408) 257-2140.

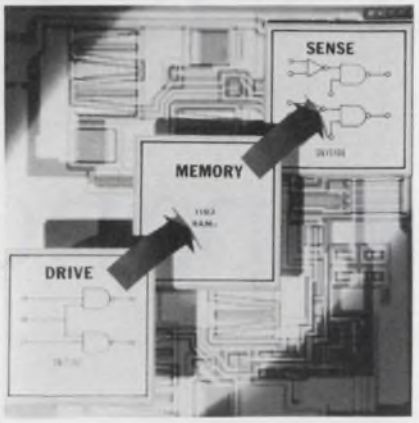
CALL TODAY AND ORDER YOUR SUPPLY.

Monsanto

INFORMATION RETRIEVAL NUMBER 68

ICs & SEMICONDUCTORS

Monolithic RAM drivers optimized for 1103s

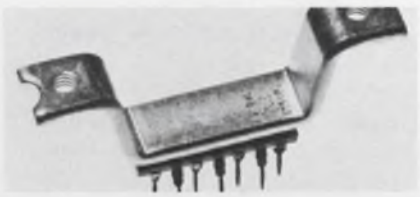


Texas Instruments, Inc., 13500 N. Central Expressway, Dallas, Tex. Phone: (214) 238-2011. P&A: Under $3 (100 quantities); 6 wks.

Two new monolithic drivers have been optimized to drive the 1103 MOS RAM. With a 100-pF load, the SN75360 switches high to low in 13 ns and low to high in 24 ns. The SN75361 switches the same load from high to low in 18 ns and low to high in 25 ns. Both are dual NAND drivers with TTL/DTL-compatible inputs.

CIRCLE NO. 285

Monolithic power amp delivers 2.5-A output



Societa Generale Semiconduttori, Via C. Olivetti, 1, Agrate Br., Milan, Italy.

A new monolithic power amplifier, designated TBA641, can achieve a peak output current of 2.5 A. Coupled with a supply voltage range from 6 to 18 V, it is suitable for applications requiring high output power, low distortion and high reliability. With a 9-V supply, the TBA641A will produce an output of 2.2 W into a 4-Ω load. The TBA641B will produce an output of 4.5 W into a 4-Ω load with a 14-V supply.

CIRCLE NO. 286

COMPONENTS

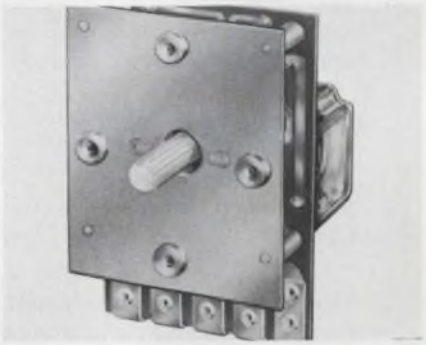
Mercury wetted relay responds under 950 ms

C. P. Clare & Co., 3101 Pratt Ave., Chicago, Ill. Phone: (312) 262-7700.

The low-profile HGQ is a new ultra-high-speed mercury wetted relay with low noise and bounce-free operating characteristics. Its response time at nominal coil power is less than 950 ms. The HGQ can be driven to 500 Hz with a minimum of jitter. Contact noise settles to less than 5 μV in 2 ms. Transfer action is random, bridging or non-bridging, with transfer time typically less than 100 μs.

CIRCLE NO. 287

Time-delay relay has low profile



Vanguard Relay Corp., 225 Cortland St., Lindenhurst, N. Y. Phone: (516) TU4-5000. Price: $13.50.

The compact model TDP hybrid time-delay relay features a low behind-the-panel profile of only 2-3/4 in. Its spdt output contacts are rated at 10 A, 115 V ac or 26 V dc resistive. The relay repeats to within 3% nominal voltage and temperature, and is polarity protected on dc. It is only 2-in. wide and rear-mounts with 4 screws.

CIRCLE NO. 288

COMPONENTS

Npn transistors are performance optimized

Analog Devices, Inc., Route 1 Industrial Park, Norwood, Mass. Phone: (617) 329-4700. P&A: $2.40 to $8.25; stock.

A family of monolithical dual npn transistors, designated AD810, AD811, AD812 and AD13, are high in current gain (400 minimum for a 10 to 5000-μA emitter range) and low in base-emitter voltage differential (as low as 0.5 mV). They are also low in voltage drift (2.5 μV/°C maximum), low in base-current differential (less than 2.5 nA), and high in breakdown voltage (45 V minimum).

CIRCLE NO. 289

Optical encoders come as modules

Sequential Information Systems, Inc., 249 N. Saw Mill River Rd., Elmsford, N.Y. Phone: (914) 592-5930. P&A: under $50; 30 days.

A new modular line of optical rotary encoders is available. Known as the Mod-Coder/R line, it includes a complete "do-it-yourself" assembly kit, incremental encoders with direction sensing and zero index, tachometers up to 5000 cycles/revolution and plug-in lamp modules with 100,000-hour lifetimes.

CIRCLE NO. 290

Snap-on thumbwheel switches stack easily

A. W. Haydon Co., 232 N. Elm St., Waterbury, Conn. Phone: (203) 756-4481.

A new line of miniature thumbwheel switches snap together, side-by-side, on 5/16-in. centers in any quantity. They are available in versions which include encoders, decoders, decimal and BCD switches. Max current capacity for the switches is 2 A dc and working voltage is 60 V dc. Switch wipers and tracks are gold-plated for reliable contact.

CIRCLE NO. 291

PC-board trimmers cost as low as 10¢

Waters Manufacturing Inc., Wayland, Mass. Phone: (617) 358-2777. Availability: stock.

A new line of PC-board imported carbon-film trimming and adjusting potentiometers are priced for use in industrial, commercial and consumer applications—10¢ to 15¢ each in 1000 quantities. They have 10 different solder lug and plug-in styles and both screw-slot and finger-knob adjustment. Resistance ranges from 500 to 1 MΩ and tolerance is ±20%.

CIRCLE NO. 292

Reed relays lower thermal emf to 1 μV

Coto-Coil Co., Inc., 65 Pavilion Ave., Providence, R. I. Phone: (401) 941-3355.

A new line of low-thermal-emf reed relays features offsets of less 1 μV. Designated as the CR-3200 series, the relays offer high isolation, speed and a long life expectancy under practically any environmental conditions. Units are also available at less than 500 nV/switch, or at less than 1 μV of differential between switches.

CIRCLE NO. 293

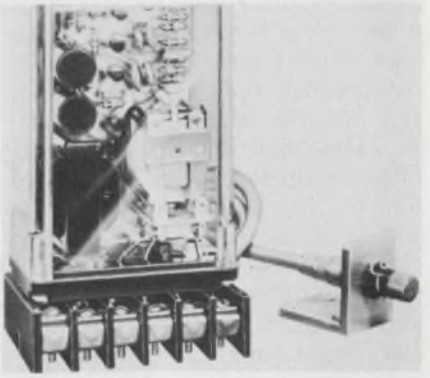
Tiny high-voltage diodes lower reverse current

Scientific Components, Inc., 350 Hurst St., Linden, N.J. Phone: (201) 925-4022.

Miniature high-voltage diodes are available with maximum reverse currents of 2 nA at PIV ratings from 1000 to 4000 V and continuous forward currents of 20 mA. The new diodes have a maximum capacitance of 1 pF at 0 V. Only 0.06-in. square by 0.13-in. long, they can be used in multiplying circuits that require high efficiency and a low battery drain.

CIRCLE NO. 294

Small proximity switch gives precision control

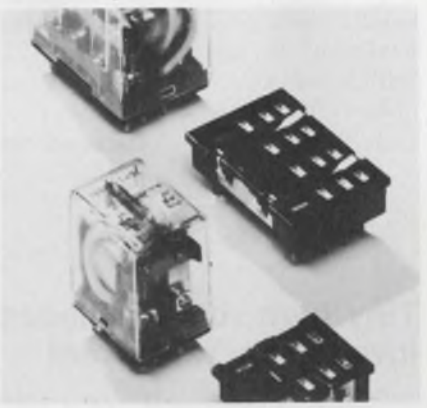


Licon Div. of Illinois Tool Works, Inc., 6615 W. Irving Park Rd., Chicago, Ill. Phone: (312) 282-4040.

A compact solid-state proximity switch provides precise control without physical contact and will sense ferrous and non-ferrous metals at up to 1000 operations/minute. Sensing range can be varied from 0.048 to 0.5 in. with a potentiometer sensitivity control. The switch provides accuracy to within 0.0005 in.

CIRCLE NO. 295

Multipole 10-A relay shrinks down in size

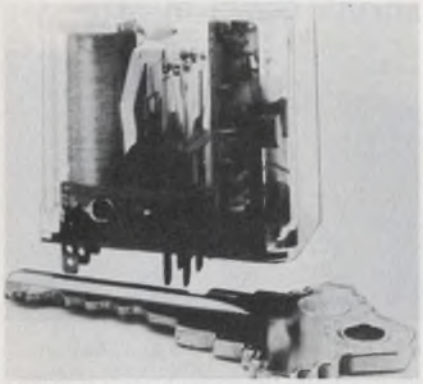


Sigma Instruments, Inc., 170 Pearl St., Braintree, Mass. Phone: (617) 843-5000.

A new 10-A multipole relay, designated series 76, provides twice the switching capacity per contact volume than existing electrical equivalents. Available in two and four-pole ac/dc types, the 76 is designed for plug-in front-panel mounting. The two-pole version has a standard 8-pin plug; the four-pole one has a 14-pin plug.

CIRCLE NO. 296

Solid-state hybrid relay handles 5 A



American Zettler, Inc., 697 Randolph Ave., Costa Mesa, Calif. Phone: (714) 540-4190. P&A: $15 to $19; 4 to 6 wks.

A new solid-state hybrid relay designated AZ-1400 is rated to handle 2 to 5 A across its contacts. The relay's mechanical side consists of a cradle-type relay with dpdt contacts. Its electronic part utilizes a unijunction transistor, a thyristor, and tantalum capacitors. The relay measures 3/4 by 1-3/16 by 1-3/8-in.

CIRCLE NO. 297

Thin, industrial relays complement PC boards

Babcock Electronics Corp., 3501 N. Harbor Blvd., Costa Mesa, Calif. Phone: (714) 540-1234. Availability: stock.

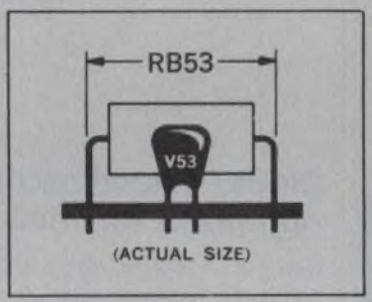
A new lift-off contact system which assures chatter-free operation, higher sensitivity and longer life are features of a new line of thin industrial relays. Known as the series NF, these extremely thin units for PC-board applications are available in 2 and 4-pole models, for operation at 2 A. Voltage ratings are 6, 12, 24, 48 and 60 V.

CIRCLE NO. 298

BREAKTHROUGH BY VISHAY THREATENS WIREWOUND RESISTOR PRICING

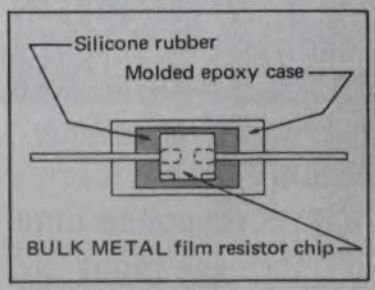
New BULK METAL film resistors stated to be superior replacement for wirewounds at less cost!

Malvern, Pa.: G. V. Gerber, **Vishay · Resistor Products** Vice President and General Manager, announced today a significant breakthrough in resistor technology: a low T.C., virtually non-inductive, BULK METAL film resistor available at less cost than precision wirewounds...and with superior specifications. According to Gerber, this new line of resistors is the result of a two year research and development program initiated to expand **Vishay's** share of the precision resistor market.



Size comparison between V-53 and RB-53 type wirewound. Vishay V-53 requires only 1/8 the space needed by the RB-53.

Consisting of a BULK METAL film on a ceramic substrate, this new series V-53 resistor has a max. temperature coefficient of (-) 10 ppm/°C over the range of −55°C to +125°C, capacitance is only 3 pf, noise is non-measurable, all values will track to ± 3 ppm/°C without selection, tolerances to ± 0.02% are standard, and stability is 30 ppm/year.



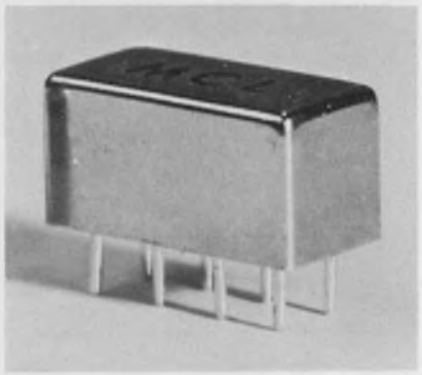
Section of Vishay Model M-53 Molded Resistor for direct RB-53 replacement.

The **Vishay** marketing group has no concern that a portion of their high precision resistor sales could be converted over to this new product line. One representative stated: "Although the V-53 costs less than the S102, I can't see engineers beating a path to their drawing boards to redesign S102 circuits to utilize this new V-53 series. Our S102 is a higher performance device having T.C. of ± 1 ppm/°C, tolerances down to ± 0.005%, and tracking of ± 1½ ppm/°C for all values without selection! I envision the V-53 taking over the precision wirewound market, not replacing our S102 applications."

Vishay Resistor Products, a division of **Vishay Intertechnology, Inc.,** recently expanded its Malvern, Pa., facility to 75,000 square feet; a portion of this expansion will be devoted to manufacturing this new low cost precision resistor.

INFORMATION RETRIEVAL NUMBER 78

1-GHz double balanced mixer costs only $14.95

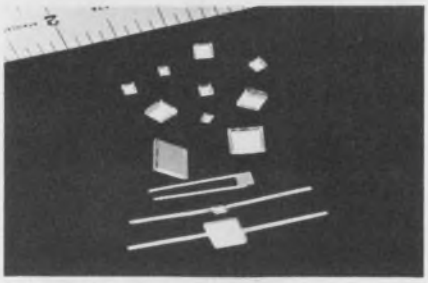


Mini-Circuits Laboratory, 2913 Quentin Rd., Brooklyn, N. Y. Phone: (212) 252-5252. Price: $14.95 (500 quantities).

Offering isolation greater than 45 dB over the lower portion of its 0.5 to 1000-MHz range and 30 dB at 1000 MHz, the inexpensive SRA-2 double balanced mixer exhibits a low conversion loss of 5.5 dB typical (7.5 dB at 1000 MHz). The unit is designed for PC-board mounting and is packaged within an emi-shielded metal enclosure. Its volume is 0.1 in. cube and it has a hermetically sealed header.

CIRCLE NO. 299

Rf ceramic capacitors shrink down in size



JFD Electronics Corp., 15th Ave. at 62nd St., Brooklyn, N.Y. Phone: (212) 331-1000.

Designed for use at frequencies up through microwave, new miniature ceramic-dielectric capacitors measure only 0.546-in. square by 0.172-in. thick. UFP series capacitors exhibit 8-A ratings at +25° C. Capacitance values are available from 10 to 3000 pF. Their leads are of flat fine-silver ribbons to carry high currents. Wire leads are also available.

CIRCLE NO. 301

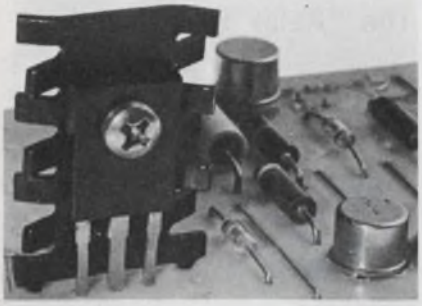
Diode/X-band oscillator optimized for mini-radar

General Electric Co., Microwave Devices Product Section, 316 E. 9th St., Owensboro, Ky. Phone: (502) 683-2401. Price: $146, $257.

A new GaAs bulk-effect diode and a companion X-band oscillator microwave circuit designated the Y-2109 and C-2070, respectively, are available for mini-radar and motion-detection studies. The Y-2109 Transferred Electron Effect Diode (TEED) and its C-2070 Microwave Circuit Module (MCM) feature low side-band noise and low-voltage operation. They are designed for systems operating at 10.5 GHz. Typical output power for the diode and oscillator is 100 and 50 mW, respectively.

CIRCLE NO. 300

Aluminum heat sink mounts parts vertically

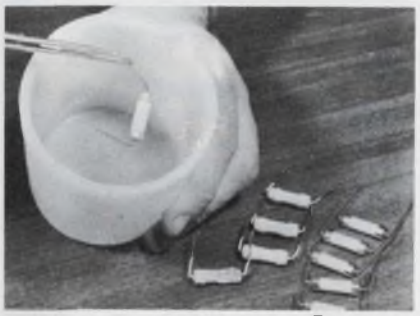


Thermalloy Co., 8717 Diplomacy Row, Dallas, Tex., Phone: (214) 637-3333. Price: 14 to 35¢.

An inexpensive aluminum heat sink accommodates most single-mounting tab and hole-through-case devices with vertical mounting. The model 6025 is a 1.75-in. high vertical cooler that requires only 0.25 by 0.875 in. of board space. It is available in black anodize, or nickel plate finishes.

CIRCLE NO. 302

High-temp coating withstands 3200°F



Aremco Products, Inc., Box 145, Briarcliff Manor, N.Y. Phone: (914) 762-0685. P&A: $40/kit (1 qt. paste, 1 qt. thinner); stock.

Cerama-Dip 538 is a single-component alumina ceramic-base adhesive coating that can be used at temperatures up to 3200°F. It is available in a paste form with a liquid thinner used to produce a soup-like thixotropic consistency. The material can then be brushed on, or a component dipped in the mixture.

CIRCLE NO. 303

Recording-head ferrites increase their density

Labtek, Inc., Box 103, Middleton, Mass. Phone: (617) 777-1233.

A family of high-density sintered ferrites are designed for uhf magnetic recording-head applications. Single-crystalline equivalent-surface finishes of 0.1 μ-in. can be attained without the usually characteristic edge chipping of single-crystal ferrites.

CIRCLE NO. 304

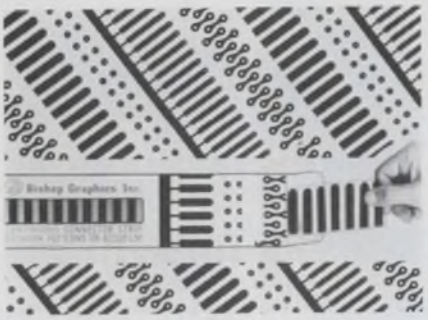
14-pin DIP sockets show 0.218-in. profiles

Vero Electronics, Inc., 171 Bridge Rd., Hauppague, N.Y., Phone: (516) 234-0400.

New 14-contact DIP sockets are designed with a low profile of 0.218 in. for high-density packaging. Their large tapered-entry channels aid IC insertion and reduce lead damage. Dual-leaf wiping contacts are available to accept round or flat leads.

CIRCLE NO. 305

evaluation samples



Connector patterns

A new line of continuous connector patterns is said to introduce several important advantages and time-saving features for designers, draftsmen and engineers preparing master artwork for printed wiring boards. Offered in varied scale sizes (1X, 2X and 6X), the line has seven basic patterns available in three basic connector types: insertion, staggered or in-line. Preprinted on Accufilm*, a special anti-static, stable-based, pressure-sensitive, 2-mil polyester film, the patterns are easy to fit and position before removing the backing material. Non-cumulative tolerances are guaranteed to ±0.002 in. over an 18-in. span. Accuracy exceeds IPC and Mil-Std 275 guidelines. A free sample and literature are available. Bishop Graphics, Inc.

CIRCLE NO. 306

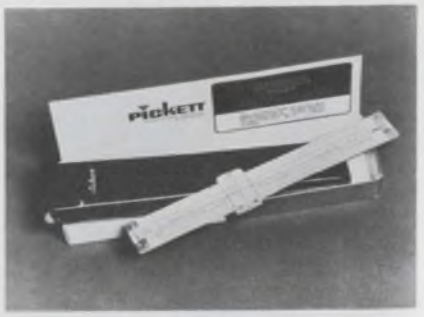
Wire terminals

Newly designed and low in cost, a line of ring and spade wire terminals in strip form are optimized for mass-production application. The terminals, in both rings and spades, are for use on wires ranging from AWG #16 to #20 and are available for stud sizes 2 to 10. Terminals are 0.16-in. thick and are of plain brass or are pretinned. Both insulation grip and non-insulation grip styles are available. Samples are available. Kent Corp. subs. of Thomas & Betts Corp.

CIRCLE NO. 307

* Trademark Bishop Graphics, Inc.

design aids



Electronic slide rule

Design engineers, technicians and students involved with circuitry and circuit design will find the new 535 electronic speed rule of particular use. In addition to basic mathematics, trigonometry and log problems, the speed rule can be used for circuit trigonometrics, determining frequencies, reactance, impedance, resonance and for determining the size and ratings of resistors and capacitors. Basic formulas and values are shown for easy reference on this $16.95 slide rule. Pickett Industries.

CIRCLE NO. 308

Corners template

The CornerGraph is a template for locating and drawing sharp square corners. Dimensions to both legs of the corner are marked anywhere along their lengths, the instrument is positioned, and the entire corner is drawn with a single pencil stroke along the inner edges of the template. There is neither overshoot and erasure nor undershooting and extending. Squareness and parallelism are within 0.01 in. It is available in three inside-size dimensions: 3-1/2 by 3-1/2 in., 6 by 6 in. and 9 by 9 in. Devonics Inc.

CIRCLE NO. 309

application notes

The "Relay Handbook"

The revised fifth edition of the "Designer's Handbook & Catalog of Reed and Mercury Wetted Contact Relays" is now available to qualified readers. This 120-page handbook assists the designer in specifying the proper reed relay for a given application. The book contains a glossary of relay terms, principles of operation, applications and design requirements and testing data. A separate section contains a catalog of new reed relays. For a free copy, write to: Magnecraft Electric Co., 5575 N. Lynch Ave., Chicago, Ill. 60630.

Microprogramming book

A 352-page handbook is available covering the subject of microprogramming in a practical and comprehensive manner. In precise terms, it tells how to microprogram, why the concept is effective and when it is most appropriate. Copies are available to those who write on their company letterheads to Microdata Corp., 644 E. Young St., Santa Ana, Calif. 92705.

Subscriber loop design

Voice-frequency subscriber loop design principles are described in detail in an engineering bulletin. The 68-page bulletin entitled "Principles of Voice Frequency Subscriber Loop Design" is used in conjunction with two subscriber line calculators showing the most economical combination of gauges, for a given distance, that meets all current transmission, pulsing and ringing requirements. In addition the bulletin describes design considerations of loaded and repeater loaded loops, expected performance of repeater loops, one-man tests for loaded loops, tabulated attenuation, resistance and miscellaneous loss data. Anaconda Wire and Cable Co., Communications and Electronics Div.

CIRCLE NO. 310

If you need rugged accuracy over a wide range of measurements... Buy Triplett's 630-NA

Model **630-NA** **$103**

1. **70-range V-O-M with single range switch and DC polarity-reversing switch.**
2. **Accuracy 1½% DC and 3% AC; mirrored scale.**
3. **Diode overload-protected suspension movement; temperature compensation.**

Its diode overload-protected suspension meter movement; simplified, long-scale, mirrored dial; and 70-range measurement capability to 6,000 V AC and DC, 12 A DC and 100 megohms demonstrate that Triplett's Model 630-NA V-O-M can handle practically any electrical measurement you may need.

All these features add up to 1½% DC accuracy (3% AC) and the ruggedness necessary to make this a take-anywhere tester that's ideal for design, maintenance, quality control and production applications.

It's a real value at $103 so see it right now at your local Triplett distributor. If you'd like 200,000 Ohms per Volt DC and 20,000 Ohms per Volt AC sensitivity rather than the 630-NA's 20,000 and 10,000 Ohms per Volt DC and AC, respectively, and you're willing to use a special high-voltage probe for the 3 and 6 KV ranges in order to get that extra sensitivity, ask your distributor for Triplett's Model 630-NS at $122. For more information, or for a free demonstration, see him or your Triplett sales representative. Triplett Corporation, Bluffton, Ohio 45817.

TRIPLETT

The World's most complete line of V-O-Ms . . . choose the one that's just right for you.

INFORMATION RETRIEVAL NUMBER 83

new literature

Newark catalog

A completely new 750-page electronics data book is the latest Newark catalog, a most detailed source on electronics and related components. Some 162 pages are devoted to directories, detailed listings with specifications, tables, charts and illustrations of ICs, transistors, diodes, rectifiers, micro and optoelectronics devices. Other components include tubes, resistors, potentiometers, controls, capacitors, switches, relays, fuses, circuit breakers, transformers, connectors, sockets, wire and cables, test instruments and meters. This publication is available to qualified readers. Newark Electronics.

CIRCLE NO. 340

Diode/microwave devices

A new 16-page brochure concisely summarizes pertinent specifications of a broad line of semiconductor diodes, transistors, and microwave modules. Hewlett-Packard Co.

CIRCLE NO. 341

DIP reed relays

A four-page product bulletin describes new DIP eight-pin reed relays. Magnecraft Electric Co.

CIRCLE NO. 342

Resistors

A revised catalog is available on on fixed-composition resistors. Airco Speer Electronics, Inc.

CIRCLE NO. 343

Tone controls

A new catalog describes modular tone controls—frequency-responsive switches, tone decoders and matching solid state oscillators. Douglas Randall, Div. of Walter Kidde & Co., Inc.

CIRCLE NO. 344

PC-board hardware

A new 12-page catalog describes a line of hardware components for users of PC boards, for both military and commercial applications. Calabro Plastics, Inc.

CIRCLE NO. 345

NBS time system

A proposed NBS TV time and frequency system is described in a 12-page booklet. The system proposes to distribute accurate time and frequency over the nation's commercial TV networks. National Bureau of Standards, U.S. Dept. of Commerce.

CIRCLE NO. 346

Used-computer blue book

A new blue book issue for used-computers lists market prices of all makes of computers. Time Brokers, Inc.

CIRCLE NO. 347

Indicator lights/LEDs

Indicator lights, LEDs and Incandescent lamps, in both miniature and subminiature sizes are shown in a catalog. General Illumination, Inc.

CIRCLE NO. 348

Bus bars

A complete technical bulletin covering bus bar design parameters, both electrical and mechanical, along with test data and dielectrics, is available. Eldre Components, Inc.

CIRCLE NO. 349

Detection/alarm products

A new 64-page catalog describes over 350 intrusion and fire-alarm products. The alarm equipment ranges from relatively simple open-loop hardware to the latest ultrasonic, radar, and IR intrusion detectors. The catalog features 6 pages of application notes. A general alarm system discussion is followed by notes on how to apply the many detector options. Some basic installation procedures are also presented. Mountain West Alarm Supply Co.

CIRCLE NO. 350

Thin-film coatings/optics

A 32-page catalog covers an entire line of thin-film coatings and precision optics. A conversion table for optical density vs transmission percentage is also included. Broomer Research Corp.

CIRCLE NO. 351

Rotary switches

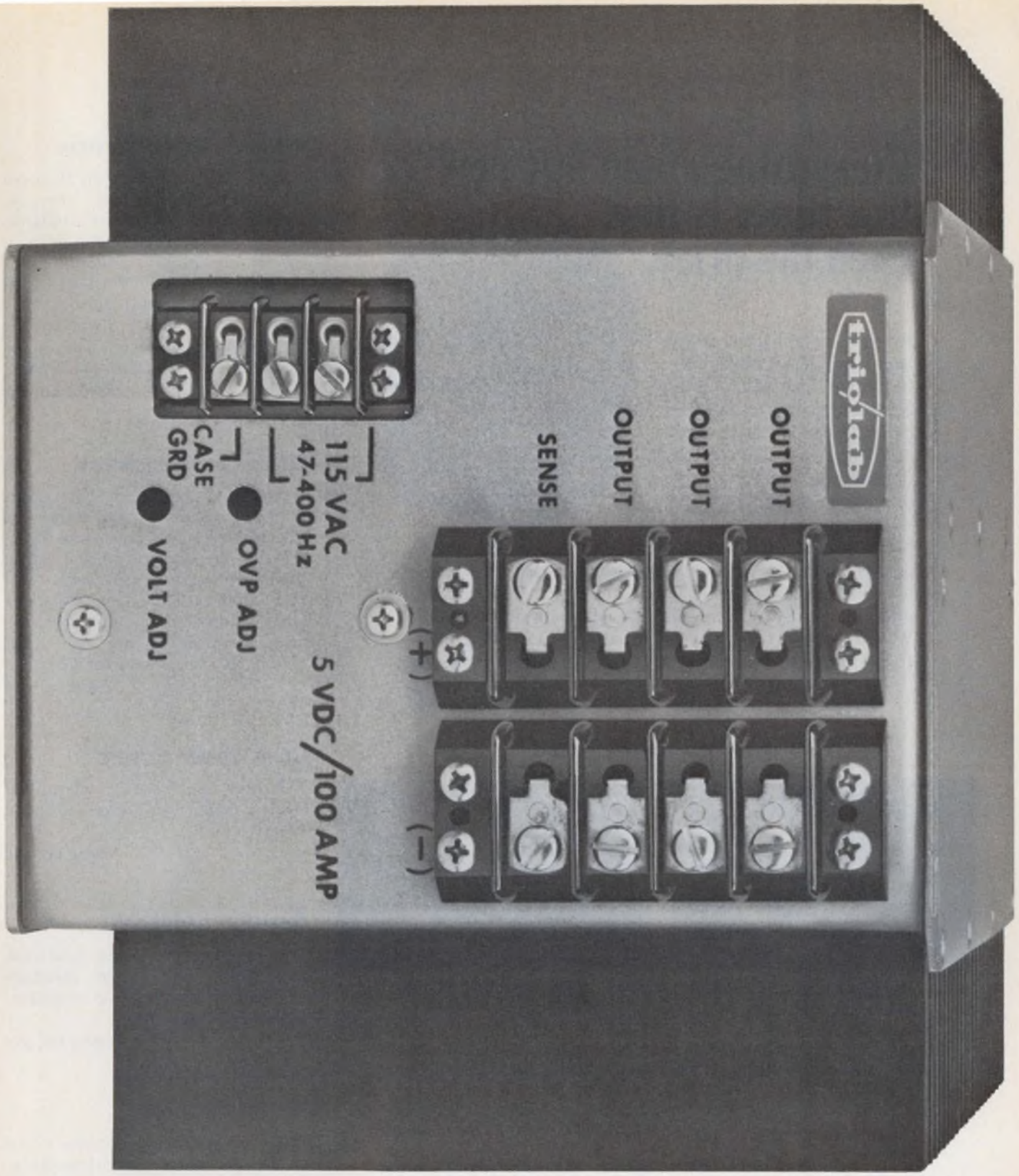
A complete set of rotary switch specifications and features are contained in a new switch handbook. RCL Electronics, Inc.

CIRCLE NO. 352

Semiconductors

A condensed semiconductor catalog shows an entire line of transistors, FETs, diodes, and linear, digital, hybrid and MOS ICs. The 72-page catalog lists significant parameters for each device. Teledyne Semiconductor.

CIRCLE NO. 353



Shown actual size.

WORLD'S SMALLEST 5VDC/100AMP POWER SUPPLY. Off-the-shelf.

The world's smallest 5VDC/100AMP supply gives you:

- Volume under 500 cubic inches! 8½" x 6¾" x 8¾"
- Lightweight. Less than 22 pounds.
- High Efficiency: 70% typical.
- Cool Operation. No forced air or external cooling for full rated output to 55°C.
- Low Cost. Priced lower than the large brute force supplies.

If our 500 watt supply overpowers your requirement, let us talk with you about our complete line of off-the-shelf high power density supplies, which offer you the same advantages as above: small size, lightweight, high efficiency, cool operation, low cost.

They come in single, dual, and triple outputs with voltages from 5VDC to 30VDC. Military and Export models also available.

We also custom develop/produce to specific needs. Call collect — or write Dept. ED

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80 Dupont Street, Plainview, L.I., N.Y. 11803
Tel: (516) 681-0400 TWX: (510) 221-1861

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INFORMATION RETRIEVAL NUMBER 84

Western Union services

New brochures on two Western Union communications services, Mailgram and Telex, are available. One brochure explains Mailgram, a new economical telegram-letter service developed by Western Union and the U.S. Postal Service. The other describes Telex, a world-wide, direct-dial teleprinter-to-teleprinter exchange service. Western Union.

CIRCLE NO. 354

Microwave transistors

A 14-page brochure lists minimum-performance parameters of a line of microwave transistors. These include frequency, noise figure, gain compression and power output. Application notes, S-parameters, suggested circuits and free sample transistors are also available. KMC Semiconductor Corp.

CIRCLE NO. 355

Quad power drivers

A new engineering bulletin describes quad power drivers. Sprague Electric Co.

CIRCLE NO. 356

Resistor handbook

A 32-page expanded precision and power wire-wound resistors engineering handbook is available. RCL Electronics, Inc.

CIRCLE NO. 357

Ferrite magnets

A revised catalog describes a line of hard ferrite permanent magnets. Arnold Engineering Co.

CIRCLE NO. 358

Modular power supplies

An expanded catalog contains information on plug-in power supplies. These include rack-mounting, premium-performance, low-profile, miniaturized, dual-output and unregulated models. Acopian Corp.

CIRCLE NO. 359

Lab measurement system

An eight-page catalog contains information on a versatile, low-cost electrical/electronic measurement system. Basic components, arranged for easy interconnection, provide Wheatstone, Kelvin, inductance or capacitance bridges; differential voltmeters; millivolt potentimeters and ac-dc transfer units. They also provide lead and phase compensators; inductive voltage dividers; programmed dc sources and sine, square or triangle-wave sources. Laboratory Systems Research, Inc.

CIRCLE NO. 360

Relays/coils

A 48-page catalog describes a line of relays and coils. Solid State Electronics Corp.

CIRCLE NO. 361

Semiconductor materials

"Materials for Semiconductor Applications" catalog covers new products used in the manufacture and research of solid state devices. Transene Co.

CIRCLE NO. 362

Sample-hold module

A two-page sheet describes in detail electrical and mechanical specifications for a sample-and-hold module. Varadyne Systems.

CIRCLE NO. 363

DPMs and DMMs

A revised short-form catalog includes the latest products in a line of digital panel meters and multimeters. Digilin, Inc.

CIRCLE NO. 364

Conductive elastomer

A data sheet describes an electrically conductive silicone elastomer formulated to provide high to moderate conductivity. Technical Wire Products, Inc.

CIRCLE NO. 365

Design Data from Manufacturers

Advertisements of booklets, brochures, catalogs and data sheets. To order use Reader-Service Card.

bulletin board

of product news and development

Tektronix, Inc. is **replacing its Scientist 909 calculator with the lower-cost and higher-performance model 909-01.** The new calculator reportedly increases the number of available program steps from 85 to 256 and has the same number of registers—26. It costs $3200 compared to $3780 for the 909.

CIRCLE NO. 366

Computek, Inc., Cambridge, Mass. has released a **software package** that supports its **series 400 line of interactive graphics terminals.**

CIRCLE NO. 367

MARTHA is a new group of general-purpose **computer programs for analyzing linear electrical networks.** The programs are available from APL General, Inc. of Trenton, N. J.

CIRCLE NO. 368

Fairchild Semiconductor has added **11 new silicon-gate circuits** to its line of **standard MOS ICs.** These include four character generators, two 2000-bit ROMs, five shift registers and two metal-gate devices.

CIRCLE NO. 369

Peripheral Equipment Corp., Chatsworth, Calif. has **reduced prices on its incremental tape transports,** across the boards, by up to 25%.

CIRCLE NO. 370

Wesco Electrical Co., Inc., Greenfield, Mass. has announced **up to 50% price reductions on its standard 32MPC metalized polycarbonate capacitors.**

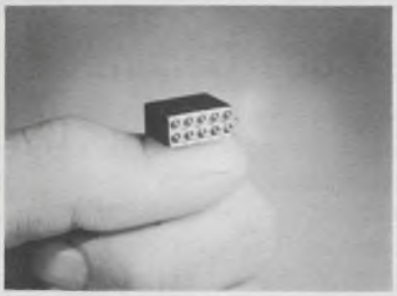
CIRCLE NO. 371

Video Systems Corp., Pennsauken, N. J. has **reduced the price of its VST-1200 CRT data terminal from $2760 to $1795.**

CIRCLE NO. 372

quick ads

New and current products
for the electronic designer
presented by their manufacturers.



Smallest latching relay with 1 Amp contacts meets MIL specs. Coils for 6, 12, 24 VDC. Other QPL Relays to MIL-R-5757/19 and MIL-R-5757/90. Send for free catalog. Branson Corp., Box W, Denville, N. J. 07834. Phone: 201-625-0600.

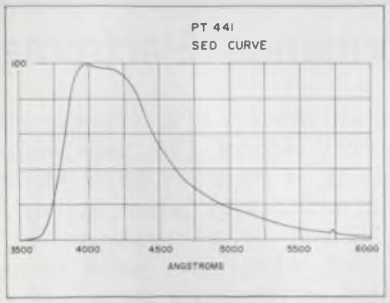
INFORMATION RETRIEVAL NUMBER 181

Low-Cost Internally bussed terminal connectors feedback or feedthrough styles designed to accept insertable/removable pin contacts, crimp terminated to 16, 18 or 20 AWG. wire. All terminations protected within the dielectric body. Combinations are available to your requirements. Appleton Electronics Div., 1701 Wellington Ave., Chicago, Ill. 60657.

INFORMATION RETRIEVAL NUMBER 182

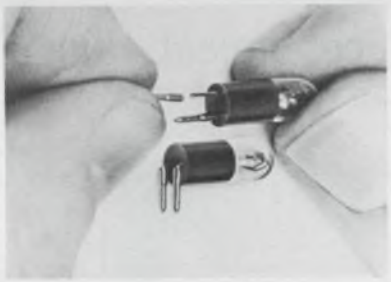
Program all fusible-link programmable ROMs manually with the Model 300. Designed with a 4096 bit (512 words x 8 bits) capacity. Both 115 VAC and 220 VAC versions available. Spectrum Dynamics, Inc., 2300 East Oakland Park Boulevard, Ft. Lauderdale, Florida. Phone (305) 566-4467 or 566-2547.

INFORMATION RETRIEVAL NUMBER 183



New fast decay CRT screen. A new long life phosphor screen is available with a decay time of 80 nanoseconds and with an efficiency substantially higher than standard P-16. Available in a wide variety of CRTs for scanners and readers. Thomas Electronics, Inc., 100 Riverview Drive, Wayne, N. J. Phone: (201) 696-5200.

INFORMATION RETRIEVAL NUMBER 184



Tu-Pin Lamps soldered to PC Board Unplug for Replacement. When the lamp must be replaced, it is simply unplugged, leaving the gold plated pin sockets behind firmly soldered to the PC board and ready to receive a replacement. Hudson Lamp Co., Kearny, N. J. (201) 997-1850.

INFORMATION RETRIEVAL NUMBER 185

Dual-channel 5002A Oscilloscope offers simplified, stable triggering to beyond 50 MHz; internal delay line; 25-MHz bandwidth. Rugged, compact design for complete portability. Easy-to-use front panel controls. Value priced at $845. Hickok Electrical Instruments. Cleveland. Call collect: (216) 541-8060.

INFORMATION RETRIEVAL NUMBER 186

UNIVERSAL TIMING CIRCUIT: TA-6030 23-stage array, providing customer specified metalization, operates from 1.3-volt mercury cell to 15-volt battery. For wrist watches, wall, automobile, or digital clocks, etc. COS/MOS achieves low power, high noise immunity. RCA Solid State Division, Somerville, N.J. Phone (201) 722-3200, ext. 3434.

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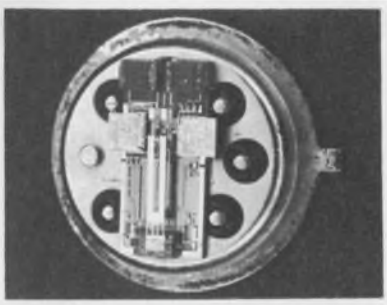

Ultra-miniature crystal oscillator and filter products are available from 10-100KHz in TO-5's or flatpacks, with as low as 10 micro amps consumption and O's of 2-40K. Products include timers from seconds to months, telemetry systems, clocks, signal processing filters, etc. Statek Corp., 1200 Alvarez Ave., Orange, CA 92668. 714-639-7810.

INFORMATION RETRIEVAL NUMBER 188

Digital logic probe indicates lows, highs, pulses, and open circuits. Features include power and input protection, detachable cord, high input impedance, replaceable tip, dual lamps at each tip. Models 5 Vs (5 nsec) $75, 5 Vs-c 10 nsec $45 in single quantities. Concept Designs, Box 1167, Sunnyvale, Ca. 94088. (408) 732-2252.

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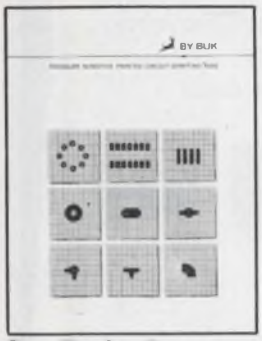
PC Drafting Aids Catalog



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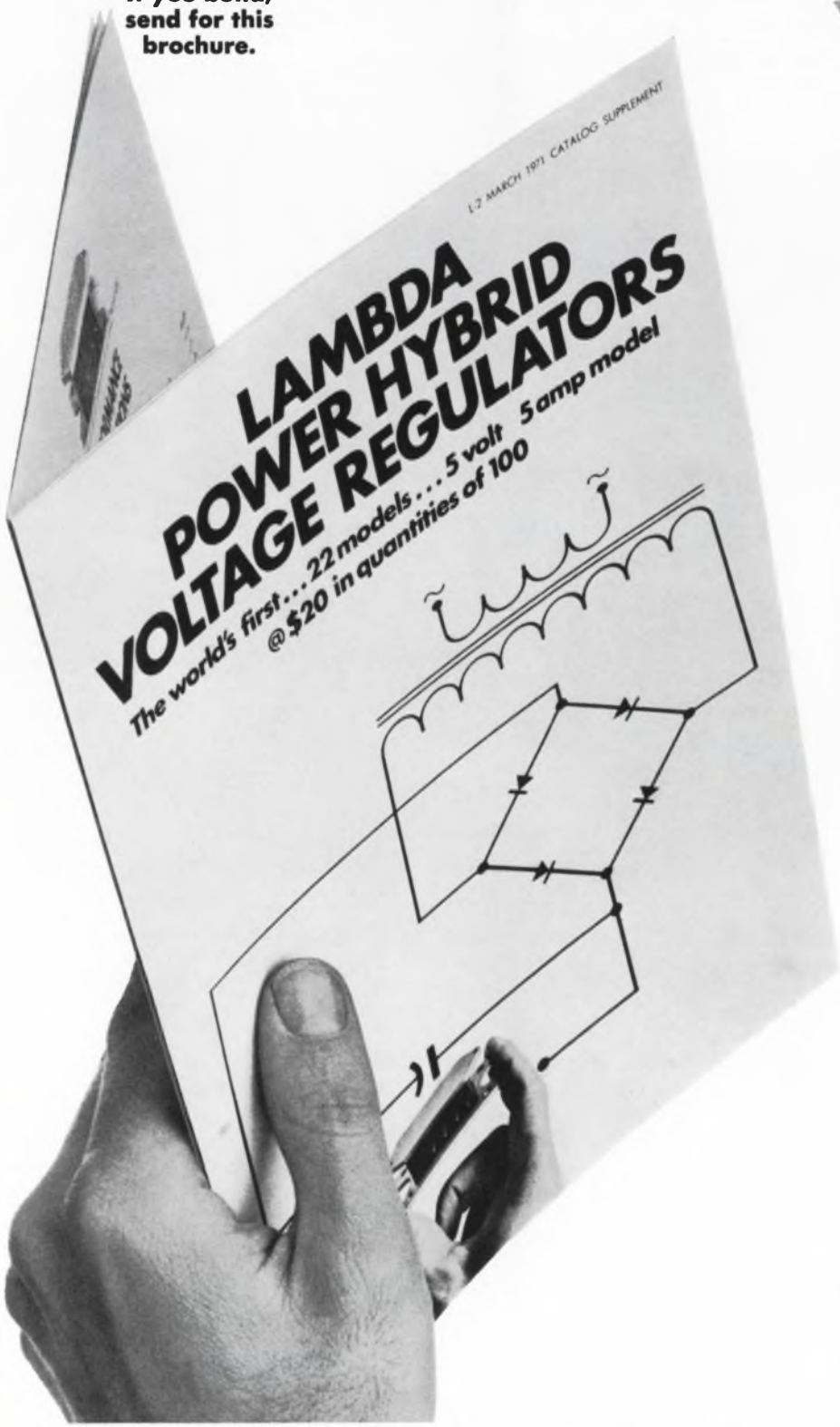

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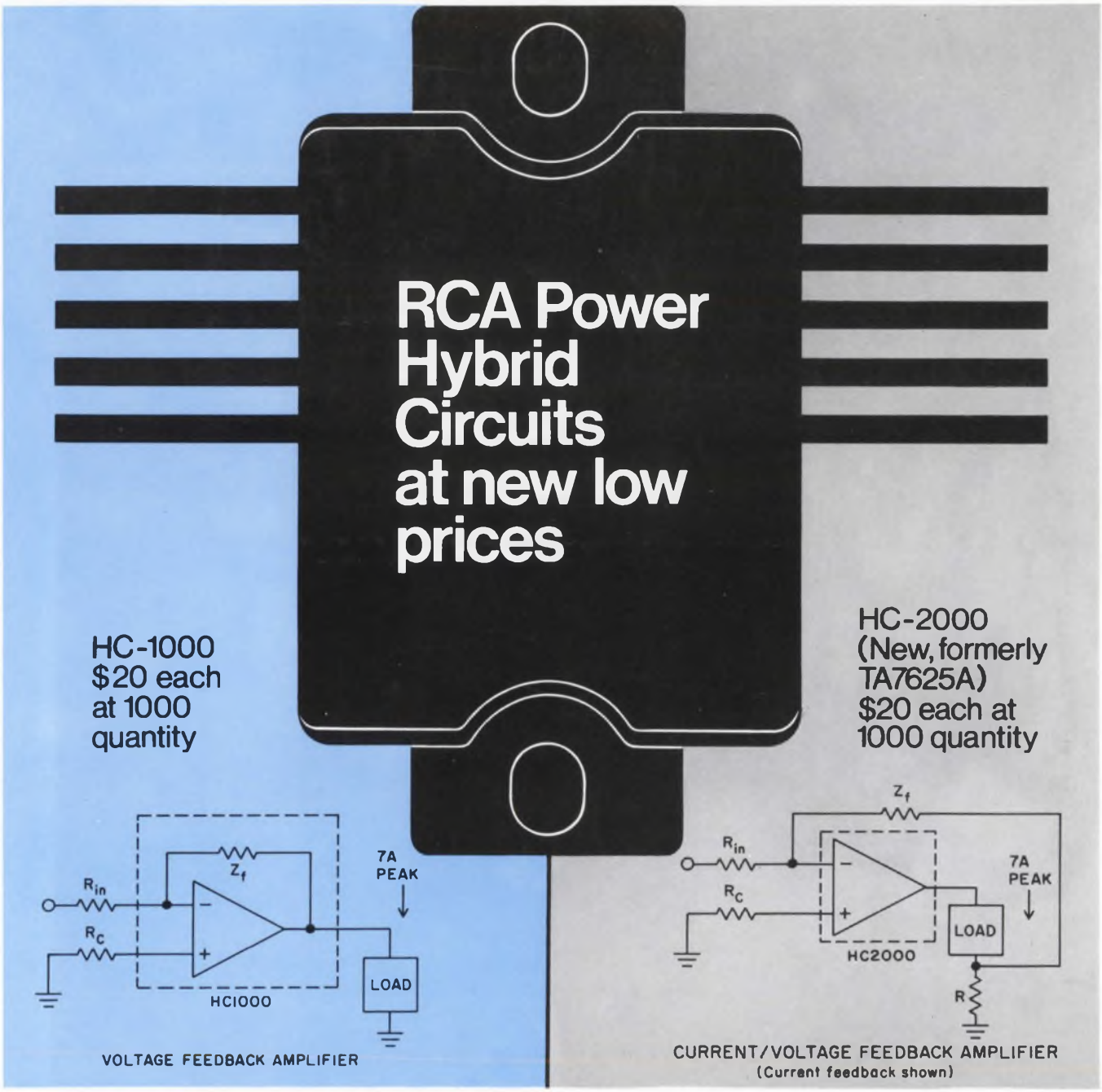

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