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June 22, 1970

Electronics

Implanted ions lower MOS threshold

GR knocks down the price of Frequency Synthesizers!

Across-the-board price changes now offer you the chance to pick up just the synthesizer you need at the lowest prices ever!

GR's fully equipped synthesizers (including 7 programmable digits and a continuously adjustable decade) have been reduced by as much as 26%. For instance:

- The 1161 and 1162 Synthesizers, with respective frequency ranges of 0 to 100 kHz and 0 to 1 MHz, are now only $4990.
- The 1163, with 30-Hz to 12-MHz range, is reduced to $5290.
- The 1164 (10-kHz to 70-MHz range) is now $7195.

If you don't need fully equipped models, you can compound the savings by omitting some of the features. You can save $300 if you have no need for the continuously adjustable decade. Or you can order your synthesizer with as few as three digits — subtract $230 for each digit you leave out.

These are the same synthesizers you wanted before because of their specifications — now they're even better because economy has been added to quality! Even with the new lower prices you still get a room-temperature quartz-crystal oscillator with a temperature coefficient better than $2 \times 10^{-7}/^{\circ}C$, 200-$\mu$s switching time, rms phase-noise modulation as low as −70 dB, spurious signals down 60 dB and beyond, and compact size (only 5½ inches high)! It's a buyer's market!

If you're looking for performance up to 160 MHz without an oversized price tag, GR also has the 1165 Synthesizer for only $5900.

Complete pricing information and specifications are available from the General Radio District Office nearest you or from our home office at 300 Baker Ave., West Concord, Mass. 01781. In Europe write Postfach 124, CH 8034, Zurich, Switzerland.

Prices apply only in the U.S.A.

GENERAL RADIO

ATLANTA 404 633 6183 / BOSTON 617 646-0550 / CHICAGO 312 992-0800 / CLEVELAND 216 886-0150
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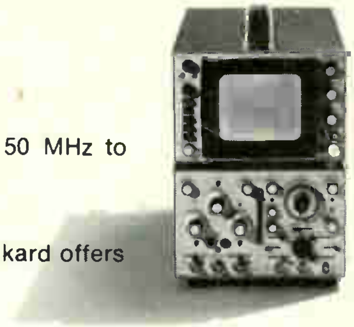
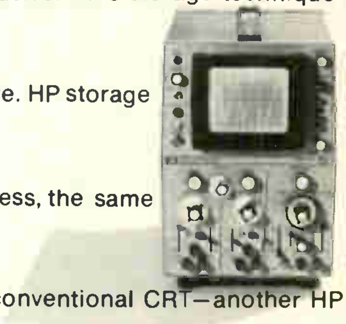
Circle 900 on reader service card

Need A Scope That Remembers?



☐ If you make real-time measurements in the 50 MHz to 100 MHz frequency range, here's something for you to remember: Only Hewlett-Packard offers a storage scope with bandwidth capabilities in these frequencies. In addition to this exclusive capability, Hewlett-Packard offers a scope that remembers sampling displays and spectrum analysis displays. ☐ If you want low-frequency, high-sensitivity in a low-cost scope that remembers, HP has it, too. ☐ In all the HP scopes, at the twist of a knob, you can vary persistence—an HP exclusive. HP's storage technique allows you to store gray shades for complete Z-axis information—another HP exclusive. HP storage CRT's use industry-standard, aluminized, P-31 phosphor; so you get the same brightness, the same burn-resistance, the same writing speed, the same operating life you get with a conventional CRT—another HP exclusive. And, HP storage CRT's are the only ones with an internal graticule to eliminate parallax. ☐ With an HP storage scope, you really get three scopes in one. Use it to store, or to vary display time, or as a conventional scope. Choose a 180 or 140 series storage oscilloscope with plug-ins which match your high frequency needs. Choose the low-cost 1200 series for your low-frequency measurements. ☐ For application information on HP scopes that remember, contact your local HP field engineer.



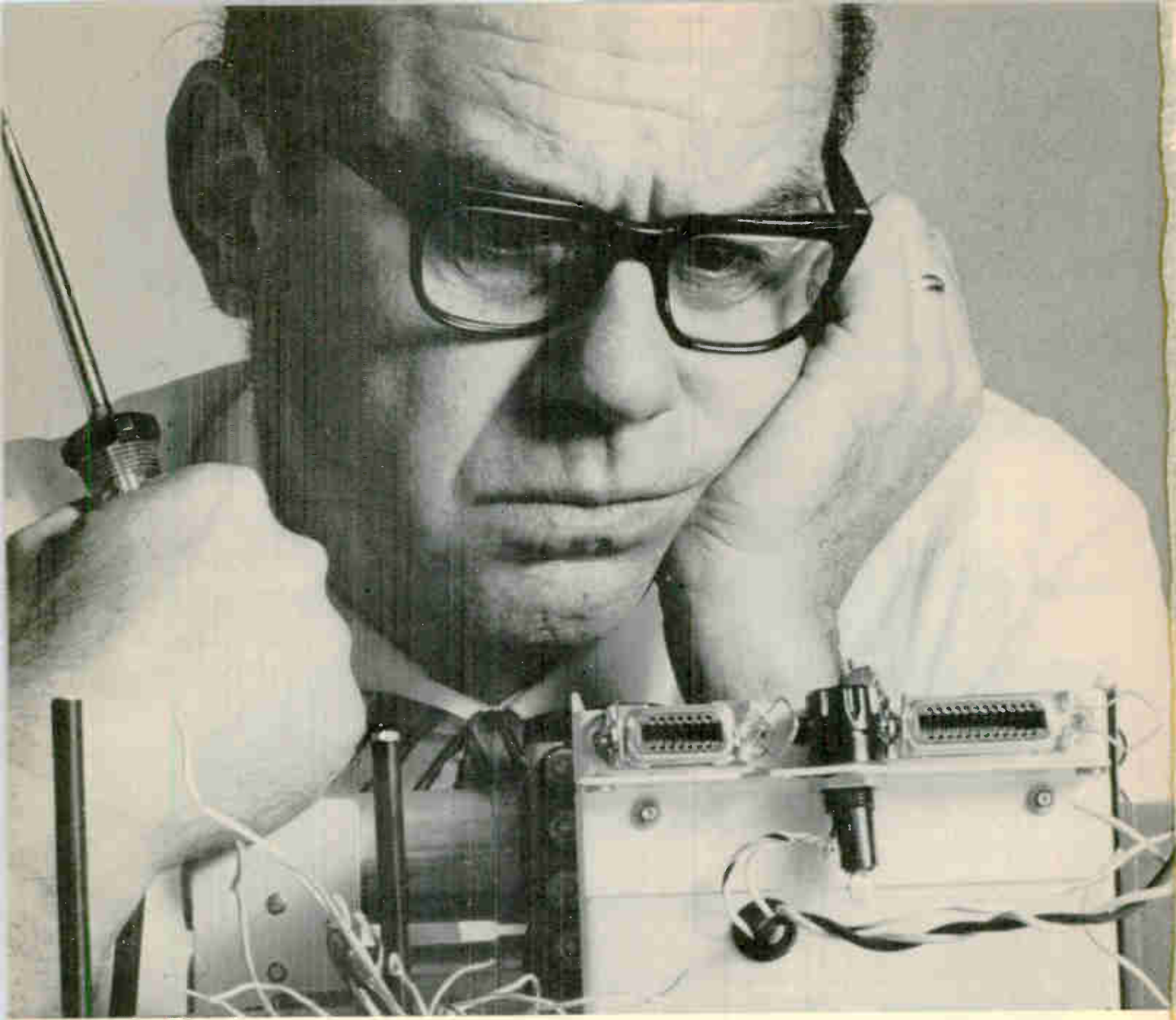
080/5

Or, write to Hewlett-Packard, Palo Alto, California 94304.
Europe: 1217 Meyrin-Geneva, Switzerland.
Prices: HP 141 Mainframe, $1395 or $1500;
HP 181A Mainframe, $1850; HP 1200 Series, $1550 or $1900.

HEWLETT hp PACKARD

OSCILLOSCOPE SYSTEMS

Circle 194 on reader service card



HP instrumentation recorders work with hours less downtime. How much is <u>your</u> time worth?

When you're putting instrumentation measurements on tape, the last role you want to play is maintenance man. And who can afford all those time-wasting adjustments? Hewlett-Packard's instrumentation recorders are so reliable they require up to five times less routine maintenance than most machines. Both the HP 3950/3955 Series Systems for lab use and the lightweight HP 3960 portable for the field have what it takes to make you more researcher and less caretaker.

You won't be plagued by misalignments that cause you slowdowns on other recorders. Tape transport components on all HP machines are mounted to a single, rugged cast-aluminum frame that's precision machined to assure permanent alignment. So you'll never have to make shimming or other adjustments in the field. You can use the time you gain for more rewarding work.

Both the IRIG-compatible lab models and 50-pound portable feature a simple, uncluttered tape path that lets you clean head assemblies in just seconds. Even mounting of tape reels and tape threading goes easier and faster with a snap-on reel hub assembly.

Whether you choose the interchangeable 7 or 14-track lab models or the economy 4-track portable, you'll have high-performance recorders that will sharply reduce your operating costs.

To that, add the initial low price that comes with HP quality electronics. If you want to see what these recorders can do, it's easy to set up. Your local HP field engineer will be happy to demonstrate the wide uses of these recorders in the medical, scientific and industrial fields. Call him. Or write Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

HEWLETT hp PACKARD

MAGNETIC RECORDERS

42004

Circle 2 on reader service card

Electronics

Volume No. 43, Number 13 June 22, 1970

Features

Probing the News

U.S. Reports

Electronics International

New Products

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Readers Comment

Feels left out

To the Editor:

Upon reading your interesting and informative article about metal oxide semiconductor calculating techniques [May 11, p. 104], I was somewhat dismayed to observe the exclusion of the General Instrument Corp. from the bibliography listing MOS ROM manufacturers.

I would like to point out that General Instrument has been a leading supplier of read-only memories for all applications for the past two and a half years. We have delivered quantities of custom and standard product ROM's to do arithmetic calculations, character generation, code conversion, and sequencing functions.

The company's proprietary metal thick-film nitride semiconductor process now allows the manufacture of ROM's as well as other large-scale integrated circuits with direct transistor-transistor logic compatibility (no external components required); in addition, higher ambient temperature and reliability are possible.

Since General Instrument continues to actively pursue ROM business, we would be remiss were your oversight to pass unnoticed.

Stan Schiller
Eastern MOS application manager,
Microelectronics Division
General Instrument Corp.
Hicksville, N.Y.

Background on strapdown

To the Editor:

In your Washington Newsletter [March 30, p. 81], you refer to the strapdown guidance being studied for the space shuttle and mention, "the only use of strapdown on manned spacecraft was Hamilton Standard's backup system on the lunar module."

The backup system for the lunar module, also known as the abort guidance system, was designed and manufactured by TRW Systems group for the Grumman Aerospace Corp. It is the first strapdown system ever to be used in space and did an exemplary job helping to return Apollo 13 astronauts safely to earth. Its operational flexibility with low power consumption caused it to be favored over the primary guidance system for the operational emergency.

The sensor unit, or abort sensor assembly, of the AGS was indeed manufactured by the Hamilton Standard Systems center under contract to TRW.

D.L. Meginnity
Project manager,
Lunar module abort guidance systems
TRW Inc.
Redondo Beach, Calif.

Presses for sound

To the Editor:

I was intrigued by your article on Compressed Multisound [June 8, p. 61]. Why couldn't this principle be used for stereo audio? Future sets could incorporate the necessary circuitry. For compatibility with existing sets, television stations could combine the two channels and broadcast in mono as they are now doing.

B.F. Johnson
Portland, Ore.

June 22, 1970 Volume No. 43, Number 13
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4SC-9153R2

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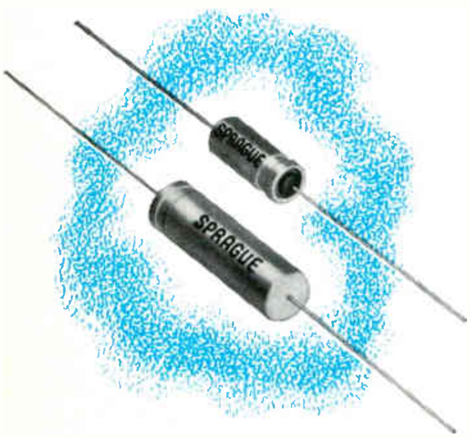

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SPRAGUE®
THE MARK OF RELIABILITY

THE BROAD-LINE PRODUCER OF ELECTRONIC PARTS

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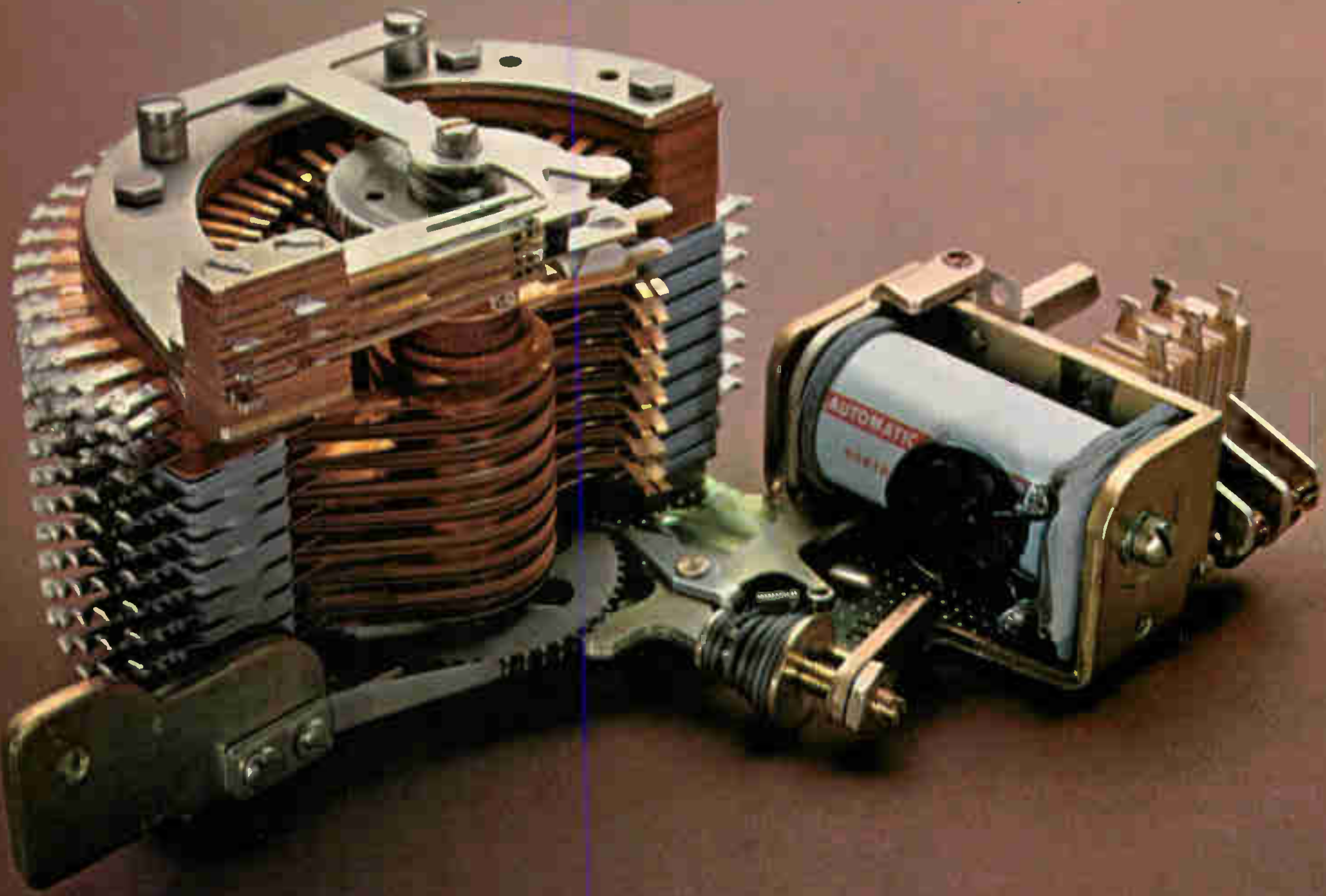
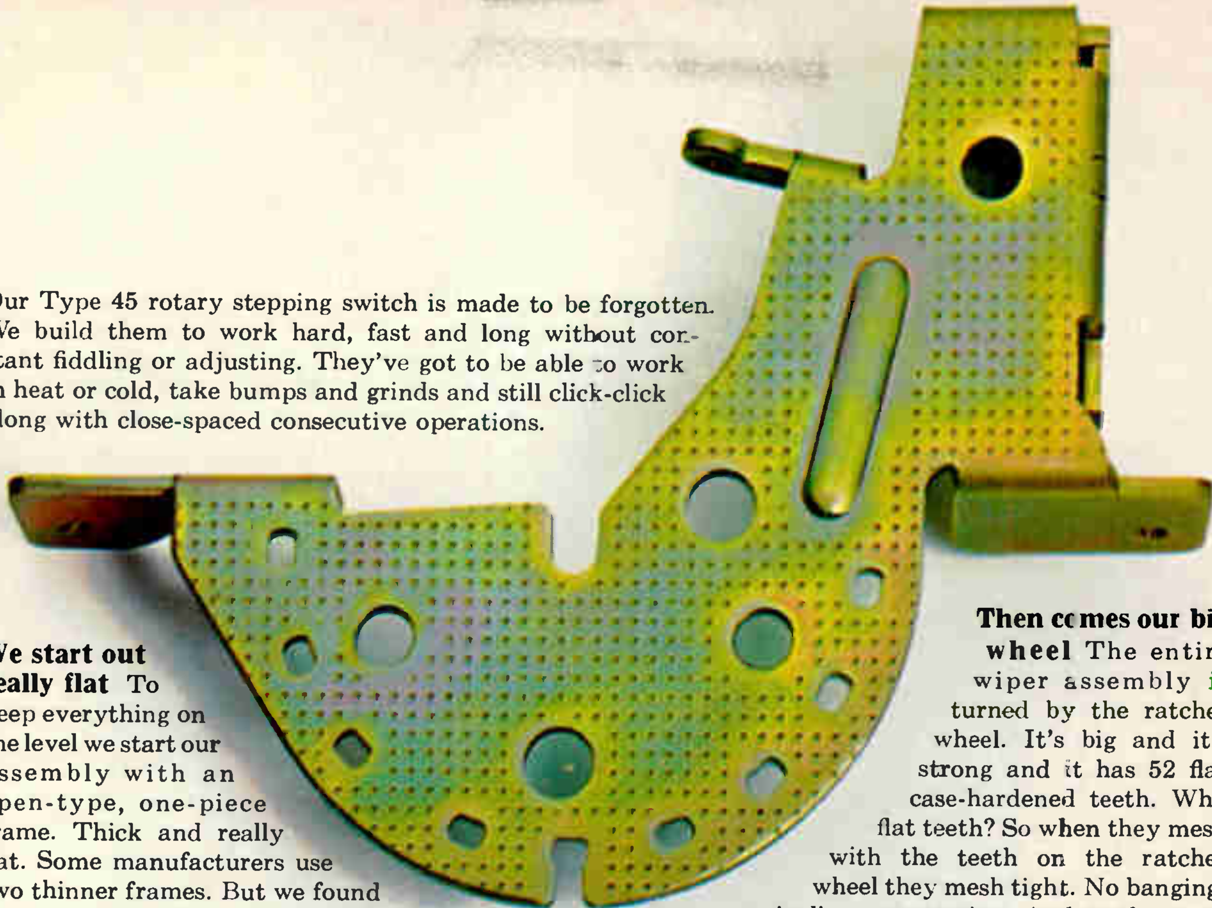
Reliability is a single-sided frame, a ball and a cricket room.





Our Type 45 rotary stepping switch is made to be forgotten. We build them to work hard, fast and long without constant fiddling or adjusting. They've got to be able to work in heat or cold, take bumps and grinds and still click-click along with close-spaced consecutive operations.

We start out really flat To keep everything on the level we start our assembly with an open-type, one-piece frame. Thick and really flat. Some manufacturers use two thinner frames. But we found that starting with a single thick frame eliminates problems of matching the switch parts. Everything stays in line. And a single-sided frame takes a lot less room—the switch is only as wide as need be.

A lube job that lasts a lifetime The entire wiper assembly rotates on a large-diameter stainless steel shaft around a full-length hub bearing. We lubricate this bearing and seal it during assembly. So throw away the oil can.

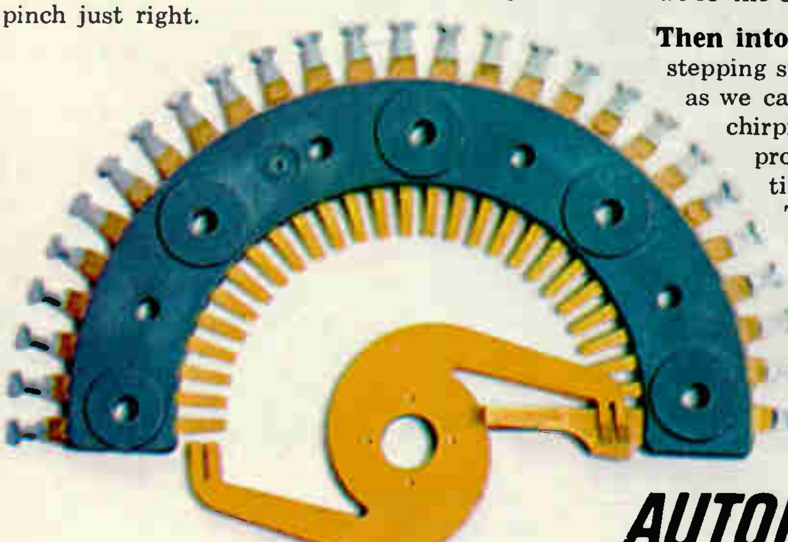
Then we supply a pinch that's just right Each pair of wipers is tension-adjusted during assembly. As they click around the bank levels on a flat plane, we want each pair to pinch the contact just the right amount. Too hard a pinch and the contacts will wear out quickly. Too soft a pinch will cause a poor connection. We teach our wipers to pinch just right.

Then comes our big wheel The entire wiper assembly is turned by the ratchet wheel. It's big and it's strong and it has 52 flat case-hardened teeth. Why flat teeth? So when they mesh with the teeth on the ratchet wheel they mesh tight. No banging, wiggling, or scraping. And as the teeth wear, they just mesh deeper in the grooves.

Ball bearing anchor for good measure The armature assembly has to be securely fastened to keep it from wiggling up and down, or everything goes out of whack. So we choose a big stainless steel pin and secure it with wide bearings to the armature yoke. To make sure this pin never slips out of the yoke, we drill a hole in both ends. Then we force a steel ball bearing into these holes. This expands the walls of the pin into and against the walls of the armature and the whole assembly is anchored for life. We're the only ones that do it this way. So we're the only ones that offer a lifetime fit.

Then into our cricket room Every single AE stepping switch goes to the run-in test room. Or, as we call it, the cricket room, because of the chirping noise all the switches we're testing produce. Here, every switch is tested 50 times a second for 45,000 operations. Then, and only then, are they ready for delivery to our customers.

Now that we've explained all the little things we do to make our Type 45 reliable, put it through your own tests. Industrial Sales Division, Automatic Electric Company, Northlake, Ill. 60164.



AUTOMATIC ELECTRIC
GENERAL TELEPHONE & ELECTRONICS

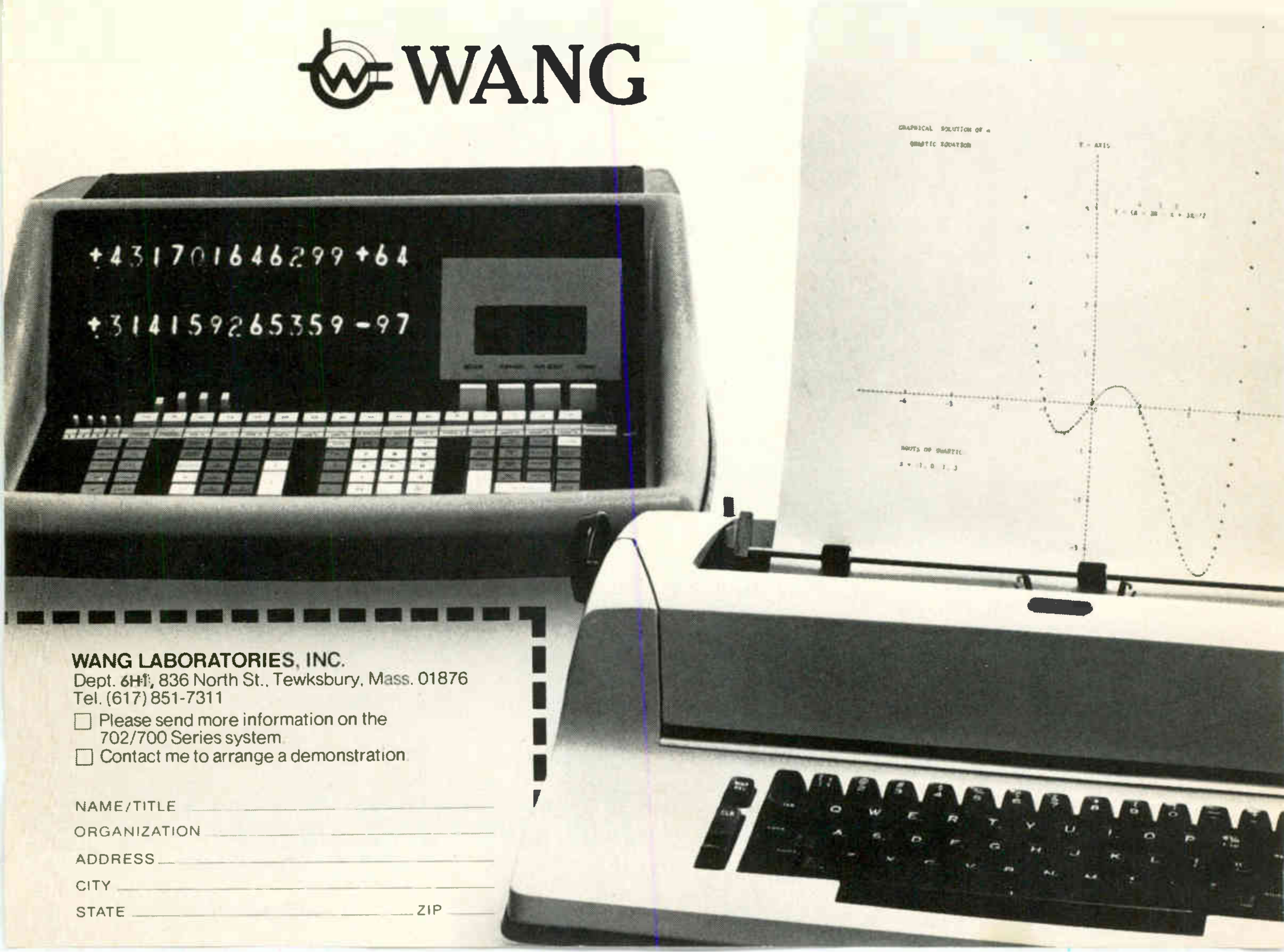
Circle 7 on reader service card

A well calculated plot.

Wang unites digital plotting (x,y) and data printout with the world's most powerful computing calculator.

The result is a personalized small computing system with unmatched convenience and capabilities. Combined with a *Wang 700 Series calculator*, the *702 Plotting Output Writer* can provide fully formatted graphic output including plots, heading, labels, and numeric notations as well as tabulated data. It eliminates the need for time-consuming correlations from various printout media and reduces the possibility of error. The calculator offers you a choice of 120 to 248 data registers for memory. And programs may vary in length from a few steps to as long as 960 or 1984 steps per block on tape cassettes. If you're intrigued, we'll give you more information on this fast-moving plot.

WANG



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Dept. 6H1, 836 North St., Tewksbury, Mass. 01876
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☐ Please send more information on the 702/700 Series system.
☐ Contact me to arrange a demonstration.

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Who's Who in this issue

Rivera　　Dierking　　Ranalli　　Bourbon

Four men got together at Autonetics to write the Syscap program article that starts on page 74. Bruce R. Bourbon and William H. Dierking are still with Autonetics. Edward Rivera was at Autonetics before moving to NCR. And Ralph Ranalli, the other Autonetics veteran, now is general manager of Rohe Scientific Corp. and Shurtronics Corp.

Palmer　　Macdougall

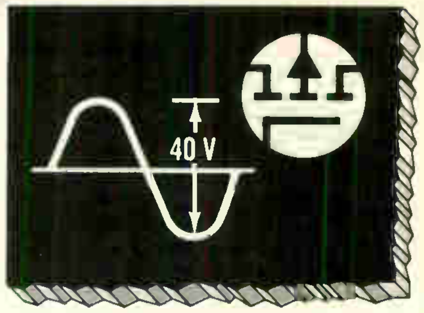
Manchester

Three's not a crowd when the three are authors of an important article like the one on ion implantation that starts on page 86. Both John D. Macdougall and Kenneth E. Manchester are with Sprague Electric Co., where they have been active in ion implantation. Bob Palmer is a founder of Mostek Corp., where he's manager of R&D.

Meilander　　Fulmer　　Rudolph

With a collective 62 years in computer R&D behind them, the authors of the associative memories article that begins on page 96 are qualified to write it. All are with Goodyear Aerospace, where J. A. Rudolph is a manager, L. C. Fulmer works with associative processors, and W. C. Meilander has contributed many ideas to associative memories research.

←Circle 8 on reader service card

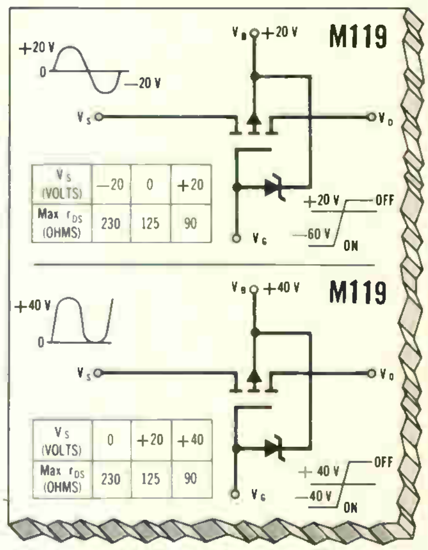


75 VOLT MOS FET SWITCHES

Problem: You need a MOS FET switch that will stand large analog signals and high overvoltages.

Solution: The new Siliconix M119 P-channel MOS FET with 75 volt source-drain breakdown.

These circuits show biasing for ±20 V and 0 to +40 V analog signal operation.



Write direct for further information and the data sheet on this newest Siliconix MOS FET!

Siliconix incorporated

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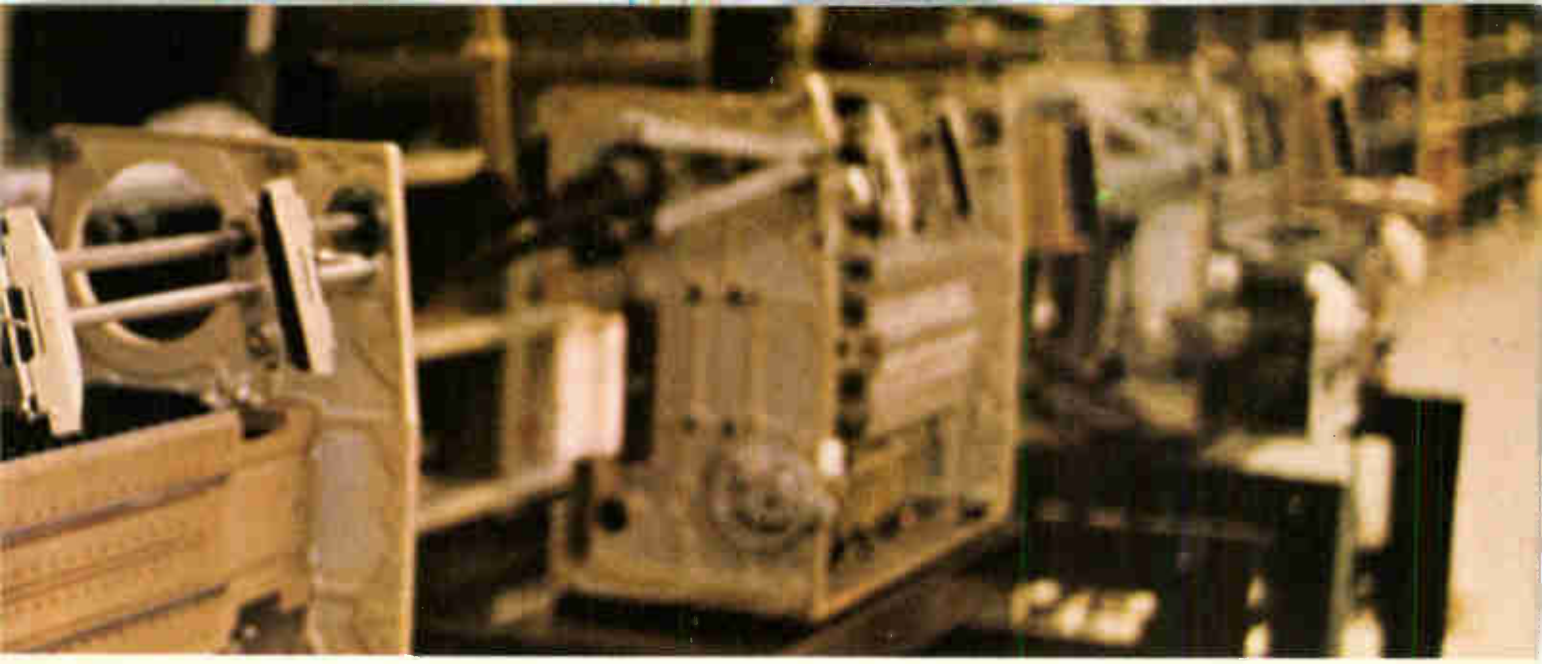
In Europe: Siliconix Limited, Saunders Way, Sketty, Swansea, Great Britain

Circle 9 on reader service card

"No one made a small, quiet, medium-speed chain printer for $9500. So Mohawk did."

George C. Hohl, OEM Marketing Director, discusses a new product.



"We saw a gap in the printer field. Either you paid a lot of money to get a lot of speed and sophistication, or you could pay a little and get very little in return. We decided to aim our printer somewhere in between.

"Chain printers are mechanically simpler, easier to maintain, less expensive. Their flat face characters give good print characteristics, too.

"Our design requirements were rough. We wanted 300 lines-per-minute with such niceties as easily changeable fonts, and yet we wanted to sell it for less than $10K. It had to be small, and yet we couldn't lose accessibility. The design engineers grumbled, but they made it.

"The changeable font cartridge is great—an operator can quickly switch the font chain—and we're offering fonts from 16 to 128 characters.

"We designed a disposable ribbon cartridge to make ribbon changes quick and clean. Paper handling is enclosed to stay clean, too. And everything that could be modularized, was modularized.

"We considered noise reduction vital—anyone who has worked in a printer room knows why. Well, compared to other printers, you'd hardly know this one was working.

"We're selling the printer for $9500 in OEM quantities, and some variations cost even less. So you get a lot of performance in a very little printer—for very little money."

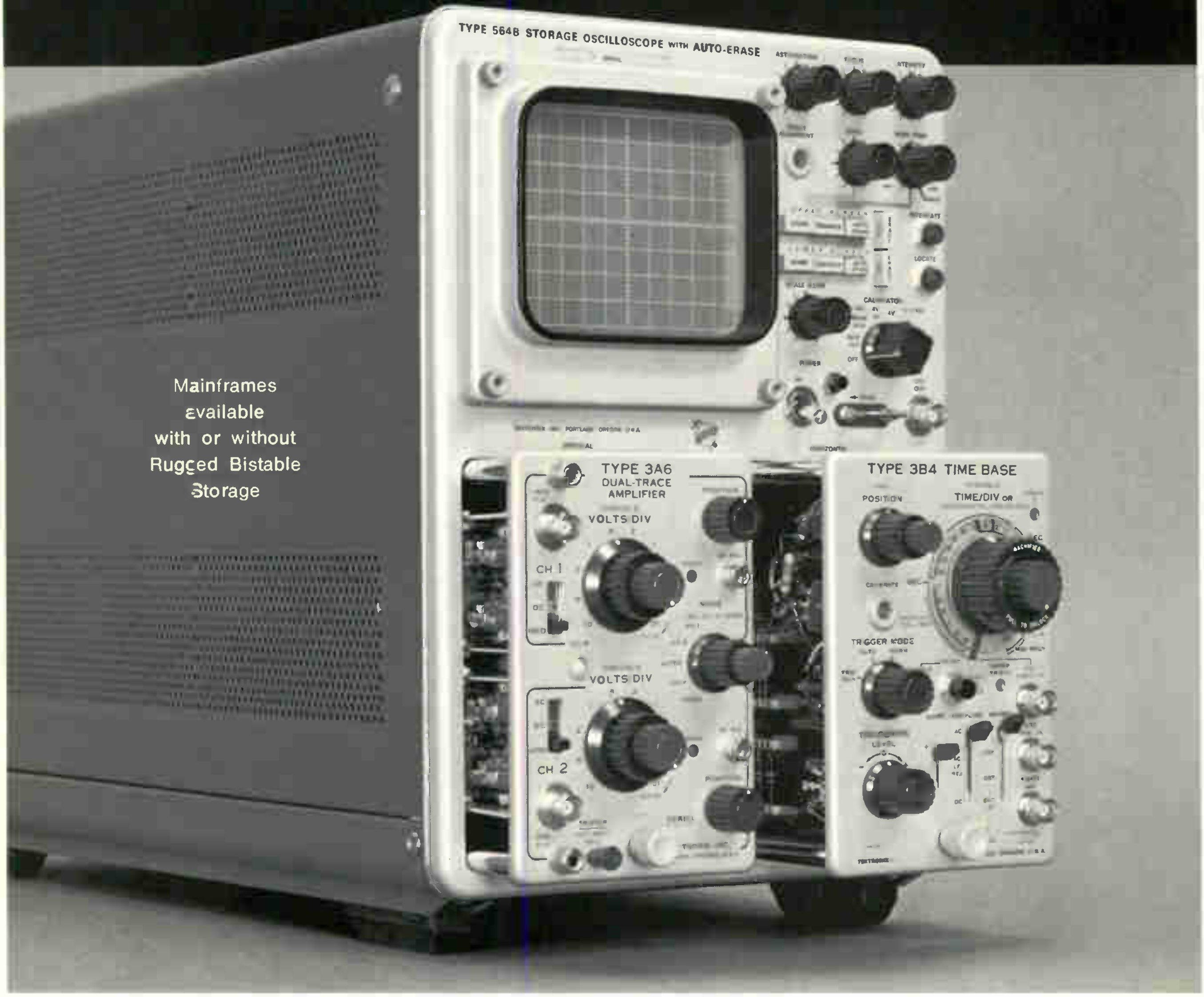
Mohawk Data Sciences Corp.
Herkimer, New York

OEM MARKETING CENTERS: CORPORATE (315) 867-6475; NORTHEAST (617) 891-5870; SOUTHEAST (404) 631-3443; CENTRAL (312) 298-4141; WEST COAST (213) 685-5165.

Tektronix

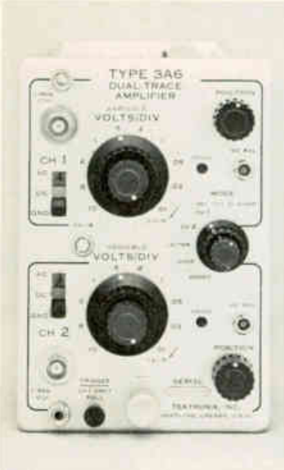
PLUG-IN

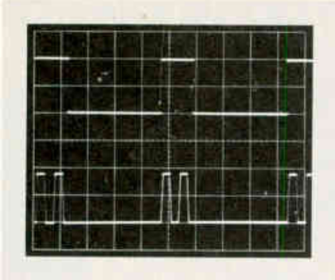
measurement flexibility



The Dual Plug-In Feature of the 560-Series Oscilloscopes allows conventional Y-T or X-Y displays with either single-trace or multi-trace units. The 564B MOD 121N (pictured above) provides stored displays at constant brightness independent of signal repetition rates. Seven-inch rackmounts are available in this family of valued performers.

561B . . . . **$595**   **564B MOD 121N** . . . **$1,250**

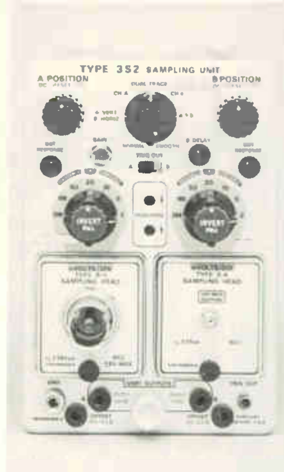


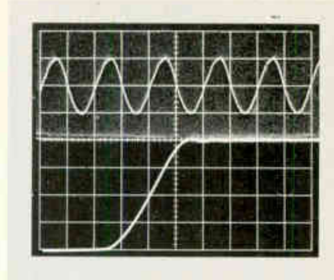


MULTI-TRACE

Compare time related pulse trains using this DC to 10 MHz, 35-ns risetime plug-in with deflection factors from 10 mV/div to 10 V/div.

Type 3A6 .... $550

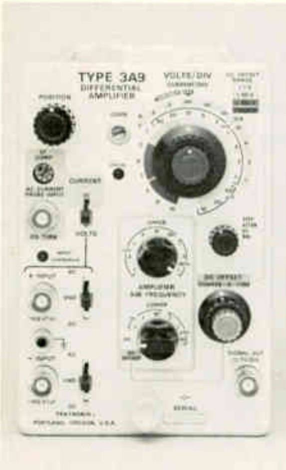


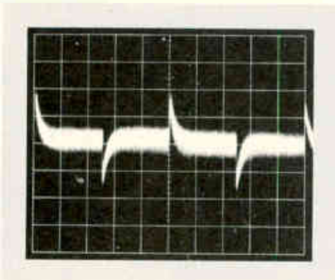


SAMPLING

Extend your measurement capabilities to 14 GHz with 25-ps risetime, internal triggering, dual-trace and interchangeable heads.

Type 3S2 .... $950

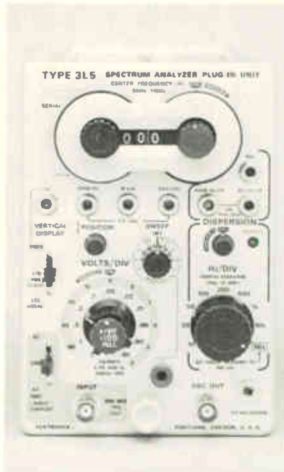


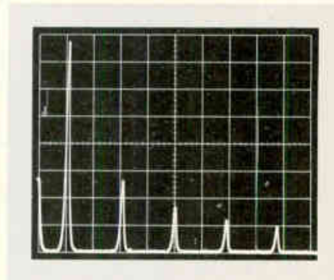


DIFFERENTIAL

Make differential measurements from DC to 1 MHz with 10-μV/div deflection factor and 100,000:1 common-mode rejection ratio.

Type 3A9 .... $525

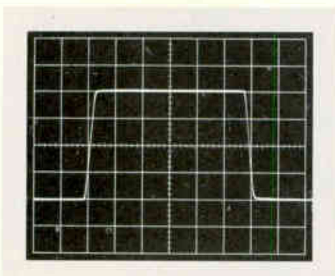




SPECTRUM ANALYSIS

Analyze the frequency spectrum from 50 Hz to 1 MHz with calibrated dispersion and calibrated deflection factors.

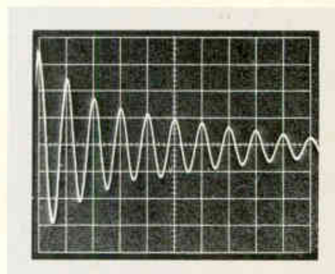
Type 3L5 .... $1125



SINGLE-TRACE

Perform single-trace measurements from DC to 1 MHz at deflection factors from 50 mV to 50 V/div with this low-cost plug-in.

Type 2A60 .... $140



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Measure force, acceleration, strain and displacement in applications such as stress analysis, vibration studies and fatigue tests.

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The Tektronix 560-Series Oscilloscopes have a complete selection of plug-ins, permitting you to adapt your measurement capabilities to meet your changing measurement needs. More than 25 plug-in units are available covering single channel, multi-trace, differential, sampling, spectrum analysis and other special purpose applications. Adapting your measurement capability to meet your changing measurement needs is assured.

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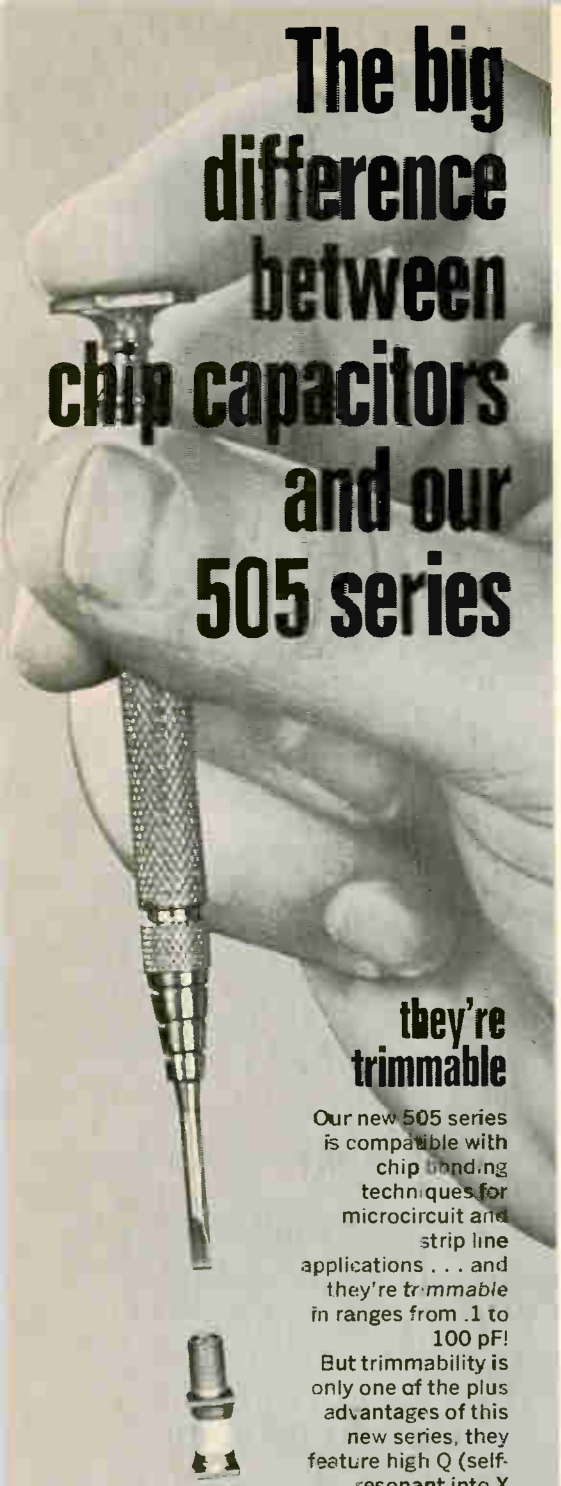

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Electronic Accuracy Through Mechanical Precision

Who's Who in electronics

"Right now, we don't even have the capital to buy a diffusion furnace, but we've taken a calculated risk." That's a candid assessment of General Digital Corp., a new MOS/LSI firm in Santa Ana, Calif., and it was offered by Alvin B. Phillips, General Digital's chairman and president.

Phillips quit in frustration as general manager of North American Rockwell's Autonetics Products division [*Electronics,* Jan. 19, p. 33] because he felt his efforts to put the division's contract with the Sharp Corp. for calculator circuits back on the track were getting bogged down in the red tape typical of a large aerospace corporation.

He incorporated General Digital on April 23, and now has five vice presidents and a 3,000-square-foot facility that he hopes to outgrow quickly. "We've got a complete five-year plan that will be triggered when our financing comes through," Phillips says. He can't say when, but emphasizes that he's working through Wall Street sources. He adds, "I think our strength is in the reputation of our team, which brings high investor confidence, because we're a group of experienced managers in the semiconductor business."

Come along. Phillips did stints at Sylvania's and Motorola's semiconductor operations before moving to Autonetics. Two of his vice presidents came with him from Autonetics: Joseph Baia, 39, General Digital's vice president for operations, who was operations manager, and Henry Rodeen, 43, vice president for process engineering, who was manager of manufacturing engineering. Baia went to Autonetics from Sylvania when Phillips moved; Rodeen was at Radiation Inc. before joining Autonetics.

Richard Sirrine, 51, vice president for research and development, was engineering manager at General Electric's IC department and shares the Sylvania patent on SUHL transistor-transistor logic. Albert Dall, 44, vice president for marketing at General Digital, came from Transitron, while Lawrence

Phillips

Alves, 30, vice president for finance and administration, was controller at Sylvania's Semiconductor division.

Phillips initially is looking for high-volume custom MOS/LSI business. He doesn't feel General Digital was too late in getting started. "The size of the market justifies our position," he says. "Besides, companies such as Motorola and TI are just getting started in MOS, and a lot of smaller companies are specializing in memories only. We want to serve the broad MOS market, not just the memory market.

"I believe hybrid LSI soon will be a powerful way of going, and we're looking to take on six to 10 chips on a substrate in a customer's subsystem requirements," he asserts. Phillips is sold on the MOS self-aligning gate and silicon nitride passivation. He thinks silicon-gate processing is "one of the better ways" toward self-alignment, and says General Digital will make both low- and high-threshold products because the nitride process allows both.

Why would a man leave the space program for the Department of Transportation? John D. Hodge, 41, new director of transportation systems concepts at the Transportation Systems Center, came from the Manned Space Flight Center in Houston where he was manager of the Advanced Missions Program. He directed planning for lunar ex-

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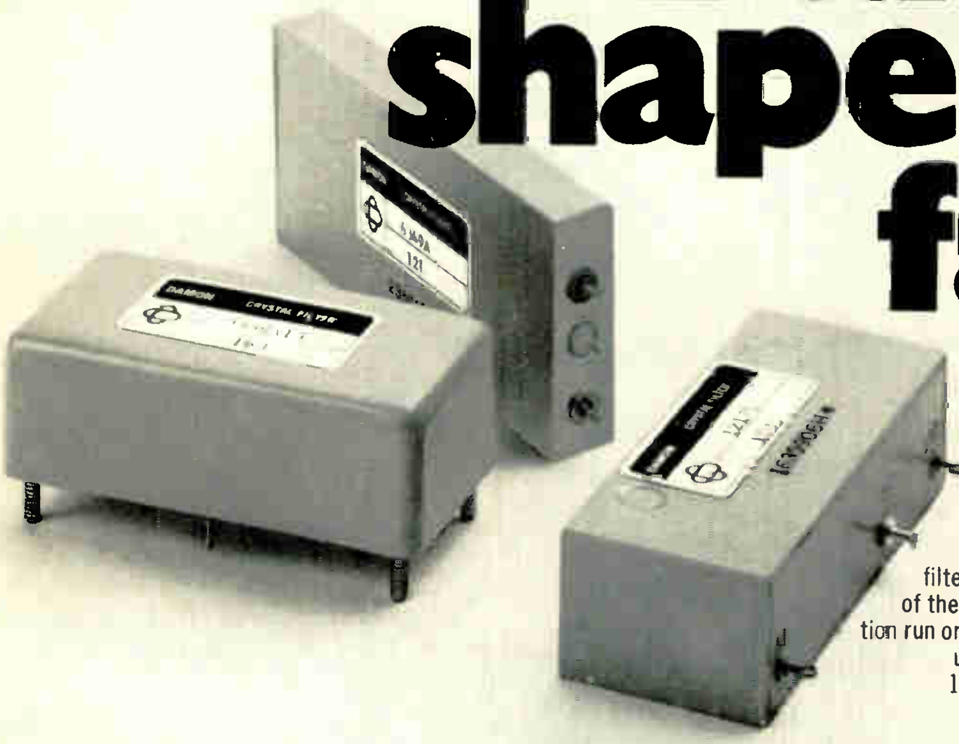

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Bandwidth	.01% 3% of C.F.
Phase Linearity	<±5%
Transient Overshoot	>40 db
Shape Factor	<1.25:1
Differential Phase Shift	<±2°
Group Delay Uniformity	<±5%

Band-Reject Filters

PARAMETER	RANGE
Center Frequency	10 Khz-35 Mhz
Reject Bandwidth	.01% to .5% of C.F.
Pass Bandwidth	Up to 100% of C.F.
Shape Factor	<1.8:1
Notch Rejection	>80 db
Insertion Loss	<0.5 db
Ripple	<0.25 db

Single Side-Band Filters

PARAMETER	RANGE
Center Frequency	10 Khz-35 Mhz
Pass Bandwidth	.01% to 2% of C.F.
Carrier Rejection	>40 db
Shape Factor Carrier Side	<1.15:1
Shape Factor Side-Band Side	<1.25:1
Insertion Loss	<3 db
Ripple	<1 db

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ploration, the first phases of the space shuttle, and space station efforts. He had a job with more romance than almost any other in engineering.

"But when Jim Elms (TSC's Director) asked me to come, I never even hesitated," says Hodge. "TSC is where the action is; the problems of intra- and interurban transit and the efficient linking of all the various modes of transportation are real, present, and pressing."

Hodge feels a kinship between the new TSC and the space task group formed by NASA in 1959 to map what became the Apollo program. He feels the same sense of new vistas and challenges opening in transportation systems that he once felt in the early days of the space effort.

The areas. If challenge means a hard job, then Hodge is challenged. In his new slot he will direct thinkers investigating far-out topics such as:

- The needs of air traffic control for the 1995 time period—and then use these findings to scale back down to nearer term goals.
- The relationships between modes of transportation. ("It shouldn't take you as long to get to the airport as to fly to where you're going.")
- Auto safety, driver monitoring, communications, and more efficient roads through car control.

These and other problem areas will be studied by his group, using computer simulation and analysis techniques and the knowledge of experts in fields not generally associated with today's approach to technology. By way of illustration, TSC's director Elms has a report now on his desk with a title beginning "The Ecological Implications of an Airport in. . ."

As of now, Hodge is 25% of his department. He inherited only two men from the old NASA Electronics Research Center in Cambridge, Mass., and brought one from Houston. "I'm looking forward to a staff of about 30 to 40 people in the first year—big enough for ideas to ferment, but small enough to run easily and have fun. And we are going to have fun; we are where the action is."

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Those are the same reasons why the industry has bought over $150 million worth of Sorensen power supplies.

And those are the same reasons why you may want to consider Sorensen the next time you consider power supplies. For complete information on any of our power supplies (or for our 124-page Power Supply Handbook and Catalog) call our Applications Engineer, Steve Charleston (collect) at (203) 838-6571, or write to him at Sorensen, Richards Ave., Norwalk, Connecticut 06856. Circle 200 on the inquiry card.

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The HP 3480 A/B is the first 4-digit multifunction DVM having an ac converter that is true rms responding to eliminate large errors caused by harmonic distortion or noise and extends your measurement capability to include the rms value of non-sinusoidal wave forms. The 3480 A/B has a 100 mV range and covers from 1 Hz to 1 MHz and will measure ac *plus* dc.

The HP 3480 A/B DVM is ideal as a bench instrument. No other instrument — single purpose or multiple function — equals the 3480 A/B. Top performance in measuring dc, three-terminal dc ratio, true rms ac, ac-plus-dc in one measurement, and ohms is assured by the accuracy designed into the instrument.

You get four-digit readout plus 50% overranging which results in greater resolution and less range change. The high dc input resistance ($>10^{10}\Omega$ on the lower three ranges) reduces the possibility of loading errors.

True rms ac conversion makes the 3480 A/B immune to large errors caused by small amounts of harmonic distortion and expands the range of precision ac measurements to non-sinusoidal wave forms.

The wide bandwidth (1 Hz to 1 MHz) and the capability of making ac-plus-dc measurements gives the 3480 A/B a broader range of applications not available before. And, the high ac and dc sensitivity (100.00 mV full scale) reduces the need for preamplification.

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never before has there been a DVM so ideally suited for bench and systems use as

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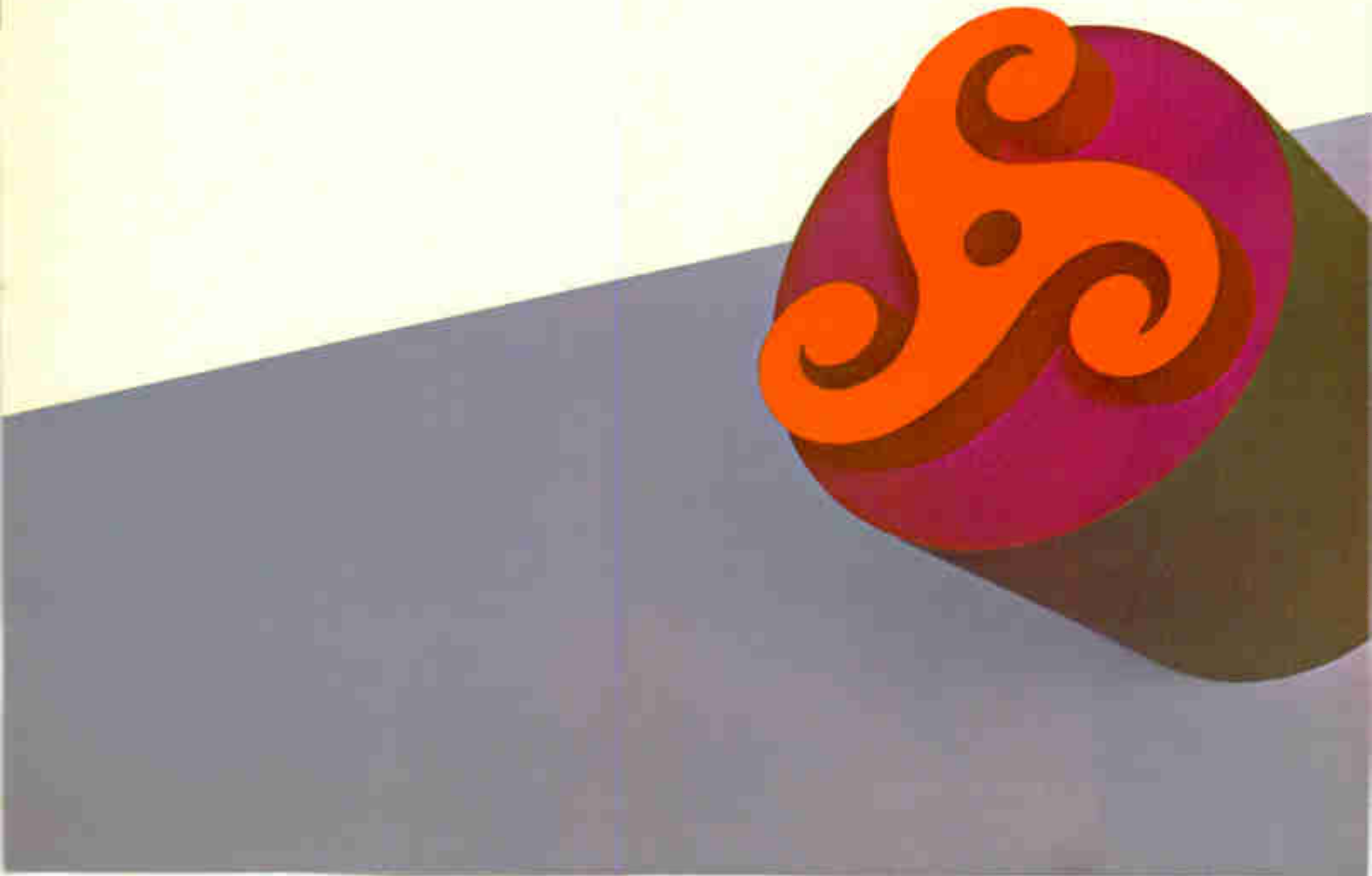

The HP 3480 A/B DVM is ideal as a systems instrument. Up to this time, DVM's have been the slowest part of a measurement system. Now, the system doesn't have to wait for the DVM. The HP 3480 A/B DVM can make up to 1000 dc and ohms readings per second. You can save automatic test time and increase production—or you can appreciably reduce computer idle time.

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Modest prices, too! All the capability packed into the 3480 A/B is not expensive. Prices range from $1150 for one range of dc to $3375 for multi-function ac, dc, ohms capabilities with isolated BCD and isolated remote control.

For the best in bench and systems DVM's, get the omniscient triskelameter—the new HP 3480 A/B DVM. Ask your local HP field engineer for full particulars, or write to Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin—Geneva, Switzerland.

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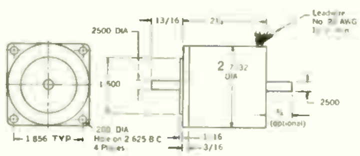

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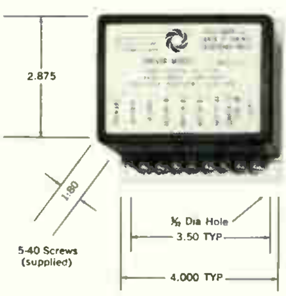

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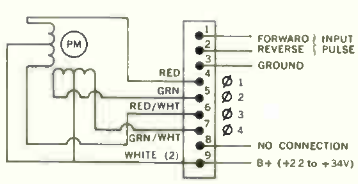

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Meetings

Over the horizon with EMC

In addition to the topics one might expect to be covered at a conference of electromagnetic compatibility specialists, those who attend the 1970 IEEE International Symposium on Electromagnetic Compatibility July 14-16 at the Anaheim, Calif., Convention Center will find a number of subjects not heretofore treated at the symposium. There's a good reason for it. The symposium theme is "The Expanding Science of EMC."

Besides sessions on EMC standards, antennas and field-suppression techniques, emission analysis, and susceptibility analysis, the program includes a session entitled "Electromagnetic Smog," with the purpose of showing how electromagnetic incompatibility can have harmful or unusual effects. One paper in the session, by G. Anzio of NASA's Lewis Research Center, presents indigenous noise survey measurements data.

Two other papers in the same session are extensions of what has been traditional thinking about EMC problems. One by Leo Inglis of Atomics International compares Soviet and U.S. reports on the effects of microwave radiation on humans, pointing up disagreement over what levels are harmful. Another, "Hazardous Electromagnetic Degradation to Medical Electronics," is significant in that it, too, focuses on medical-biological problems in hospitals, including electrocution of patients through improper administration of electrocardiograms and the risks associated with improper monitoring of heart pacemakers. The authors are J.E. Bridges and E.E. Brueschke of the Illinois Institute of Technology Research Institute.

Arcane. A Third paper in that session has the innocuous title, "New Horizons in EMC," but author Rexford Daniels, president of Interference Consultants Inc., has some provocative fare for his listeners, including phenomena—as yet unexplained—not unlike dousing for water. Daniels will discuss the use of brass rods to locate tunnels in Vietnam, among other things.

Two other papers are significant in that they go beyond topics that have traditionally been considered at the symposium—one on undersea electromagnetic interference considerations by authors from the Genisco Technology Corp. and the Hughes Aircraft Co., and one entitled "EMC in Radio Astronomy" by James Dolan of the National Radio Astronomy Observatory.

There is an EMC education workshop scheduled to acquaint those attending with expanding opportunities for advanced education in the EMC specialty, and the symposium committee is having an experimental program of free consultation by EMC experts.

For further information, write James Senn, Lectromagnetics Inc., 6056 W. Jefferson Blvd., Los Angeles, 90016

Calendar

Joint Automatic Control Conference, IEEE; Georgia Institute of Technology, Atlanta, June 24-26.

Summer Power Meeting and EHV Conference, IEEE; Biltmore Hotel, Los Angeles, July 12-17.

Conference on Dielectric Materials, Measurements and Applications, IEEE; University of Lancaster, London, July 20-24.

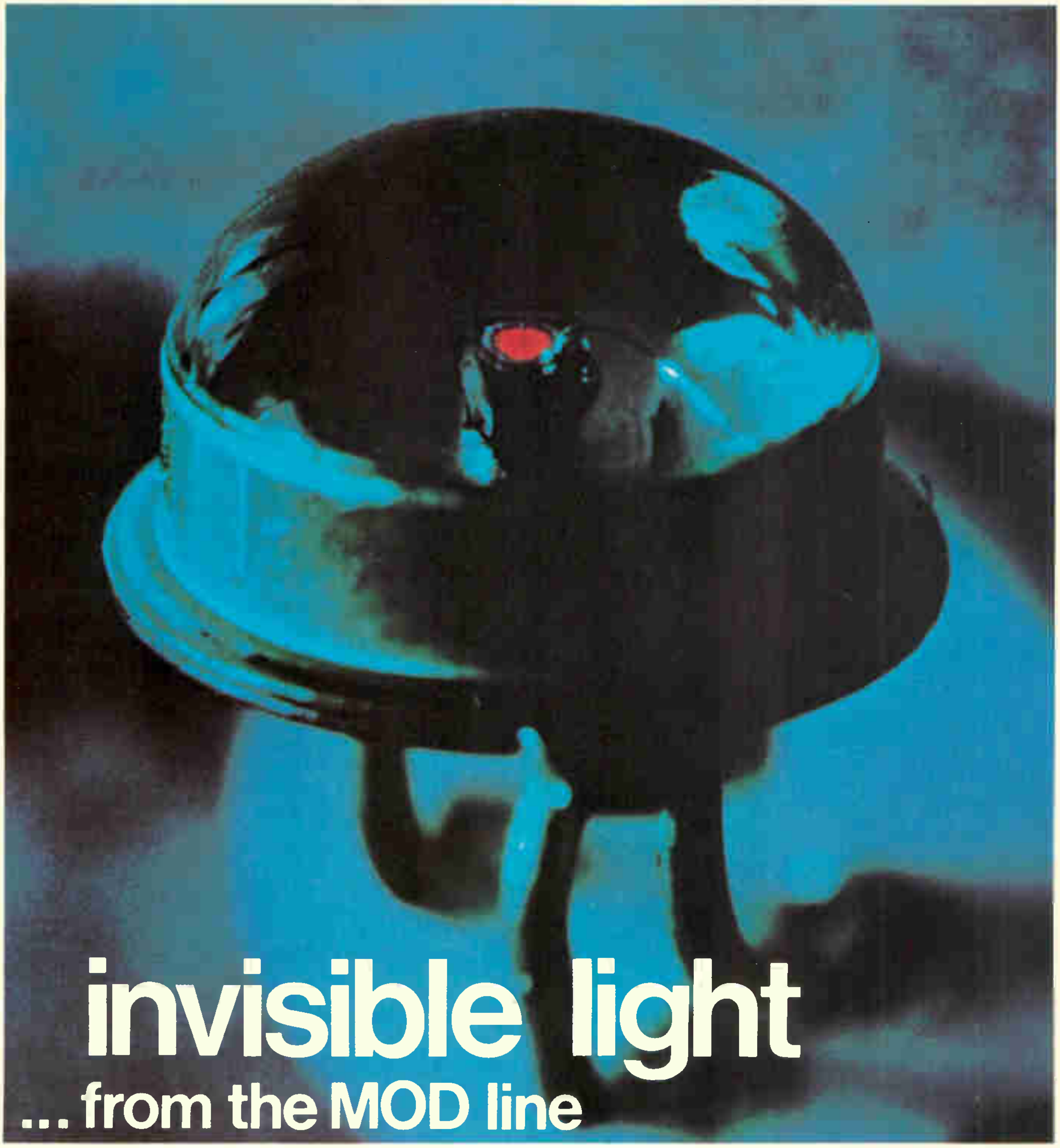
Reliability and Maintainability Conference, Society of Automotive Engineers, the American Society of Mechanical Engineers, and the American Institute of Aeronautics and Astronautics; Sheraton-Cadillac Hotel, Detroit, July 20-22.

Conference on Nuclear and Space Radiation Effects, IEEE; University of California at San Diego, July 21-23.

International Conference and Exhibition on Water Pollution Research, IEEE; San Francisco, July 19-21; Honolulu, Aug. 2-5.

Photovoltaic Specialists Conference, IEEE; Seattle Center, Washington, Aug. 11-13.

(Continued on p. 24)



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For further information on the advantages of invisible light in your systems, contact your Fairchild MOD representative. Upon request we'll send you a genuine 4 color photo of the FLD100 doing its thing, a six page brochure, lots of other data sheets and a product profile. All these are astutely written to help you solve your system design problems.

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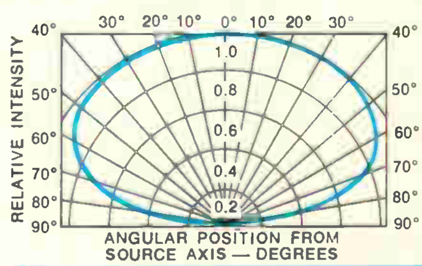

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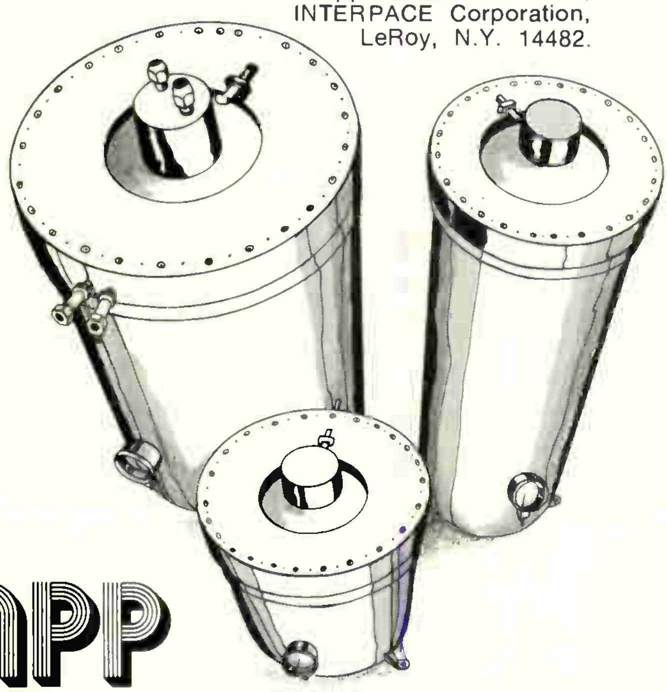

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Meetings

(Continued from p. 22)

International Conference on Microelectronics, Circuits, and Systems Theory, IEEE; University of New South Wales, Kensington, Sydney, Australia, **Aug. 18-21.**

AFMA National Conference, Armed Forces Management Association; International Hotel, Los Angeles, **Aug. 20-21.**

Western Electronic Show and Convention (WESCON), IEEE; Biltmore Hotel, Sports Arena, Los Angeles, **Aug. 25-28.**

Preparation and Properties of Electronic and Magnetic Materials for Computers, The Metallurgical Society, Statler-Hilton Hotel, New York, **Aug. 30-Sept. 2.**

Application of Computers to the Problem of Urban Society, Association for Computing Machinery; New York Hilton Hotel, **Aug. 31.**

Association for Computing Machinery Conference, New York Hilton Hotel, **Sept. 1-3.**

International Electrical and Electronics Engineering Conference, Korean Institute of Electrical Engineers, Korea Institute of Electronics Engineers, Korea Institute of Science and Technology, IEEE; Korea Institute of Science and Technology, Seoul, **Sept. 2-4.**

Conference on Microwave and Optical Generation & Amplification, IEEE; Amsterdam, the Netherlands, **Sept. 7-11.**

International Broadcasting Convention, IEEE; Grosvenor House, Park Lane, London, **Sept. 7-11.**

Petroleum & Chemical Industry Technical Conference, IEEE; Camelot Inn, Tulsa, Okla., **Sept. 14-16.**

Annual Technical Symposium, Society of Photo-optical Instrumentation Engineers; Anaheim Convention Center, Calif., **Sept. 14-17.**

International IEEE/G-AP Symposium and Fall USNC/URSI Meeting, Ohio State University, Columbus, **Sept. 14-17.**

Conference on Gas Discharges, IEEE; London, **Sept. 15-18.**

Intersociety Energy Conversion Engineering Conference, IEEE; Frontier Hotel, Las Vegas, **Sept. 20-25.**

Conference on Engineering in the Ocean Environment, IEEE; City Marina

(Continued on p. 26)

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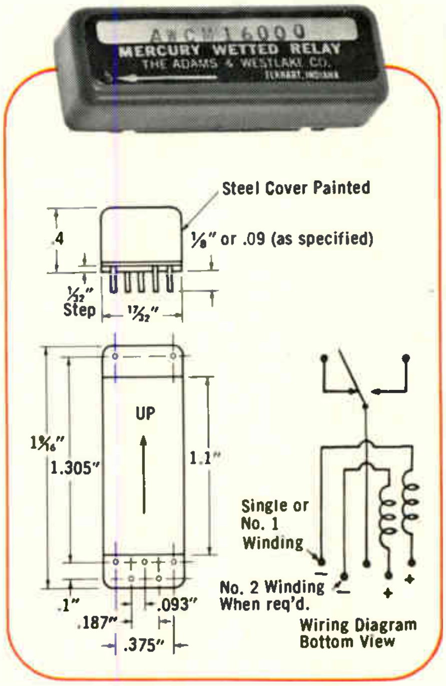

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Meetings

(Continued from p. 24)

Auditorium, Panama City, Fla., **Sept. 21-24.**

Conference on Electron Device Techniques, IEEE; United Engineering Center Auditorium, New York, **Sept. 23-24.**

Fall Broadcast Technical Symposium, IEEE, Washington Hilton, **Sept. 23-26.**

Short courses

Industrial Applications of Modern Magnet Technology, Massachusetts Institute of Technology; Francis Bitter National Magnet Laboratory, **June 22-July 3; $475 fee.**

Topographical Approach to Computer Aided MOS/LSI Design, University of Southern California; Olin Hall of Engineering, Room 122, **June 29-July 3; $275 fee.**

Computer Systems Analysis, University of California at Los Angeles, Engineering and Physical Sciences Extension, University Extension; Boelter Hall, **July 6-10. $310 fee.**

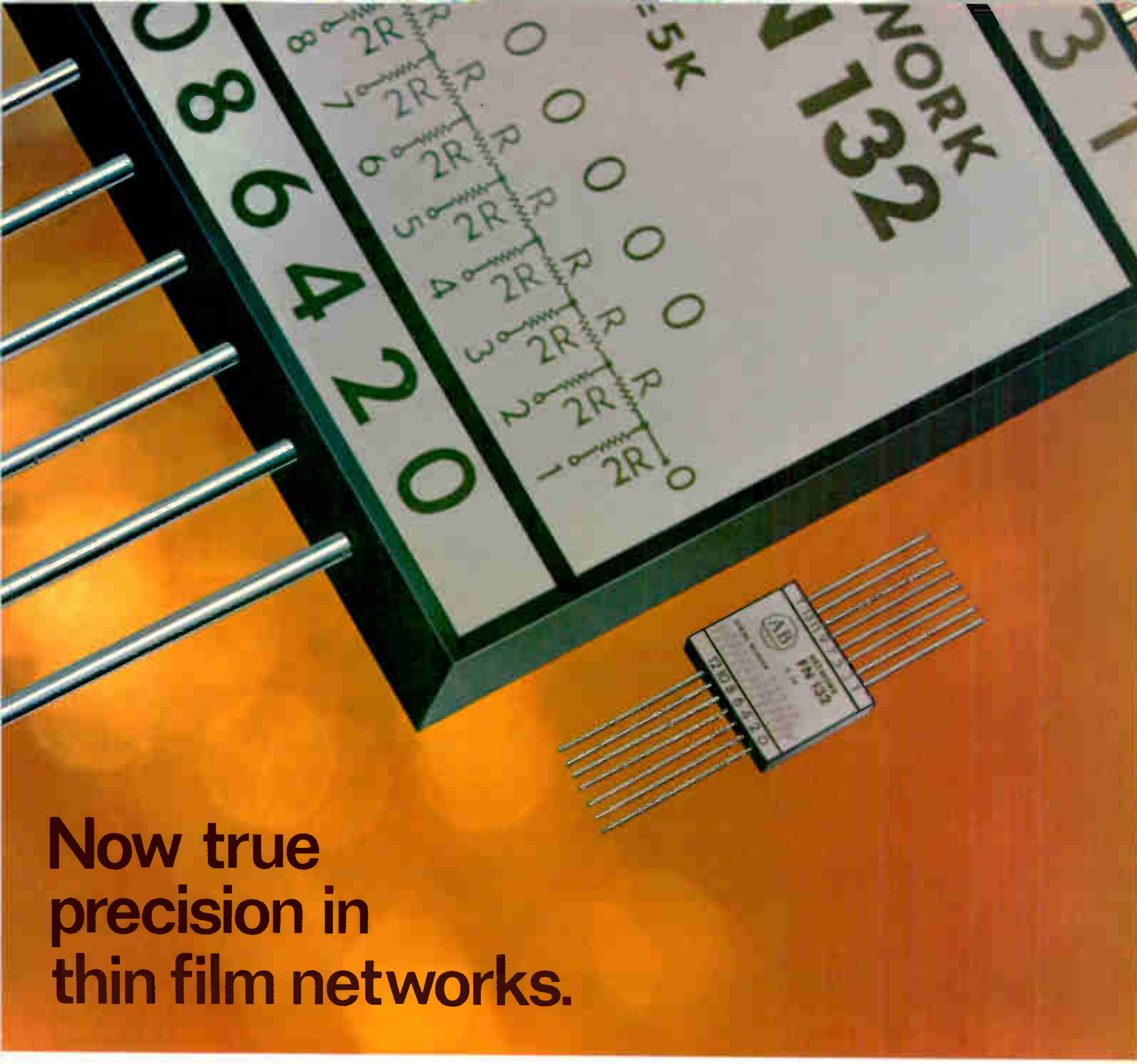
Call for papers

Canadian Symposium on Communications, IEEE; Queen Elizabeth Hotel, Montreal, Nov. 12-13. July 15 is deadline for submission of papers to Dr. M.L. Blostein, Electrical Engineering Dept., McGill University, Montreal 110, Canada.

Underground Distribution, IEEE; Hotel Pontchartrain and Cobo Hall, Detroit, Mich., Sept. 27-30, 1971. **Sept. 30** is deadline for submission of abstracts to the Technical Program Chairman, B.E. Smith, Virginia Electric and Power Co., P.O. Box 1194, Richmond, Va., 23209.

Magnetism and Magnetic Materials, IEEE, American Institute of Physics, Hotel Plaza, Miami, Nov. 17-20. **Aug. 4** is deadline for submission of abstracts to Dr. H.C. Wolfe, American Institute of Physics, 335 East 45th St., N.Y., N.Y. 10017.

Asilomar Conference on Circuits and Systems, University of Santa Clara and the Naval Postgraduate School; Pacific Grove, Nov. 18-20. **Aug. 30** is deadline for submission of abstracts to Professor Shu-Park Chan, Department of Electrical Engineering, University of Santa Clara, Santa Clara, Calif.



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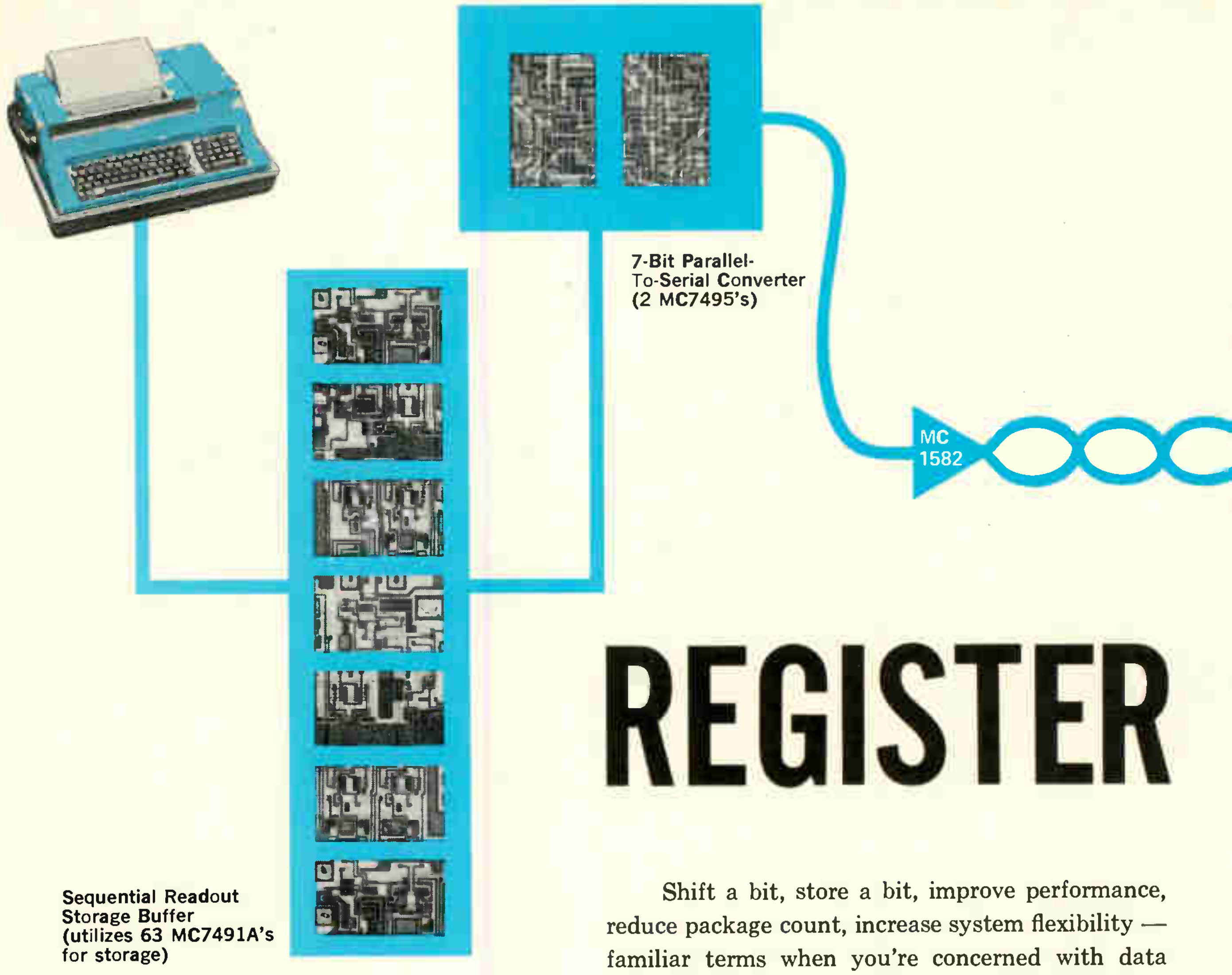

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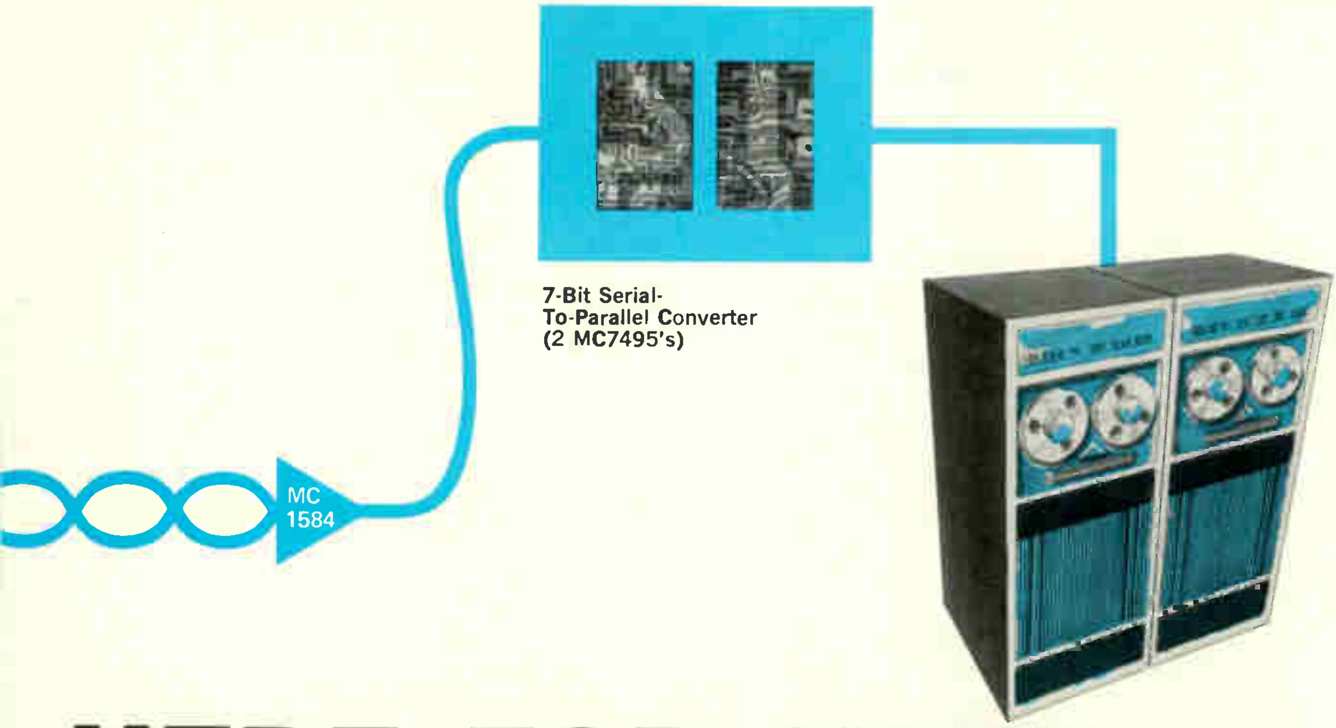

HERE FOR DATA

transmission in teletype-computer interface systems. In these systems, each character on the teletype keyboard is expressed in a 7-bit ASCII code for transmission to the computer. As each teletype key is depressed the 7-bit code for that character is presented at the inputs to the storage buffer. The buffer, utilizing MC7491A's for storage, accumulates the ASCII coded characters until an end of transmission signal is received. Next the 7-bit words are converted to serial by the 7-bit parallel-to-serial converter which is comprised of two MC7495's.

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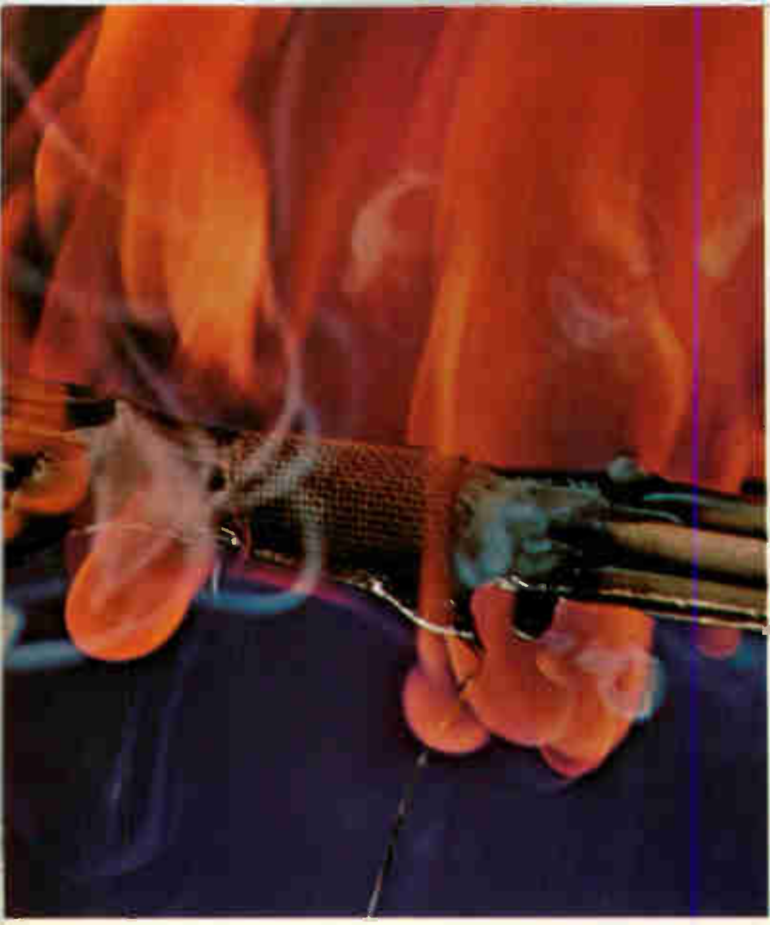
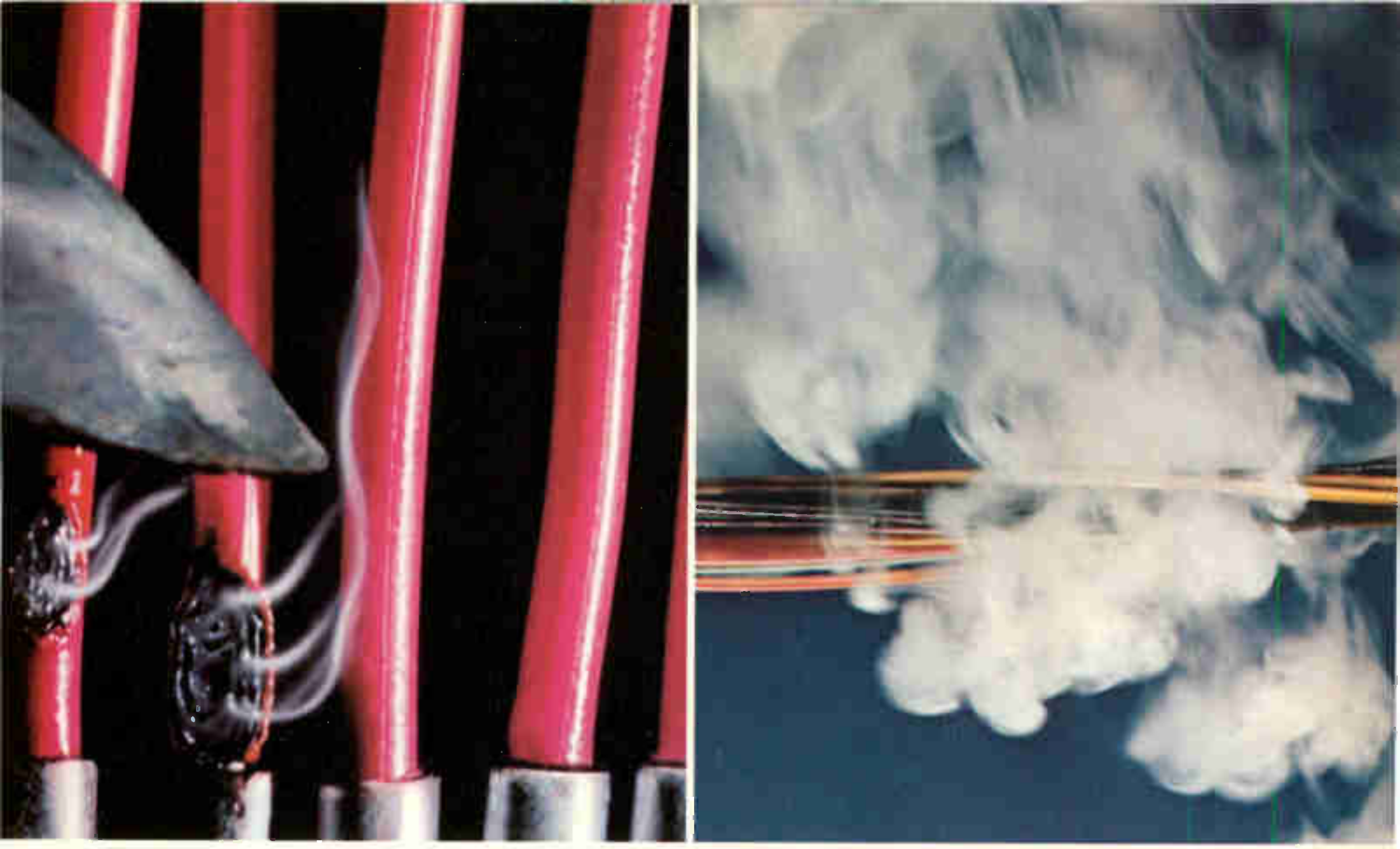


In a world where things



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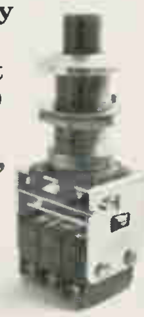

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Electronics Newsletter

June 22, 1970

Navy surprised by wide bid range for Omega receiver

The range of quoted prices in the Navy's recent procurement for 500-plus AN/SRN-12 Omega receivers was unexpectedly wide. The bids, which ranged from a high of $10,975 per set down to $3,615, were as much a surprise to the Omega Project Office, which had expected a considerably higher low bid, as they were to Northrop's Electronics division. Northrop, which earlier was reported to have the inside track [*Electronics,* March 2, p. 40] bid an off-the-track $5,318 per receiver.

The $3,615 low bid, by General Atronics in Philadelphia, is attributed to two factors: industry-wide hunger for business, which has sharpened most appetites and costing pencils, and the fact that the procurement is a straight production job. The last Omega receiver procurement was a two-step unit, requiring both a technical and a cost proposal, and thereby excluding a simple copying exercise. This time the Navy sent out sets of prints and invited bidders to examine the insides of an operational receiver. The result: the Fleet's needs through 1975 will be met at about half the anticipated price.

One Navy source estimates that if the proposal had been a directed procurement—sole source for reasons of urgent need, for example—the price per unit might well have topped $12,000.

Northrop ready to pare its work

Northrop Electronics, underbid by several of the 22 firms competing for the SRN-12 contract, is considering getting out of the shipborne and commercial Omega receiver market to concentrate on the more sophisticated—and lucrative—airborne Omega systems. Northrop feels that the ease with which shipborne Omega receivers can be built has attracted low-technology companies that can underbid bigger ones because they have little capital invested in the system.

IC in future Fords needs better idea

It's back to the drawing board at Motorola's Semiconductor Products division in an effort to find a way to cut the cost of the voltage regulator using thick-film hybrid integrated circuits that the division had been supplying to the Ford Motor Co. Motorola discovered that a redesigned version of the regulator that went into some 1969 Thunderbirds and Lincolns [*Electronics*, Sept. 15, 1969, p. 71] would cost about $6, instead of the $1.50 to $2 Ford might have been willing to pay to incorporate the unit in its complete model line.

The redesigned version went into some top-of-the-line 1970 Ford products, but the business is dead now; Motorola hasn't shipped any since last fall, and it looks like Ford has abandoned hopes of putting a solid state regulator into any of its 1971 line. The problem: even though Motorola was using a flip-chip IC in its design, wire-bonding costs for the discrete portions remained high.

New IBM computer? Hold your breath

When IBM finally announces its new computers—probably within a month—the machines could merely be additional models in the System 360. However, some features indicate that they'll be a whole new series. The main evidence is the probable appearance of a high-speed buffer memory, or "cache," in the larger versions, and the use of an electrically alterable read-only memory (Earom) that will vary from model to model.

Electronics Newsletter

The new machines will be controlled, like the six-year-old 360, by firmware—microprograms stored in a read-only memory. Data communications capability also is certain to be available.

Those who believe that the new machines will be new 360's point to some of the advanced features of the 360/195 [*Electronics*, Sept. 1, 1969, p. 39] and to a version of an Earom tried in the 360/25.

NCR to use cores for new Century

NCR apparently is taking no chances on being caught without a memory for new versions of its Century computer series. Facing inadequate deliveries from its semiconductor memory suppliers [*Electronics*, Nov. 24, 1969, p. 33; March 16, p. 34], NCR has turned to cores for at least one new Century series entry. Core memories also are said to be planned in follow-up shipments to customers asking for more of the Century 100 and 200 computers that now use a wire rod memory.

Electronic Memories and Magnetics has an NCR order said to be between $10 million and $12 million—for core memory systems—presumably for new models and those in production.

Sylvania to offer memory selling for tenth of a cent a bit

While semiconductor memory makers are scratching to reach penny-a-bit storage prices, the Electronic Systems division of Sylvania is gearing up to produce a film memory it says will sell for 0.1 cent per bit in production quantity. Called Soniscan, the magneto-acoustic system will be aimed at bulk storage applications, and probably would be sold in eight-megabit modules. The batch-fabricated system would remain price competitive through the 100-megabit level.

Autonetics Products prepares to split

The Autonetics Products division soon will become a separate company, although it will still be related to the parent Autonetics division of the North American Rockwell Corp. The Products division manufactures MOS/LSI arrays; its principal commercial customer to date has been the Sharp Corp. of Japan, which is buying components for a small calculator. There also are signs that APD might be negotiating for a big follow-on to the $30 million contract with Sharp.

RCA going ahead with Secant work

Undismayed by a less than encouraging letter from the Air Transport Association, RCA will continue development work on the Secant anti-collision system with its own money. The letter, sent after the firm briefed the airlines last month [*Electronics*, May 25, p. 56] came from Frank White, head of ATA's CAS working group. It stated that ATA could not encourage RCA to spend any money developing Secant.

Instead, RCA is going ahead to develop flyable Secant prototypes. In fact, the company is hard at work designing the simplest member of the Secant family—the proximity warning indicator—at its Van Nuys, Calif., facility. RCA remains convinced that the ATA-sponsored time-frequency system is not the answer to midair collisions.

Though ATA is spokesman for the domestic air carriers, its opposition to Secant is not believed to represent an industry-wide attitude. At a meeting held earlier this year of the Airlines' Electronic Engineering Committee, the group voted to restrict the title of a proposed CAS specification to time-frequency CAS only.

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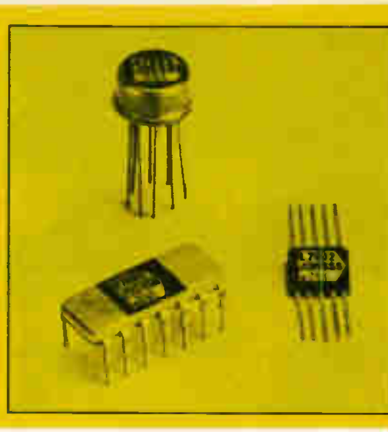

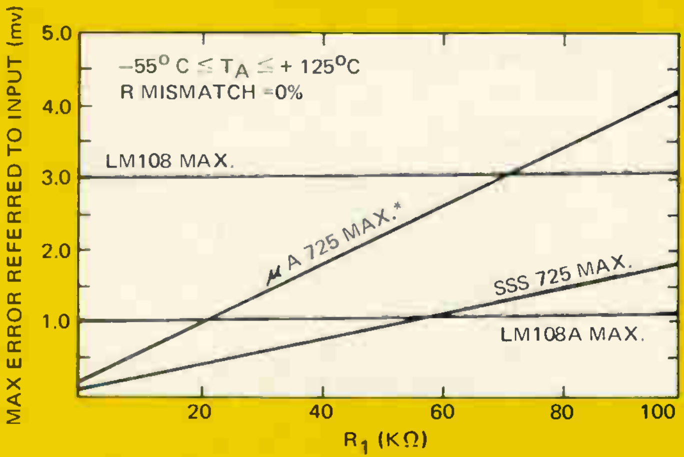

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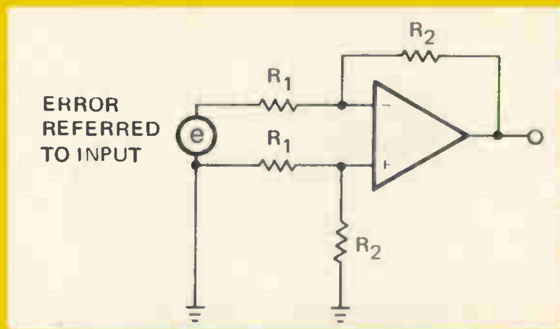

Errors shown represent the worst case summation of errors due to offset voltage and offset current for the circuit shown and closed loop gain greater than ten, using published max/min specifications. The μA725 is shown using an assumed max. drift specification of 1.5μV/°C since no maximum is specified. The SSS725 and the μA725 are shown nulled. The LM108 and LM108A are not nullable. The SSS725 is superior to all amplifiers for values of R_1 up to 50KΩ.

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Offset Current	5nA	20nA	0.2nA	0.2nA
Bias Current	80nA	100nA	2.0nA	2.0nA
Voltage Gain	10^6	10^6	5×10^4	8×10^4
CMRR	120dB	110dB	85dB	96dB
Offset Adjustment Provision?	yes	yes	no	no
Price (100 Quantity)	$37.50	$37.50	$60.00	$150.00

μA725 specifications from μA725 data sheet, 8/69.
LM108 specifications from LM108 data sheet, 10/69.
LM108A specifications from LM108A data sheet, 2/70.

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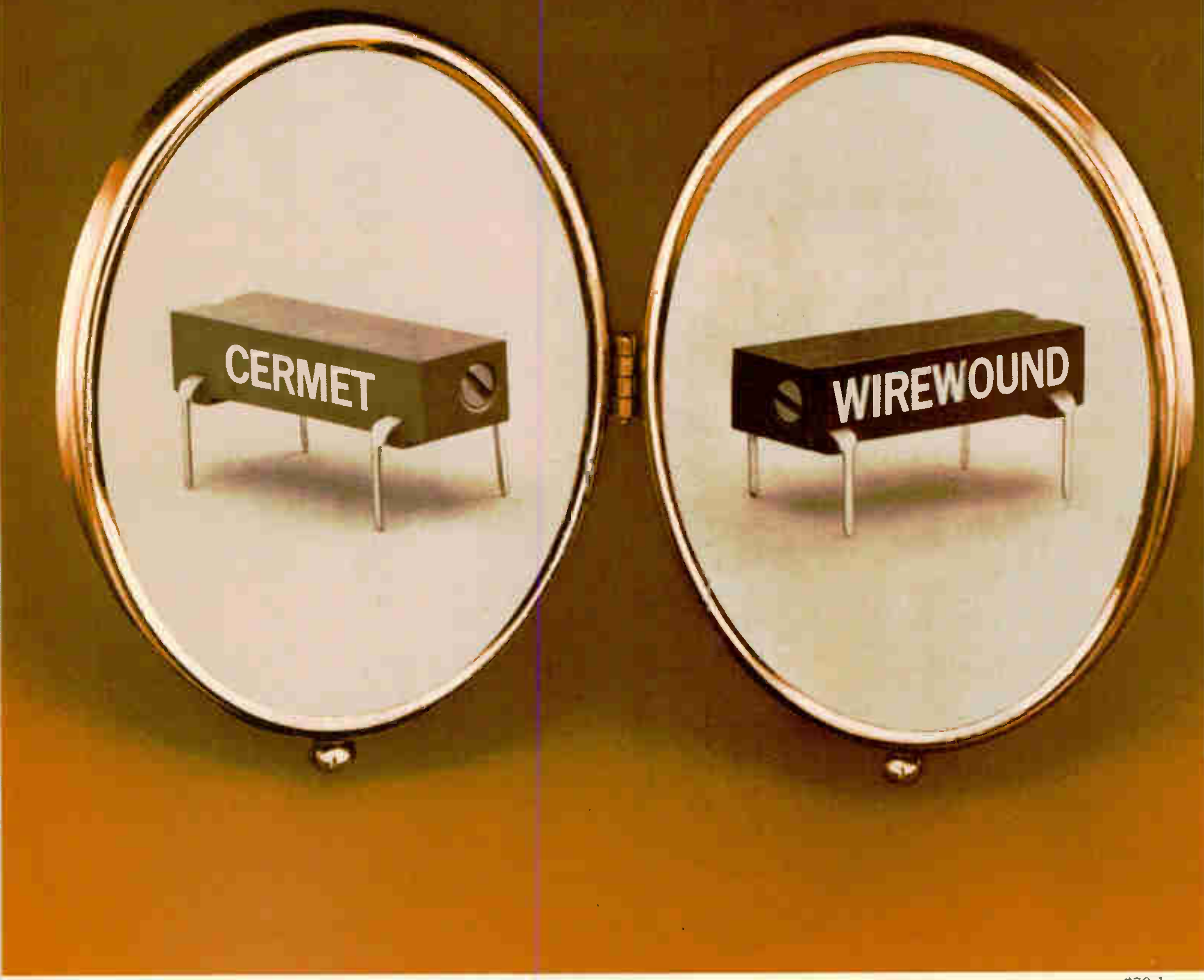

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Versatile new radar is no pipe dream

Ikor's Travatron, attached to high-voltage power supply, is keystone of a transmitter that may aid in distinguishing warheads from chaff

Stick a short length of pipe on a high-voltage power supply and what have you got? The world's simplest and possibly most versatile radar transmitter, says Art Frolich, who heads the techniques branch of the Rome Air Development Center's Surveillance and Control division.

The pipe, of course, is no ordinary one, but a Travatron—a kind of Hertzian generator recently patented by Ikor Inc. of Burlington, Mass. The Travatron has been helped along by Frolich and Bill Quinn, Rome's principal investigator of Hertzian techniques. Ikor's device consists of a series of high-voltage gap switches in the center conductor of a rigid, pressurized coaxial structure, with the last gap terminating in a dissipative load. Fed a charge surge through a side arm, the Travatron generates an extremely narrow r-f burst at a frequency determined by the spacing of the gap switches and at a conversion efficiency from d-c to r-f on the order of 40%.

Picking. No one says so, but one potential application is the discrimination of warheads from the accompanying chaff and a decoy-filled cloud.

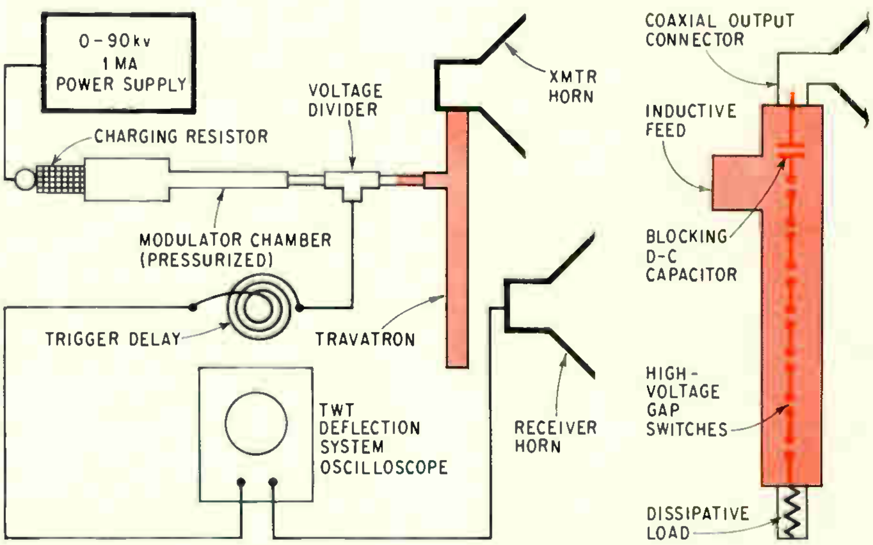
A Hertzian generator differs most significantly from a conventional radar transmitter in its signal characteristics. The Hertzian unit's pulse is inherently narrow; unlike a phase-coded-and-compressed pulse it has no troublesome sidelobes and no velocity/position ambiguity function. Furthermore, all its frequency components exist simultaneously in sharp and significant contrast to the intrapulse frequency sweep typical of signals coded for subsequent pulse compression. Finally, the transmitted signal always starts out with the same phase; it's pulse-to-pulse coherent and naturally suited to pulse-doppler received-signal processing.

Since the instantaneous bandwidth is very wide, the return from a target will tend to be a composite of the interference patterns formed as various portions of the target interact with different parts of the signal spectrum. The result may well be a target signature which, while different for each orientation, will nonetheless uniquely specify the target class.

To the bench. For the moment this is only conjecture—the severe Pentagon cutback of R&D funds has limited the program to a total expenditure of about $300,000 over the past three years. Much of the basic work has been done in-house at minimal cost as RADC engineers worked within a tightened budget by leaving their desks for laboratory benches.

Experimental work to date includes the radar shown schematically. It operates at 1,300 megahertz, generating a 3-megawatt, 10 nanosecond-wide pulse at a pulse repetition frequency selectable from 100 hertz to 400 hz. Separate coaxially fed exponential horns are used for transmitter and receiver. The receiver consists simply of a pair of low-noise, L-band traveling-wave tubes which, in tandem, provide 60 decibels of gain. The amplified signal then is fed to a Tektronix 519 which has a twt deflection system, a 0.3 nsec rise time, and can directly display L-band signals.

In this experimental system the prf is determined by the time it takes the power supply to build up to arc-over voltage after it has discharged into the driver spark gap. Ongoing work at RADC seeks to trigger the gap with a "tickle" probe driven by a prf pulse generator and to use the same pulse to pretrigger a transmit receive tube to get around the tube's 30-nsec

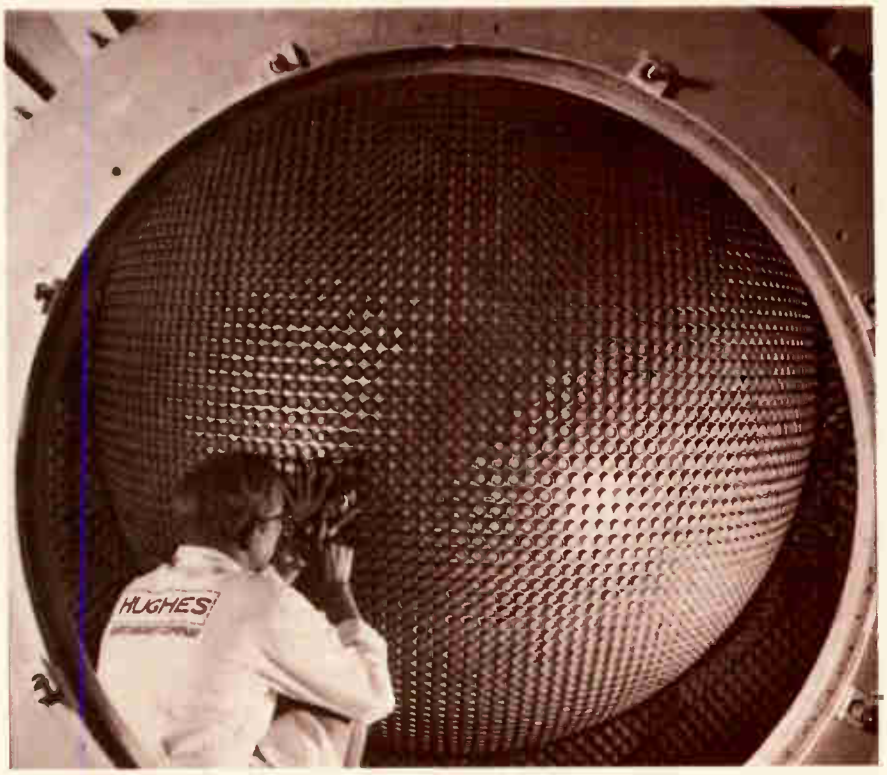


Through the pipe. Ikor's Travatron, shown in detail at right, has been incorporated in radar transmitter developed at the Rome Air Development Center.

turn-on time. Then a common antenna could serve both transmitter and receiver.

Pressure. One problem that would have to be overcome in any operational unit is the low average power due to the small ratio of pulse width to interpulse period. However, average power could be raised by boosting peak power—Travatrons can be pressurized to several atmospheres and can thus handle very high voltages—or by operating several tubes in parallel. If such generators are ever used for strategic defense radars, thousands of Travatron-type tubes will fill each face of a phased array. In anticipation of this eventuality Ikor has done some developmental work on wideband phase shifters.

Ikor has also developed a new type of antenna which feeds a reflector with an open (two-sided) horn to achieve an instantaneous bandwidth of 100%.



In the eye. Hughes engineer adjusts energy feeds on the receiving antenna of Advanced Design Array Radar. Prototype is undergoing final tests. Funds came from Air Force.

Radar

Sorting it out

A prototype radar using a beam-steering technique that appears to be significantly better than that of antiballistic-missile radars has been tested successfully. Built by the Hughes Aircraft Co., the radar, with its hemispherical bugeye antenna, is the first to use real-time delays—for beam steering and to compensate a receiver array for short-pulse, off-boresight reception.

ADAR, for Advanced Design Array Radar, is being funded by the Air Force's Rome Air Development Center; however, it's no doubt being eyed by the Army's Advanced Ballistic Missile Defense Agency for its potential in target discrimination.

While details of such systems are secret, insiders can put together bits and pieces of information and make some strong assumptions.

Compensation. One problem with such radars as the Perimeter Acquisition Radar (PAR) and Missile Site Radar (MSR) of the Safeguard system, is that their compressed pulse widths must be at least twice as long as the radar antenna aperture to prevent ruinous dispersion of signals received from off boresight. In an ordinary uncompensated array, the edge of the array closer to the target receives the signal first, while the farther edge receives the signal last. Unless the signal is at least long enough to simultaneously illuminate all elements of the array, it cannot be efficiently summed. Instead, the signal becomes smeared through several resolution cells, contaminating them while causing a loss in system sensitivity.

ADAR solves this problem by steering with real-time delays so that the whole signal, received from whatever angle, can be summed. Furthermore, the hemispherical shape puts most of the effective aperture broadside to the beam angle; this minimizes the required compensating real-time delays.

Hughes' radar uses a standard, phase-steered planar array for transmission. The bugeye array is for reception only. The radar is a small version of the full-scale array that might be used in an ABM role. It appears to operate at S-band and to cover a 120° cone so that three arrays could provide full 360° coverage. The array elements are scanned much less than 60°, since the antenna shape itself is used to accomplish most of the off-boresight pointing by simple activation of the appropriate array elements. Fine pointing is then accomplished by trimming the beam angle through real-time delays for each element. These delays are in addition to those required to compensate for the array's shape.

Cut down. The experimental array is about five feet in diameter and appears to house several thousand traveling-wave tubes in its face. The real-time delay system permits the use of much shorter pulses: a compressed pulse width of 10 nanoseconds, equivalent to a five-foot range resolution, may be practical even in a full-scale array.

Such high range resolution coupled with the array's ability to form on the order of 10 independent receiving beams may make it possible to divide an incoming ICBM cloud into resolution cells containing only a single object each. Given sufficient parallel signal processing capability, this would be the first step in discriminating warheads from chaff and tankage.

Packaging

Unprinted circuit

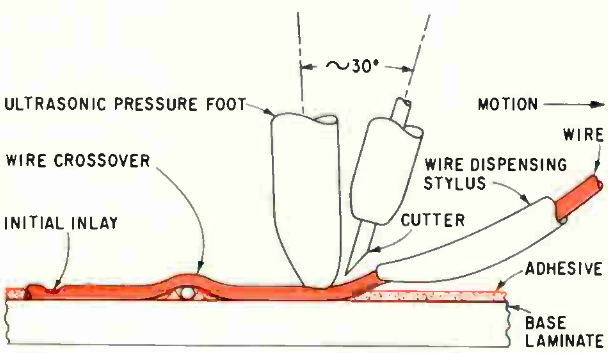
When is a printed-circuit board not a printed-circuit board? When it's a board with wiring that's not "printed" on it by any of today's metal-etching techniques. Called Multiwire, a method of preserving the planar p-c board format for mounting and linking components without going through the time-consuming mask-making, exposure, and etching steps is being developed by the Photocircuits Corp. of Glen Cove, N. Y. Interconnections are made with polyimide-insulated magnet wire laid on the board in any desired interconnecting pattern by a numerical-control setup.

Since the system requires no artwork, turnaround time is low and changes are easily made simply by changing the software. In this way, it resembles the wire-wrapping methods, but it also connects components via the plated-through hole rather than having to use special terminals.

More are better. The company says that although printed circuitry may be more economical for large numbers of boards with low complexity—up to about five connection points per square inch (one dual-in-line package per square inch, a common component density, results in about 15 pins/in²)—the Multiwire process becomes more attractive as complexity increases, even for large quantities. That's because layouts in the 30 pins/in² range require critical artwork and the yield on multilayer boards of such complexity drops. For example, for 15 pins/in², the Multiwire approach would be more economical for up to 1,000 boards. The blank board uses any of the common p-c board base material, with a layer of thermosetting adhesive about four mils thick covering it. The adhesive holds the wire.

The wiring head comprises a feed tube for the wire, a cutter, and a pressure foot that also acts as an ultrasonic transducer providing the initial push to tack the end of the wire into the adhesive.

After ultrasonic energy does its job, only a light pressure is maintained as the wire is laid into the adhesive. With 7-mil wire, the wires can be laid on 25-mil centers; the head can move in any direction over the x-y positioning table that holds the board.



Over and under. New wiring technique, called Multiwire, produces unprinted "printed" circuit. No artwork is required.

Crossovers are made simply by crossing over. The wires are insulated; in fact, cross-section photos show that the magnet wire itself will deform while the insulation maintains its integrity.

After the wire is laid down, holes are drilled through the board at the desired points, either directly through the end of a wire or somewhere along its path. During drilling, the wires are held down firmly by a pressure plate so that they do not wobble as the drill clips off their ends. A clean hole is formed, with the wire end matching the rim of the hole. Then the hole and wire end are plated with an electroless copper deposition system.

Multiwire samples are now being evaluated by several companies. The next step, says Photocircuits, is scheduled to be a custom design service.

For sale

Union Carbide is finally crystallizing market plans for parylene, a class of thermoplastic polymers that has excited many electronics packaging men. They see it as a pinhole-free conformal coating for components ranging from individual integrated-circuit chips to complete circuit boards. Maintaining its properties to 200°C and beyond, and exhibiting great moisture and chemical protection, parylene looks good as a passivation coating for IC's that go into plastic packages [*Electronics*, March 16, 1970, p. 50].

Two types are being offered by Union Carbide—parylene N where electrical properties such as dielectric constant and breakdown voltage are most important, and parylene C where thermal and protection properties are of paramount importance.

However, the heralded parylene AF-4 polymer reported in a 1969 paper in the Journal of Applied Polymer Science will not be offered yet, even though potential users and Union Carbide chemists agree that AF-4 may be better than either of the other types when operating in air. The Journal paper says that AF-4, in which fluorine is added to hold the hydrocarbon bonds that tend to break down at high temperatures in an oxidizing atmosphere (air), retains its useful mechanical and electrical properties after aging for 3,000 hours at 250°C in air. This performance is equivalent to what the other types can do when they're in an inert atmosphere or protected from air by a coating of material such as an epoxy or silicone.

Electronics packagers have criticized Union Carbide's reluctance to market AF-4, but Union Carbide says that it hasn't seen any applications where the high-temperature AF-4 would be operated in direct contact with air—it's always coated, they say, with another material for extra mechanical strength, such as to protect the wire bonds on an IC chip. However, there is a trend in electronics packaging toward the use of unpackaged chips, with a simple nonhermetic cover, where AF-4 could offer better reliability. And some users may want the option of using AF-4 without the extra coating. But if the demand does develop, Union Carbide says, it will offer AF-4.

Deals. Three arrangements are offered by Union Carbide to electronics users of the N and C polymers. One is a custom-coating service at the company's Bound Brook, N.J., plant for prospective customer study and evaluation, but not for incorporation in a marketed product. The charge here is $340 per run, where as many components as will properly fit in any of the various size deposition chambers will be coated in the one run. Another is an experimental arrangement where electronics manufacturers may set up their own deposition systems, paying only for the parylene itself at $250 a pound, but still not offering the coated products for sale. Finally, there's a full-scale commercial license for manufacturers who want to sell parylene-coated products. The cost here is a one-time $10,000 license fee, a running royalty based on use, and again the cost of the parylene itself.

Considering only the material and running royalty, the cost of a typical 0.5-mil coating with a deposition efficiency of 50% (as a conservative estimate, only half the parylene sent through the chamber actually deposits on the piece) the cost will run from 1.45 to 2.2 cents per square inch. To this would have to be added labor, equipment, maintenance, and amortization of the license fee.

Optoelectronics

Get it and keep it

There is another entry in the automated document storage and retrieval field, but unlike the Ampex Videofile—an electronic system—this one is mainly mechanical, employing microfilm holders and a rapid conveyer system. Called the Varian Adco 626 microfilm storage and retrieval system, it provides 10-second maximum access from any number of remote points to a multimillion-page master file. Videofile's maximum is two minutes.

In the Ampex system, a video camera photographs documents, and, along with an identifying code, the image is put on video tape. To retrieve, the code number is keyed in, and the document shows up on a display. The Varian system puts the document on microfilm. Depending upon the quality of the original material, up to 60 pages can be put in one microfilm holder. The document also is retrieved by keying in a code number and then viewing the page on display.

According to Wayne D. Anstin, Varian Adco founder and board chairman, the system is so flexible that the single central file can range in size from 300,000 pages to hundreds of millions, or even billions, of pages with the same 10-second maximum speed available at remote terminals. Total initial investment for a 300,000-page capacity, Anstin says, is less than $100,000; typical Videofile price is $750,000. The system, which doesn't require a computer, utilizes a specially developed film carrier.

Pick a number. The 626, which also can make hard copies of any document in a maximum of 10 seconds at a price competitive with current copy costs, uses any numbering system that a company may be using—insurance policy numbers, Social Security numbers, bank account numbers, and so on. No special programing knowledge or coding language is necessary.

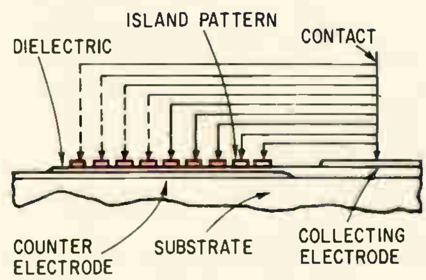
The proper film carrier is selected by means of a high-speed optical scanner. Any number of film carriers can be picked out by an index that was notched on its edge when it was filed. Then the carrier is placed in a high-speed miniature belt conveyor, which brings the microfilm to a high-resolution—1,225 lines—television camera. At this point the user can review on a tv screen all the pages summoned from the master file. Hard copies can be produced at the user's remote terminal.

The carriers are returned to place in the file in the same manner. Communication with the optical scanning device is by simple keyboard. While it doesn't need a computer, the system can be tied to one.

Production will begin this year with delivery scheduled to begin in early 1971.

Components

Variations on a theme



Islands. Sprague uses these discontinuous conductors to produce variable capacitor with 1,000 to 1 range.

It has been considered nearly impossible to get a variable capacitor with a wide range into a tiny space, because conventional manufacturing methods require an impractically small gap between the electrodes. Even using a high dielectric material doesn't do the trick. But engineers at the Sprague Electric Co., using thick-film techniques and multiple ohmic contacts, have built a device that's manually variable from 10 picofarads to 0.01 microfarad—a range of 1,000 to 1—into 0.375 cubic inch.

Sprague sees the prime market for its capacitor in frequency filter networks. These are best suited as replacements for the car radio's

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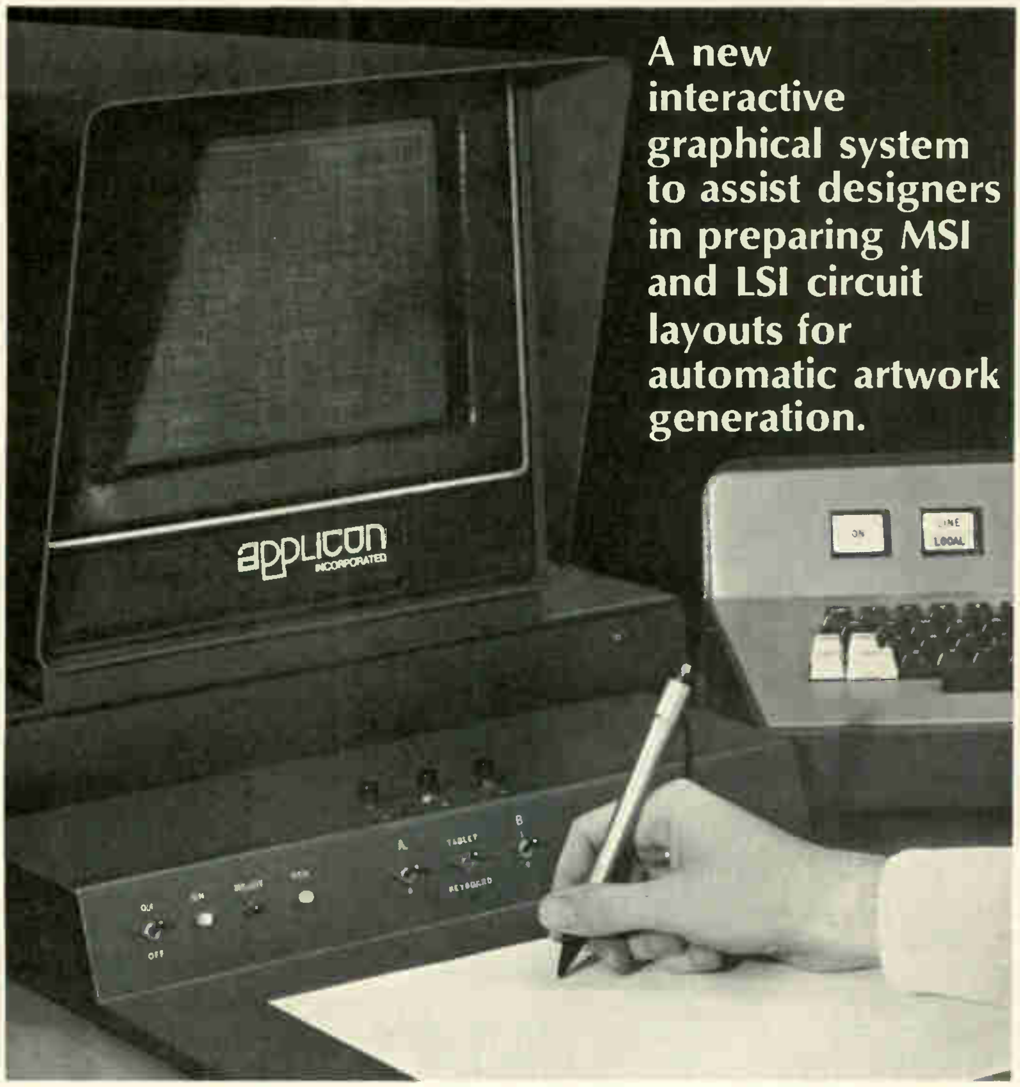

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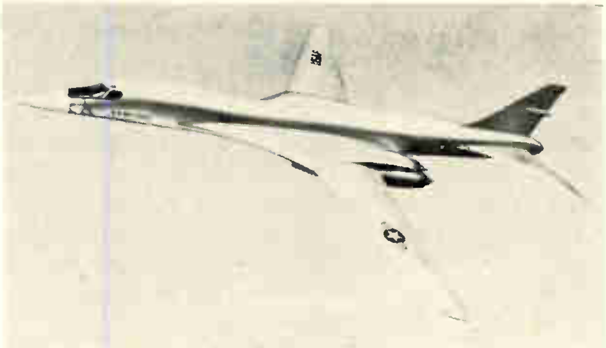
conventional tone control, where the listener essentially cuts off the high frequencies when he turns up the bass. However, with the new variable capacitor arrangement, he can reproduce the full range of frequencies—20 hertz to 100 kilohertz—and still maintain the desired tone. What he has, then, is a bass and treble control in one knob. The car radio circuit using the new device, says Sprague, will do away with at least eight passive components—resistors and capacitors. And the new capacitor is cost competitive with those now used in such circuits.

Island hopping. Instead of widening capacitance range past the usually obtainable 1 to 10 pf by using a thinner dielectric, the Sprague designers took a different approach. They recognized that they could molecularly bond the conducting material to both sides of the dielectric with one conductor made discontinuous. In this way, they eliminated the interface gap. To achieve the discontinuous surface with its tiny islands, they added 1,600 ohmic contacts to one side of the dielectric through screening techniques. These contacts form capacitor islands that can be contacted in various combinations by a rotating disk controlled by a radio's tone-control knob.

Avionics

B-1 makes a wave

The ink was hardly dry on the contract between North American Rockwell and the Air Force for development of the B-1 strategic bomber before the fur started to fly. Questions from the press and charges by Pentagon critics on Capitol Hill alleged that NAR's technological proposal received the lowest score and that its bid price was highest. Reports were that McDonnell Douglas achieved the best point score by a small margin over Boeing for technology, but that Boeing's lower price put it ahead in the overall competition. The Defense Department denied the charges, but hedged.



Bulgy. Drawing of the winning B-1 design—by North American Rockwell—shows its Coke-bottle shape.

The Pentagon said that NAR "received the highest weighted score of the three proposals and its negotiated bid was the lowest—some $1.35 billion compared to $1.45 billion and $1.56 billion for the other competing contractors." The total represents the cost of five flight test aircraft, one static test and one fatigue test airframe, spares and special equipment for the test program, plus a target fee of $115 million for the company—but no avionics. In addition, General Electric's engines will cost an estimated $406 million, including a $30 million target fee.

Squaring off. NAR's own Autonetics division and IBM will presumably fight it out for the B-1 avionics contract, but it's difficult to say whether the Air Force will get the degree of sophistication it would like the B-1 to have because of the austerity mood of the Congress. It's been widely reported that modified Mark 2 integrated avionics will go into the aircraft. Indeed, there's considerable doubt that the bomber will ever make it to the production stage [*Electronics,* June 8, p. 48] but that's a hurdle that happy NAR officials will evaluate later on.

At least one aerospace marketing man believes that NAR's Autonetics division has a good chance to get the avionics work even though the parent firm is the prime. But such an award might create a political furor that would make the F-111 brouhaha look like a Women's Christian Temperance Union picnic. In any event, a Hughes spokesman says his firm, teamed with IBM, will provide the multimode radar portion of the avionics; he maintains that the Mark 2 can't do all the jobs required for the B-1 without considerable modification.

Meanwhile, questions about how raw contractor data was "weighted" and how the bid was "negotiated" went begging as sources within the Pentagon and industry continued to contend that the whole story wasn't told. The Pentagon tried to cool speculation by putting a tight lid on everyone connected with the program and by reiterating that the B-1 program is only a development effort with a production decision still several years away. Yet supporters of the program at the Defense policy level continue to say that the decision to have a third nuclear deterrent against the Soviet Union—in addition to land- and sea-based intercontinental missiles—in the form of a new aircraft is a good one, and that the plane represents a good investment for bargaining at the Vienna arms limitation talks.

Space electronics

Missile magic

A laser system put together in an Army lab may be the foolproof means of preventing stray signals from turning a missile away from its target. A missile may have to activate as many as a dozen thermal batteries for short bursts of electrical power, and also trigger explosive switching devices, or squibs. The actuating signals are distributed within the missile by wires. But these wires may have currents induced in them by stray microwave energy or, in the event

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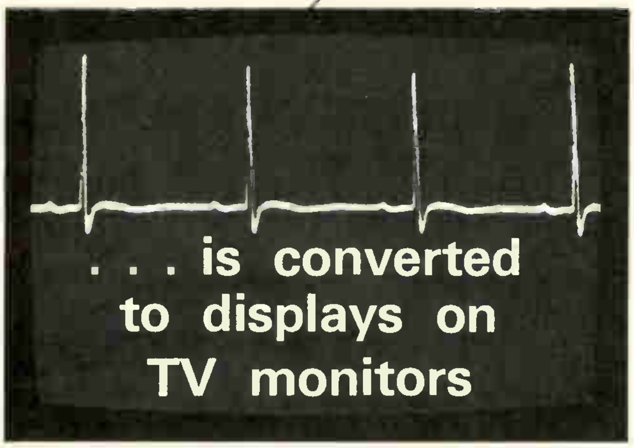

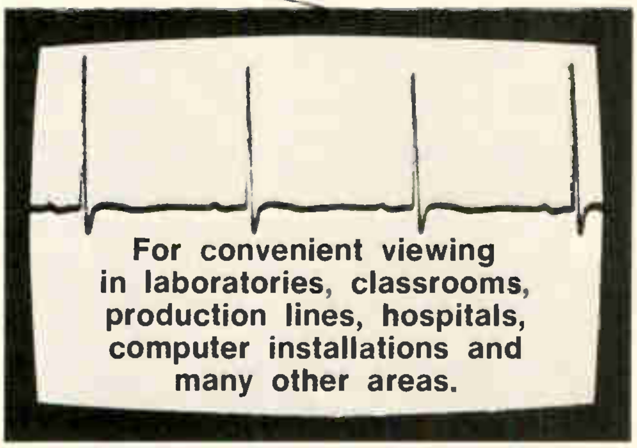

The display size is limited only by the choice of TV monitor or receiver.

The 4501 Scan Converter Unit converts alphanumeric and graphic displays written on its 5-inch CRT to displays on TV receivers and monitors operating on 525 or 625 line standards. The hi-contrast TV displays are ideal for individual or group viewing — even under bright light conditions. Displays may be viewed as light data on a dark background or as dark data on a light background, selected from the front panel.

The display device is a Tektronix bistable storage tube. With storage, displays may be written once and retained for an hour *without refreshing*. Storage is USEFUL for displaying low-repetition rate events — it's IDEAL for single events. The 4501 transfers either stored or continuously written data from its CRT to the TV monitors.

MULTIPLE DISPLAYS—The 4501 will drive multiple, inexpensive receivers and monitors. The units may be located locally or remotely. Outputs from a TV camera can be mixed with data from the 4501 to produce a picture that is an overlay of the two signal sources. With overlaying, you can instantly compare data from two different sources.

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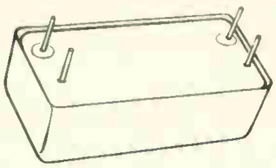

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of a nuclear blast, by electromagnetic pulse radiation. The danger: premature activation of squibs and batteries, causing the missile to miss its target.

That's why scientists at the Picatinny Arsenal in Dover, N.J., are experimenting with beams of laser energy to replace the wires. While such a laser system would be too expensive for conventional missiles, the increased reliability might be desirable for a missile carrying an atomic warhead.

Thus far, the laboratory experiments have been encouraging, says Philip Zirkind, a physicist in Picatinny's Weapons Vulnerability division. He has used a neodymium-doped glass laser to focus energy onto the explosive material in an ordinary squib.

Small can. Such a squib usually consists of a cylindrical metal container less than an inch long in which there's a small amount of explosive and a plunger. An electric signal explodes a bridge wire in the squib, detonating the explosive. This, in turn, pushes the plunger to complete the electrical contact in the circuit to be activated. Such squibs have been used for years instead of electromechanical switches. It's been found that the switches do not function reliably after missile shelf lives that can run into years.

In his experiments, Zirkind eliminated the bridge wire in the squib, using instead a transparent glass window. A laser beam in the infrared was focused through the window to detonate the explosive material. Much of the work, aided by the Unidynamics/Phoenix division of UMC Industries, studied the properties of explosive mixtures that could be ignited by i-r energy, as well as the characteristics of a laser operating in a short, confined space.

Next step, Zirkind says, is to develop a miniature system using a semiconductor gallium-arsenide or gallium-phosphide laser. And he also is interested in using fiber-optic light pipes to direct the energy within the missile. Work should begin in July, with a militarized system completed in about nine months, Zirkind says.

Sense of ERTS

In times of prosperity, the Interior Department could turn up one or two companies interested in performing R&D on a $3-million-a-year program. Whether it's a sign of hard times or, less likely, a display of industry interest in social systems, Interior finds no less than 150 organizations who want a part in its Geographic Applications Program, research in urban and regional change detection that will use a satellite platform.

GAP is aimed at improving land-use technology, and will get its data from NASA's ERTS-A satellite, due to fly in the spring of 1972 [*Electronics*, May 25, p. 133]. Until then, under an Interior project, high-altitude aircraft carrying remote sensing and monitoring devices will make test flights over Washington, D.C., Houston, and San Francisco—the areas selected for initial planning and development of display techniques and a remote sensing data base for the program.

Requests for proposals for R&D on remote-sensing applications, data handling and analysis, and regional change detection systems for GAP probably will be issued next month. For fiscal 1971, Interior's Geological Survey received a total of $3.1 million for the program—$1.5 million for data acquisition, presentation and interpretation; and $1.6 million for studies of applications, costs, and needs for remote-sensing data in natural resources problems.

Ecology. Interior wants to apply remote-sensing technology to urban environmental processes such as surface and near-surface energy; water infiltration, runoff, and balance; urban vegetation; dispersal of air and water pollution; and susceptibility to such hazards as landslides and the urban-regional energy balance. One immediate goal will be to determine the accuracy of thermal sensors in obtaining energy-emission measurements, and calculating emission differences between types of terrain, such as urban and near-urban land uses. Information obtained on urban climatological factors will be

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incorporated in a prototype analysis.

Equipment the department will investigate includes color-enhancement and additive viewers, film storage and retrieval units, magnetic tape storage and display, image-combining and sampling systems, multispectral data analyzers, optical correlation systems, digital data systems, spectral signature systems, automatic change-detection viewers, and combinations of these systems. The end product should be a semiautomatic system capable of correlation and matching, data storage and retrieval, area measurement, quick updating, distinction between classes of land use, and display of urban changes occurring over different time periods.

Computers

Digitize and conquer

Computers are idiots savant—the average one is a whiz at math but with today's input devices, most don't read very well—or at least very cheaply. And this is a problem in applications like automated stockrooms, factories, and libraries.

The basic problem is finding a low-cost, reliable way to tag the box, part, book, or person that the machine would keep track of. Unfortunately, many methods are based on optical character or mark recognition which can be confused by shake, vibration, and misaligned tapes. Often the tape must be placed a definite distance from the reader; in a magnetic system, physical contact is necessary.

Thus, what seems to be needed is a scheme with noncritical placement and noncontacting operation. The Identicon Corp., a new firm in Waltham, Mass., hopes to have the answer in a system that reads digitally coded tags almost without regard for the tag's orientation, or its distance from the reader.

Son of KarTrak. Roy P. Sallen, president of Identicon, did some of the original work on Sylvania's KarTrak railroad-car identification system. Despite KarTrak's success, Sylvania decided not to move into other fields with similar systems. Sallen left Sylvania, taking with him a license to KarTrak's basic patents in exchange for cash and some equity in his newly organized company.

But Identiscan hardly resembles KarTrak. Instead of color-coded plaques, Identiscan substitutes bar-coded digital tags small enough for test tubes, engine parts, employee identification cards, and other small items. And reading the tags is fairly simple—they use variable width reflective tape like the safety reflectors on bicycles.

An eighth-inch bar on an Identiscan tag stands for a binary 1; a bar half that width indicates a binary 0. Thus, a pulse-width modulation scheme is built right into the tag.

Within the scanner head is an incandescent lamp, some simple beam-shaping optics, and a mirror to bounce the beam onto an eight-sided reflector rotating at 1,320 rpm. Thus, the beam is scanned through a fan-shaped area in front of the reader at 176 times per second, too fast for the reader to be troubled by tag movement.

Avid reader. Any tag within that 45° fan flashes light from its strips back into the scanner, making tag positioning easy. The optics in the receive part of the scanner help also as they have a very small effective aperture allowing a large depth of field. The result is that any tag within the 45° scan angle and from two to four feet from the scanner will be read.

The returned beam hits the same eight-sided spinning mirror but is reflected into a cold-cathode photomultiplier tube. The tube's output feeds an amplifier-limiter combination and goes into decode logic as a train of width-modulated pulses. The decoder emits a bcd train suitable for computer input, or for Teletype or a paper tape punch.

Even if the tag is read upside down, the pulse train comes out right; a "start of message" bar at the top of the label tells the decode logic whether or not to invert the pulse train. Also, to prevent misidentification, a buffer stores three successive readings, all of which

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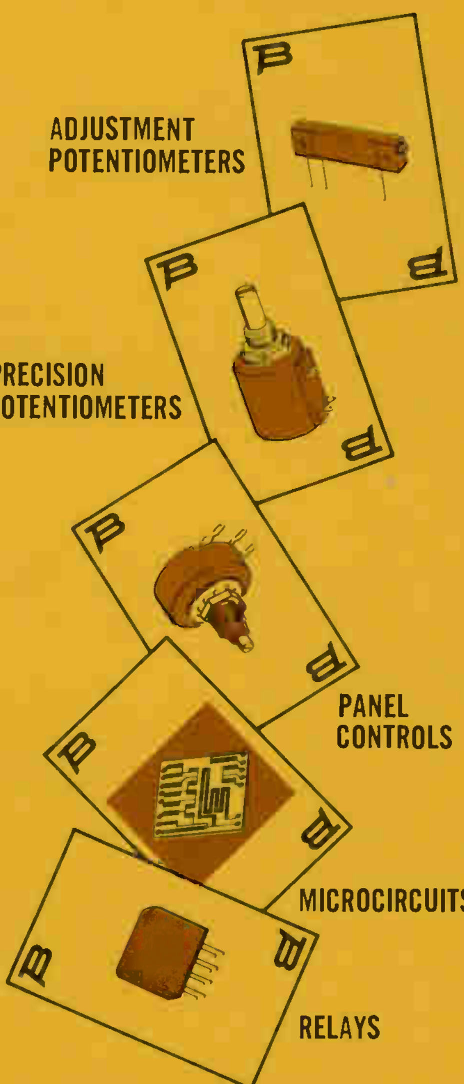

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must match before the pulse train can be transmitted. If they don't, a buzzer sounds a reject signal.

Government

Shorter shopping list

Deputy Secretary of Defense David Packard is an engineer who likes to keep things as simple as possible. He's also a very successful businessman who wants to reduce risks, particularly under tight budgets. That's why the WWMCCS (Worldwide Military Command and Control System) that Packard just approved doesn't look like the one that went into his office for review.

Instead of using a minimum of 34 standardized computers and holding options to buy up to 53 more as originally envisioned, Packard decided that a minimum of 15 computers (or as many as can be purchased for $42 million) will be acquired for use in a more austere WWMCCS.

Standard. Back in 1966, when systems studies began, the command network was planned to provide quicker information on enemy concentration and on the forces available to counteract this threat at the lowest cost. The Joint Chiefs of Staff reasoned that installing a network of standardized computers using standard software would improve data interchange while cutting the expensive software, training, and maintenance costs experienced by 55 intelligence activities using a mix of 131 computers. Batching the purchase into one contract would also reduce hardware costs, they added.

Many of the original arguments for the system still may be valid under the reduced purchase if the Defense Communications Agency is successful in keeping down the cost of developing standard programs for the new generation of hardware. But one compromise already has been made due to shrinkage—third-generation IBM equipment will be the "second standard" for 16 centers that have installed equipment until the decision is made either to retain the equipment or replace it with standard gears.

One high Defense Department official says the four computers that will be used—a duplexed large-scale processor and medium-scale processor for batch processing of intelligence files, a duplexed large-scale processor with millisecond access to its files for the actual force control, and a medium-scale scientific processor—"are third-generation machines well within the state of the art three or four years ago."

The system's communications aspects are also well within the state of the art: programs or data needed by another computer within the network will be transmitted via terminal equipment tied to the military's Autodin network. The ease of data interchange cited by the joint chiefs will result from the standard software and formating, and the compatibility of all equipment used in defense intelligence circles.

Opening. All that's really novel about the proposed system, other than cost and size, is a clause in the contract that will permit the Pentagon to buy peripheral equipment wherever it desires after the 15th computer is purchased. One Pentagon source close to the program says independent procurements of peripheral equipment were not considered for the first machines because it might cut into the savings that are expected to result from buying so many systems at once.

A request for quotations is expected to go out within two months; the first machine will be delivered in 12 to 15 months barring major obstacles. One such impediment could develop if the General Accounting Office, which has been asked to look into the system by the House Appropriations Committee, finds something amiss in the rationale for the system. A report is expected in September.

Another might result if enough companies decline to bid on the system because they would rather compete for the $400 million Air Force Advanced Logistics System, which will be opened up early

power grows where Faratron goes . . .

All Faratron modules provide the ultimate in reliability and ruggedness Designed especially for O E M systems employing the latest semiconductor devices. The FR series Power Supplies are available in six case sizes. Output voltage of 3 to 150 VDC available in each case size.

All units feature remote sensing and programming, plug in regulator board, adjustable overload protection with automatic recovery, and a unique self cooling heat sink especially designed to permit reliable operation at 71°C with currents up to 34.0 amperes.

Additional specifications include: line regulation, 0.01% (105-132 VAC); load regulation, 0.01% (no load-full load); ripple, 0.5 mv rms (3 mv peak to peak); temperature coefficient, 0.02%; and response time of 20 microseconds.

PRICE RANGE $105.00-$345.00.

For additional information ——— contact . . .

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When you buy our TWTA, you get your choice of our TWT's.

We don't think you should pay for one gigahertz more than you need.

So when you buy a TWTA from Hughes, we give you a choice of more than four traveling-wave tubes.

Besides the ten-watt tubes for S, C, X, and Ku bands, we have a selection that might fit your needs more exactly. We can guarantee, for example, ten watts of output power with 30 db of gain between 6.5 and 13.5 GHz.

We've got the power supply and the tubes available from off-the-shelf stock. We've eliminated costly custom design and manufacturing.

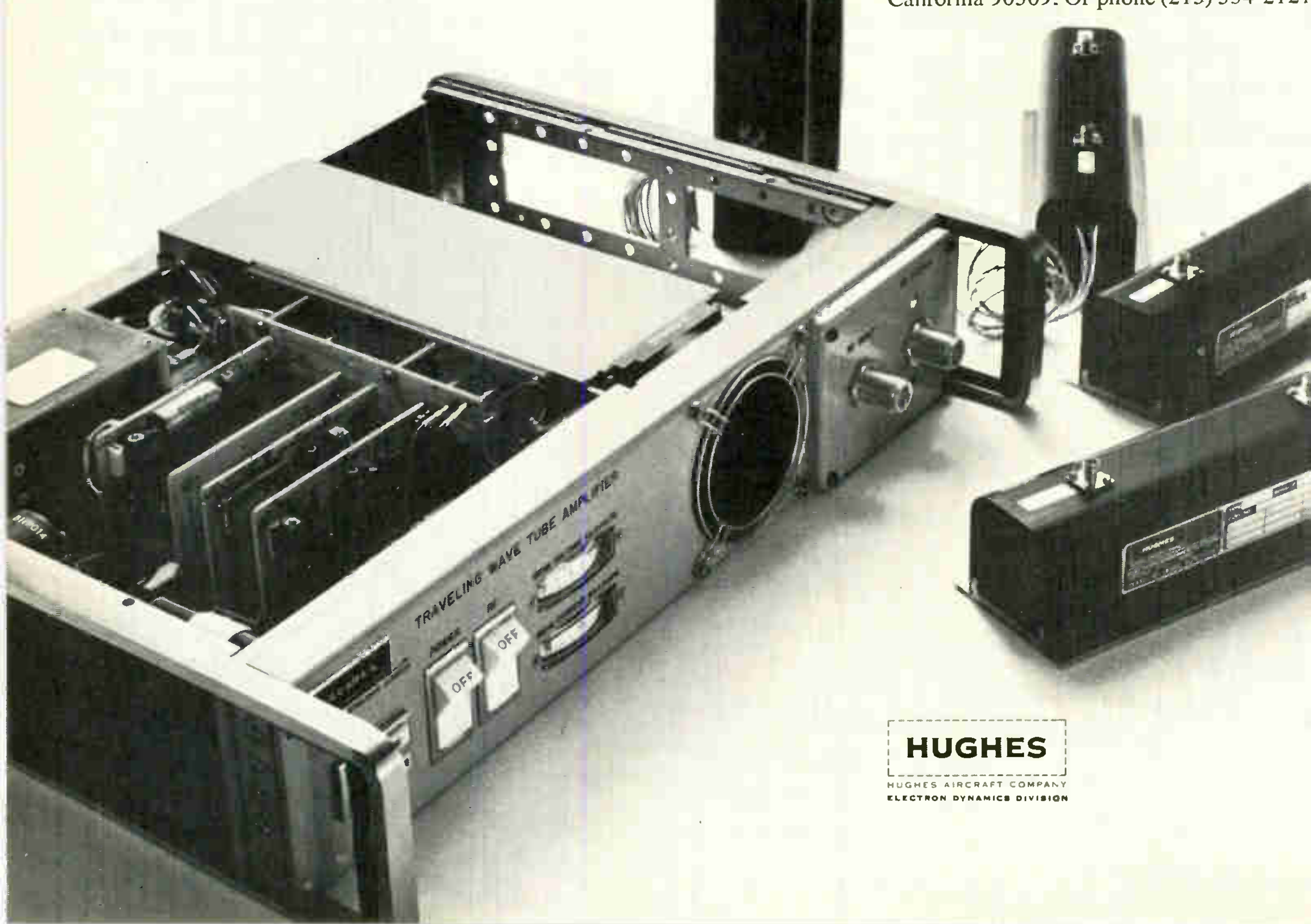
You're getting a custom unit, but it's already been engineered.

You're also getting tubes with the longest life in the business. You can expect thousands of hours of trouble-free service. (With similar tubes, we clocked 2½ million failure-free hours in space.)

We have the weight down to twenty pounds and the size down to 3⅜ x 16¾ x 13¼. Perfect for bench or rack mounting in a lab. You can carry a Hughes 10-watt TWTA just like you carry a brief case.

So if you're in the market, call us. We're the company that gives you a choice.

Write Electron Dynamics Division of Hughes, 3100 West Lomita Blvd., Torrance California 90509. Or phone (213) 534-2121



HUGHES

HUGHES AIRCRAFT COMPANY
ELECTRON DYNAMICS DIVISION

next year. "After all," one marketing man said, "only one company's bidding on WWMCCS for sure—IBM."

For the record

Pakomp. Honeywell's Data Systems division in Tampa, Fla., formed in January, has won its first contract for information-handling equipment—the prime market the division is trying to reach. The contract, worth $3.5 million, is from the Pako Corp. of Minneapolis. It calls for the development of several prototypes of a system to handle paperwork connected with the automatic photo-processing equipment that Pako manufactures. At the system's center is a Honeywell H-112 minicomputer coupled to a half-million-bit disk memory. All together, the system, which Honeywell calls Pakomp, will do such things as print invoices and bills, and calculate the retail prices to be charged for a film-developing job.

Dirt management. Pollution control programs will finally come under one roof with a White House proposal to create an independent Environmental Protection Agency to house major Federal environmental programs [*Electronics*, Jan. 19, p. 72]. In a proposal similar to one advanced by Sen. Edmund S. Muskie (D., Me.) [*Electronics*, Feb. 2, p. 79], president Nixon proposes to combine into one superagency, with a $2 billion annual budget, water pollution control from the Interior Department, air pollution and solid waste management from the Health, Education and Welfare Department, pesticide standards from the Food and Drug Administration, and radiation control from the Atomic Energy Commission.

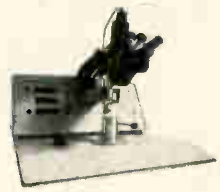
POM for COM. Computer output microfilm, or COM, is the hot new thing in computer peripheral equipment these days; but hot or not, its cost cools off a lot of prospective customers. To provide its advantages—voluminous hard copy that doesn't take voluminous storage space—at a much lower price, Advanced Terminals Inc., of Maple Glen, Pa., has introduced a continuous microfilming machine called the Formscopier. It microfilms the output of a standard line printer nearly as fast as a COM unit and much faster than hand microfilming. The company calls it printer output microfilm, or POM. One big disadvantage: it's off line. A human operator must transfer a pile of fan-folded output from an on-line printer to the POM machine. The Formscopier is priced at $4,800, compared with $50,000 to $400,000 for a COM system.

Microwaves in a can. Avantek Inc. of Santa Clara, Calif., is about to unveil a solid state microwave amplifier that has seven octaves of bandwidth (5 megahertz to 500 Mhz) and supplies 15 decibels of gain. This in itself is interesting, but what will make the announcement unusual is that the amplifier is in a TO-8 can. The devices, which are thin film IC's—gold and tantalum on a sapphire substrate employing proprietary chips—can be cascaded to provide up to 60 db.

Laser for Illiac. The University of Illinois' Illiac 4 super-computer is going to get a trillion-bit laser mass storage memory. The memory, built by Precision Instrument Co. of Palo Alto, Calif., is called Unicon (for unidensity coherent light recording) and will be built under a $1 million contract. Unicon, which will have a slower bit-transfer rate than the computer's disks, will be used to store programs, raw data, information destined for slower peripherals, and dumped data.

Fat link. To provide wider microwave satellite downlinks, Lockheed Missiles and Space figures that a laser system with a 1,000-megahertz bandwidth and a signal-to-noise ratio of 30 decibels would need just 100 watts. To show the feasibility of such a system, Lockheed has demonstrated a 450-Mhz version. It uses an argon laser, but coming are solid state lasers such as neodymium-yttrium-aluminum-garnet.

Are you thinking Hughes is big in electronics?



Good thinking.

Because Hughes put a lot of innovative thought into making better gas and solid state lasers (RS 293), microcircuit production equipment (RS 294), high vacuum equipment (RS 295), semi-automatic wire terminating and harness laying equipment (RS 296), N/C positioning tables and systems (RS 297), and FACT Flexible Automatic Circuit Testers (RS 298).

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Circle appropriate Reader Service (RS) number.

The lone ranger.

The stand-alone, do-anything 4-digit box, with resolution that makes it read like 5. Performance that won't quit, at a price that hardly gets started. $695 for the base model...lowest anywhere in the field. Our model 350 DVM.

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Plug-in our options. Like auto range, Ohms, ratio or AC. Try on a pre-amp for 1μV resolution. Fully loaded, our 350 DVM models still come in far below the nearest competition, $1570.

Hi rel, low cost. With the tightest warranty in any range. Matched by a team of Data Technology specialists, soon conducting seminars in your area, to give you insight on the newest applications and shortcuts in measurement today.

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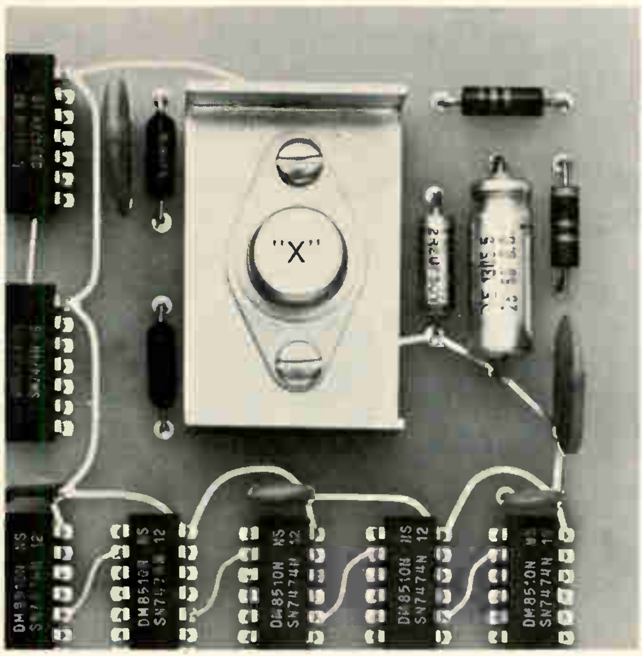
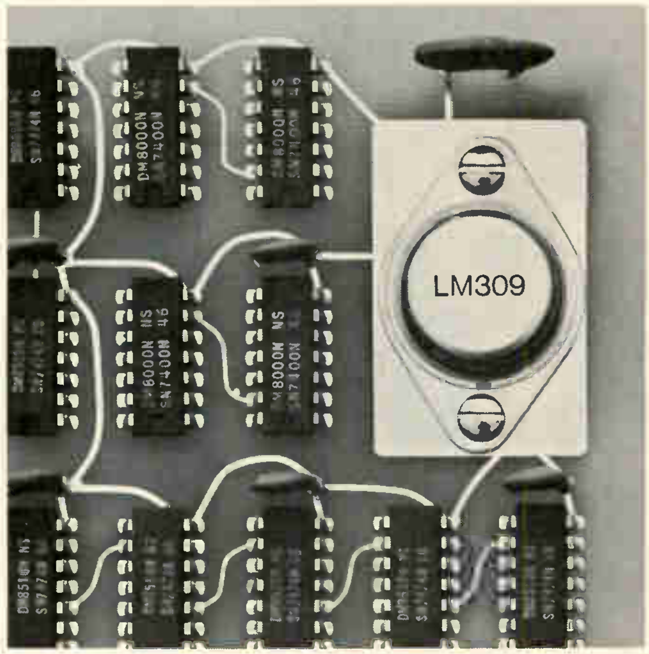
Circle 53 on reader service card

Data Technology

Get choosy about voltage regulators.

Pick a card.





Read right for the LM309 on-card 5V regulator. A single monolithic IC in a TO-3 or TO-5 package. It's blow-out proof, protected by internal thermal limiting as well as current limiting. Requires no external components or adjustments.

The LM309 is a simple replacement for the kluge on the left. The kluge also regulates voltage, after a fashion — with extra components. A few too many.

The unique low-voltage reference designed into the LM309 permits the circuit to operate at an input voltage of only 6.5 volts, increasing efficiency and minimizing the size of the heat sink. The simplicity of use, the thermal limiting and the low internal reference voltage combine to advance the state of the art for voltage regulators.

Output currents are 200mA in the TO-5 and over 1A in the TO-3 configuration. Prices in hundred lots:

TO-5 Industrial $5.50	Limited Military $7.50	Full Military $20.00
TO-3 Industrial 6.50	Limited Military 8.95	Full Military 25.00

To pick up specs and our application note, write National Semiconductor, 2900 Semiconductor Drive, Santa Clara, California 95051 (408) 732-5000 TWX: 910-339-9240 Telex: 346-353

National/Linear

Circle 55 on reader service card

RADIATION ANNOUNCES

a "do-it-yourself"

BIPOLAR ROM

512 bits (64 x 8)

65 ns access time

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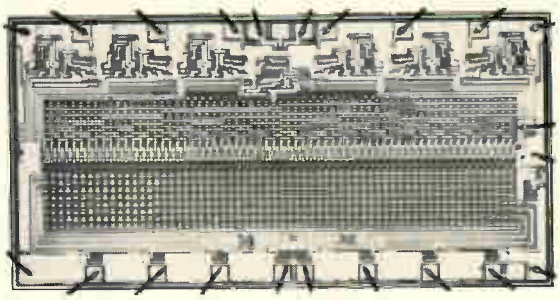
−55° to +125°C, $61.50*

*100 — 999 unit price



ONE PROM* FOR ALL ROMS

*(Programmable Read-Only Memory)

It's made for a complete range of applications:

- Microprogramming
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- Sequential Logic
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...or any application requiring many ROMS of differing patterns.

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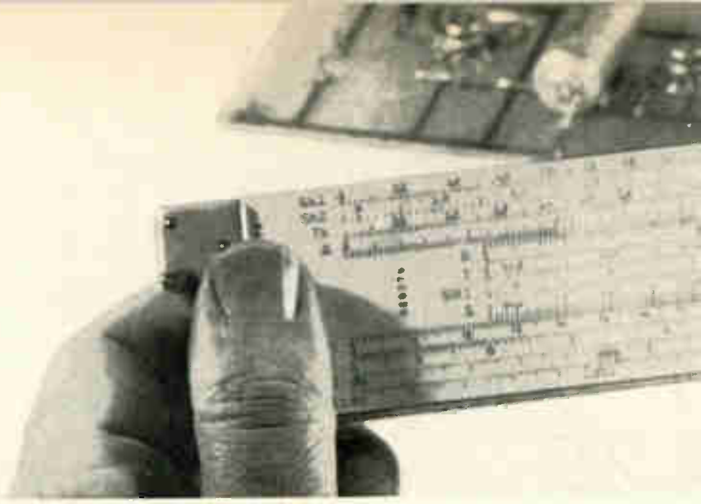
Circle 57 on reader service card

RCA Solid-State Data for Designers



Low-power astable and monostable oscillators

COS/MOS IC's offer unique advantages in low-power astable and monostable oscillator circuits.

A new RCA Application Note (ICAN-6267) describes how COS/MOS IC's in multivibrator circuits:

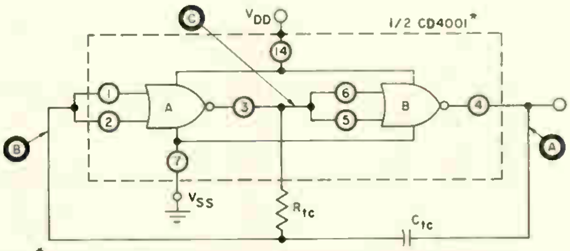
- offer large time-constants without the use of large capacitors
- operate at frequencies up to 1 MHz
- provide excellent frequency-stability over a broad operating-temperature range (−55°C to +125°C)
- permit simple circuit design—only two external components required
- consume only 10 nW @ V_{DD} = 10 V, f = 10 kHz

The schematic diagram (Fig. 1) is taken from the referenced application note and shows a typical astable multivibrator circuit using a CD4001 COS/MOS Gate. This circuit is implemented through the use of two of the gates in the COS/MOS IC plus the external capacitor and resistor incorporated to establish timing. Typical operation of the circuit is: multivibrator period approximately 0.6 ms with R_{tc} = 0.4 MΩ; C_{tc} = 1000 pF @ V_{DD} = 10 V. The voltage waveform for the circuit is shown in Fig. 2.

Application Note ICAN-6267 provides data on multivibrator frequency as a function of temperature and supply-voltage variations and includes information on nine circuits for astable and monostable oscillators built around COS/MOS IC's.

See your RCA Representative or RCA Distributor for price and delivery information on COS/MOS IC's.

For a copy of Application Note ICAN-6267, contact your RCA Sales Office or circle Reader Service No. 242.



* THIS CIRCUIT CAN ALSO BE IMPLEMENTED WITH OTHER COS/MOS DEVICES SUCH AS THE CD4000, CD4002, OR CD4007

FIG. 1. ASTABLE MULTIVIBRATOR CIRCUIT DIAGRAM

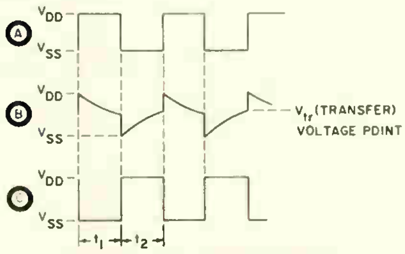


FIG. 2. VOLTAGE WAVEFORM FOR ASTABLE MULTIVIBRATOR

Thinking industrial applications? Think RCA Thyristors

There's good reason why RCA thyristors in stud and press-fit packages should be *foremost* in your mind, where industrial controls or power switching systems are your concern. Simply, RCA's broad line of SCR's and triacs provide the winning combination of quality, reliability, performance and availability for a myriad of key industrial applications. RCA has the right thyristor for the job—available now!

When you look closer, you'll find RCA is a key industrial supplier of SCR's and triacs for numerous types of industrial control equipment, motor controls, computer power supplies, heating controls, lighting controls, and power switching systems.

A broad line it is, when you consider, too, the wide selection of current ratings available from stock:

SCR's—10, 20, and 35 A

Triacs—10, 15, 30, and 40 A

Each unit is available in press-fit, stud, or isolated-stud packages. Families of RCA SCR's are rated 25 to 600 volts, and triacs are rated from 100 to 600 V—depending upon type and your requirements.

Circle Reader Service No. 243.

300-A power circuit

The RCA developmental TA7628 is a single-package power circuit containing both the TA7629 driver and the TA7630 output module—a combination suitable for use as a positive or negative switch when driven from IC logic.

The TA7628 may be used as a motor control (5—10 hp); brushless commutator assembly (300 A DC), or a high current relay (300 A).

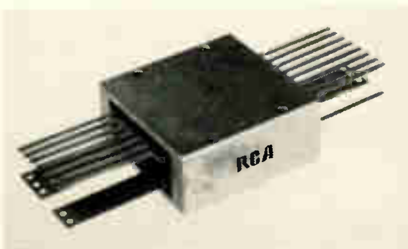
The TA7629 and TA7630 may each be purchased separately. The TA7629 provides 40-A switching capability from IC logic. The TA7630 affords higher current switching capability when suitably driven.

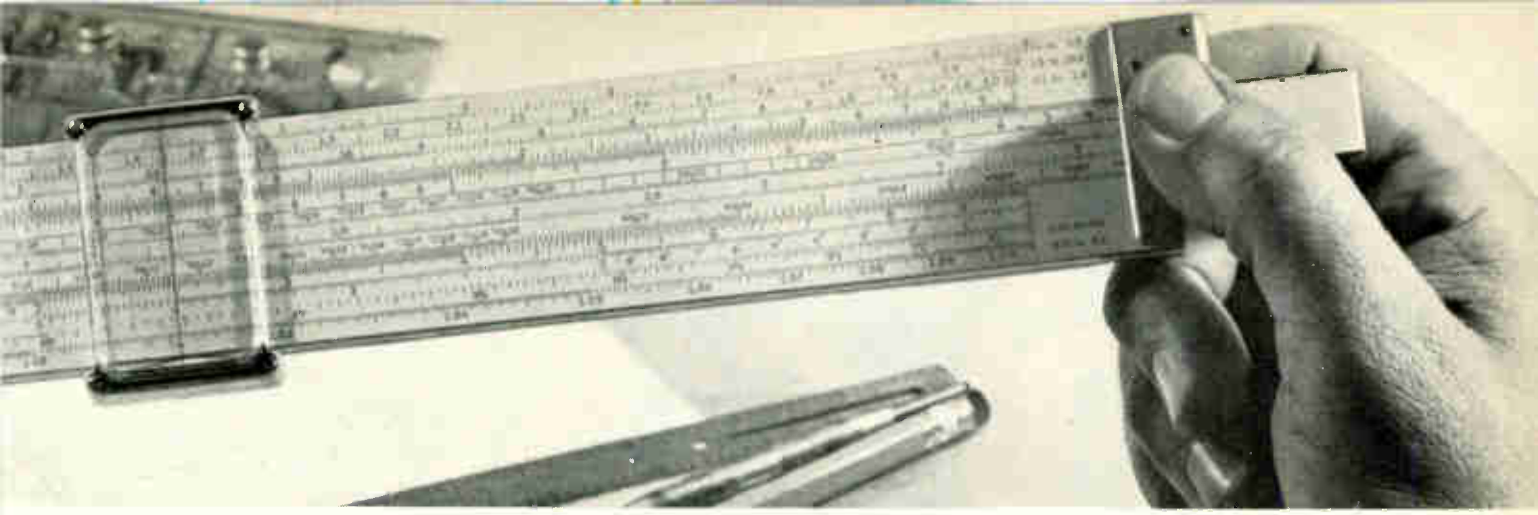
Each of these devices is obtained from basic array power modules which may be interconnected in a variety of ways to form such structures as:

- high current voltage regulators
- 4000-W inverters
- 50-A, 3-phase bridges

The basic array module used to form the TA7629 is the TA7631. It contains six 7-A and three 1.5-A n-p-n transistors; three 1.5-A p-n-p transistors; and 12 thick-film resistors. The basic array module used to form the TA7630 is the TA7632. It contains six 50-A transistors and six 50-A rectifiers. All components are electrically isolated from the case.

The TA7631 and TA7632 may be





purchased in unconnected form. Access is provided to the terminals of each internal device—permitting complete versatility in developing circuitry. These interconnections can readily be manufactured by RCA to fill your volume requirements.

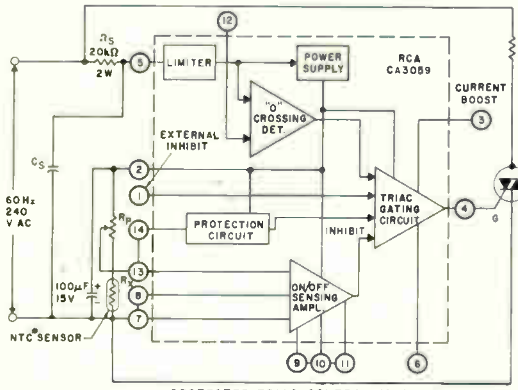
Circle Reader Service No. 244.

IC Triac control circuit with built-in protection

An IC Thyristor Trigger, RCA's CA-3059, offers the power circuit designer significant advantages:

(a) Switching transients and RFI are reduced since the IC permits switching to occur only at zero supply voltage

(b) Built-in protection against sensor failure



PROTECTED TRIAC CONTROL CIRCUIT

*NEGATIVE TEMPERATURE COEFFICIENT

In the heater application shown here, the protection circuit removes power from the load if the sensor shorts or opens. To utilize the protection circuit, connect terminal 13 to terminal 14, as shown, and then:

Set the value of R_p and sensor resistance (R_X) between 2 kΩ and 100 kΩ. Hold the ratio of R_X to R_p within 0.25 and 4. If the ratio falls outside these limits, a resistor must be added, in series with the sensor or across the sensor, to provide a resistance ratio within this allowable range.

For Triacs specifically intended to operate with the CA3059, check RCA's 2.5- to 40-ampere, 100-600 volt series, Types 40693—40734.

Circle Reader Service No. 245.

VERSAWATT: the stereophile's choice

Many "top-of-the-line" stereo manufacturers are studying the RCA 2N5494 silicon transistor—and other transistors of the VERSAWATT family—for use in their high-fidelity solid-state equipment.

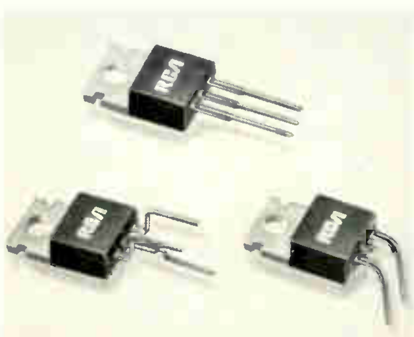
VERSAWATT TYPES FOR AUDIO APPLICATIONS

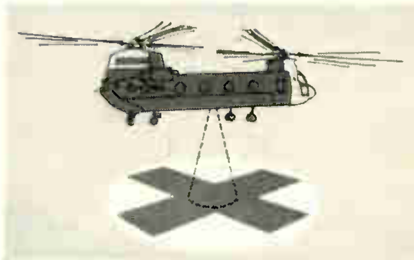
	watts	amperes
2N5296	4	1.0
2N5298	.9	1.5
2N5490	16	2.0
2N5492	25	2.5
2N5494	35	3.0

Using the 2N5494 in the output of a quasi-complimentary symmetry circuit, one manufacturer finds this low cost, 3 A n-p-n transistor especially suited to audio amplifier applications. It has a low thermal resistance rating, and its current and voltage capability contribute to high performance. An added bonus: VERSAWATT transistors employ Hometaxial-base construction to provide freedom from second-breakdown problems.

VERSAWATT transistors are available in three basic configurations—straight lead (JEDEC TO-220 AB), TO-220 AA (direct replacement for TO-66) and a package with leads shaped for easy PC board mounting.

Circle Reader Service No. 246.





High power GaAs Lasers for portable range finding devices

When a helicopter lands in a swirl of dust, the aircraft's safety may depend upon the pilot's ability to gauge distance between copter and ground.

A laser altimeter is only one device in which RCA TA7705 and TA7787 gallium arsenide (GaAs) lasers find application. They may be used in ship-docking instrumentation, anticollision devices, and many other portable ranging systems.

Since these GaAs laser diodes have short pulse duration and fast rise time ratings, equipment accuracy of a few inches is possible over a measured distance of a few feet to several hundred feet... allowing vital range resolution.

The TA7787 is unique! It is the largest single lasing chip available—55 mil source dimension. Minimum radiant power output is 60 watts at 100 PPS. The TA7705 is identical to the TA7787 except that its output is 40 W min. Drive current for both types is 250 A (typ); output pulse is 100 ns. Both units radiate at a center wavelength of 9050 angstroms.

The TA7705 and TA7787 are available in OP-12 coaxial stud packages. Why not design them into your portable ranging equipment?

Pulsing circuit diagrams for these lasers are available upon request.

Circle Reader Service No. 247.

For price and availability information on all solid-state devices, see your local RCA Representative or RCA Distributor. For specific technical data, write RCA, Commercial Engineering, Section 70F-22 /UM5, Harrison, N. J. 07029. In Europe: RCA International Marketing S.A., 2-4 rue du Lièvre, 1227 Geneva, Switzerland.

RCA

FROM THE WAVE MAKERS: A NEW SERIES OF SOLID STATE PROGRAMMABLE OSCILLATORS

Krohn-Hite's Series 4100 Rack-Mounted Solid State Programmable Oscillators are *the* new generation of medium-priced, precision general purpose oscillators. They combine the convenience of automatic programmed frequency and amplitude selection with the outstanding performance characteristics of the popular Model 4100 Push-Button Oscillator. Covering the frequency range of 0.1 Hz to 1 MHz, Series 4100 Programmable Oscillators boast a frequency calibration accuracy as low as 0.1%.

Available in four models, Series 4100 Oscillators are designed for either standard manual operation or automatic programmed frequency or amplitude selection by any one of several commonly available means, such as computer output, punched cards, punched tape or computer mag tape. Programming format is the standard 1-2-4-8 binary coded decimal system. A unique feature of the Series 4100 Programmable Oscillators is the capability to produce both sine and square wave outputs with ½ watt of power into 50 ohms with remote or local frequency control. Best of all, Series 4100 provides a degree of frequency stability, low distortion, and amplitude stability that can't be matched by competitive units.

The following chart provides a brief rundown of the important operating parameters of the new generation Series 4100 Solid State Programmable Oscillators. And don't forget the model 4100A non-programmable oscillator is still available at $550. They're all products of the recognized leader in variable filters who's out to make waves in oscillators, too. For complete technical information on any of these new Krohn-Hite Oscillators, write THE WAVEMAKERS: Krohn-Hite Corporation, 580 Massachusetts Avenue, Cambridge, Massachusetts 02139 U.S.A.

Tel: (617) 491-3211 TWX: 710-320-6583

SERIES 4100 SOLID STATE PROGRAMMABLE OSCILLATORS

Frequency Range	Osc. Model	Freq. Acc. %	Max. Volts	Output Impedance	Dist.	Square Wave	Prog. Amplitude	Approx. Ship. Wt. lbs/kgs	Price
0.1 Hz to 1 MHz	4131R	0.1	10 RMS	50	0.02%	yes	no	30/15	$1375
0.1 Hz to 1 MHz	4141R	0.1	10 RMS	50	0.02%	yes	yes	30/15	$1585
1 Hz to 1 MHz	4130R	0.5	10 RMS	50	0.02%	yes	no	27/13	$1075
1 Hz to 1 MHz	4140R	0.5	10 RMS	50	0.02%	yes	yes	27/13	$1285

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OSCILLATORS / FILTERS / AC POWER SUPPLIES / AMPLIFIERS

Washington Newsletter

June 22, 1970

New Nixon office may curb DOD . . .

President Nixon's creation of the cabinet-level Office of Management and Budget—and his appointment of the tough, liberal-oriented Labor Secretary George Shultz to head it—has defense budget planners worried. They're also concerned about the White House action creating a Domestic Council to coordinate domestic priorities, much as the National Security Council matches military programs to policy.

Preliminary estimates are that DOD could lose $5-7 billion in procurement funds over and above economies made by cutting back in Southeast Asia. With Shultz's additional authority to periodically check on every agency's adherence to spending plans, the Pentagon also sees a period of demanding justification of programs at their inception, an even tougher crunch on holding down cost overruns, and a strong economic push back to reliance on large strategic weapons, as in the Eisenhower era, rather than a broad-based deterrent force.

. . . but could give industry "handle" on urban market

Electronics industry representatives in the capital tend to share the pessimism of DOD officials that they will get less money in the year to come. But they are positive in their feeling that the new Domestic Council, headed by Nixon adviser John Ehrlichman and including all cabinet officers except the Secretaries of Defense and State, could do much toward giving industry a handle on the "urban market." Health, Education and Welfare, Interior, and Transportation, for example, "have a lot of small-money programs in their shops," says one Washington-based vice president, "and I'm hoping this new council will pull some of them together and give them more money." It will be months before the council begins coordinating technology, but a White House source concedes it will operate in that area, perhaps compensating for some of the defense cuts.

FAA seeks computer to predict collisions

The Federal Aviation Administration plans to ask industry for proposals on associative processing machines capable of predicting collision courses for air traffic controllers.

Two firms, say industry sources, have a leg up to the expected competition: Goodyear Aerospace Corp. and Honeywell Inc. Goodyear may hold the edge because it already has hardware available [see p. 96]. It recently demonstrated a 256-word by 256-bit machine using a plated-wire memory said to be able to process the equivalent of 40 million instructions per second, several times the speed of the fastest supercomputers. One of the machine's strong points is its cost—$1.9 million, against the $15 to $19 million for a supercomputer with the same prediction capabilities. Honeywell's associative processor is still on paper, but it appears to match the Goodyear machine.

NASA aims for trillion-bit flyable memory

NASA, taking the first step toward its goal of a trillion-bit optical memory for space use, will award contracts to Radiation Inc. and Honeywell Inc. The awards, from the Marshall Space Flight Center, will kick off work aimed at developing a flyable memory the size of a desk. The trillion-bit capacity will be needed, agency planners believe, aboard a 12-man space station that could be ready by the end of the decade.

Radiation gets the bigger award—about $300,000—for developing a breadboard of a holographic system able to store between 20 million bits and 200 million bits. The company plans to build an erasable page composer using manganese bismuth or lead zirconium titanate for storing laser-beam-entered data. A hologram then would be made on planar thermoplastic for permanent storage. Honeywell is expected to build an optical rotating-wheel memory with a manganese bismuth coating.

Marshall scientists say the trillon-bit memory program will have to progress in several evolutionary steps because even a satellite-borne billion-bit store is just beyond the present state of the art. NASA goals call for a 10-billion-bit memory in 1976 and one of a trillion bits by 1978.

Cable vs. satellite: FCC sets formal inquiry deadlines

The Federal Communications Commission's effort to establish policy on the controversial issue of cable vs. satellite in international communications has become a formal inquiry as predicted [*Electronics*, May 25, p. 76]. With August 16 and September 21 set as deadlines for industry comments and replies, respectively, a policy decision is not expected to come before November at the earliest. The investigation will cover present and future use of communications facilities, techniques for increasing capacity, global communications satellite systems and competition between media.

At stake in the inquiry is the communications mix of the future. The White House wants an FCC policy that regards cables and satellites as complementary rather than competitive, a stance that AT&T is expected to promote for greater diversification in facilities and routing. Comsat, on the other hand, wants an assignment of total traffic between cables, satellites and other overseas facilities.

NASA's Skylab to relay signals via Intelsat 4

It looks like Skylab is going to go up without a companion data-relay satellite. The tight budget bind is forcing NASA to turn, instead, to Intelsat 4. Thus, signals from Skylab orbiting workshops and the ground will be relayed using circuits leased from the Communications Satellite Corp.

Present plans call for leasing only a few channels for Skylab 1, but for later flights entire transponders will be leased for both voice and telemetry signals. While the use of a commercial satellite is a trial, "it could set a precedent for later flights," says one NASA official.

Addenda

The FCC is rethinking its 1968 retransmission consent policy, designed to protect uhf stations from unfair competition by fencing in 25 major market areas against CATV operation. The best alternative, says FCC chairman Dean Burch, would be to promote CATV, uhf, and educational tv, without undermining vhf broadcasters . . . The electronics industry may be one of tht biggest beneficiaries of "pollution politics"—the fight between a Republican Administration and Democratic Congress to see which can spend more. The House just approved a three-year, $775-million air-pollution control program, $200 million for fiscal 1971—nearly double the White House request. Electronics companies can expect a 5% to 10% slice of the pollution pie. . . . The Army's Missile Command will say nothing of its "fire and forget antitank system" despite its request to 22 companies for quotations on conceptual studies. However, the system is expected to be a single successor to the Tow and Shillelagh systems.

The hybrid circuit: if you don't like what we make, we'll make what you like.

We're not proud.

We've designed many different standard hybrid microelectronic modules in what we think is the optimum package type for each one.

But, if they don't suit your system, we'll gladly change the package or the circuit to suit your needs.

Our off-the-shelf line spans the spectrum from digital to video. It includes a video amplifier, memory and clock drivers and translators, gated high-power drivers and a 30-MHz IF amplifier.

All of them are our own design and if they meet your needs, we are both ahead of the game.

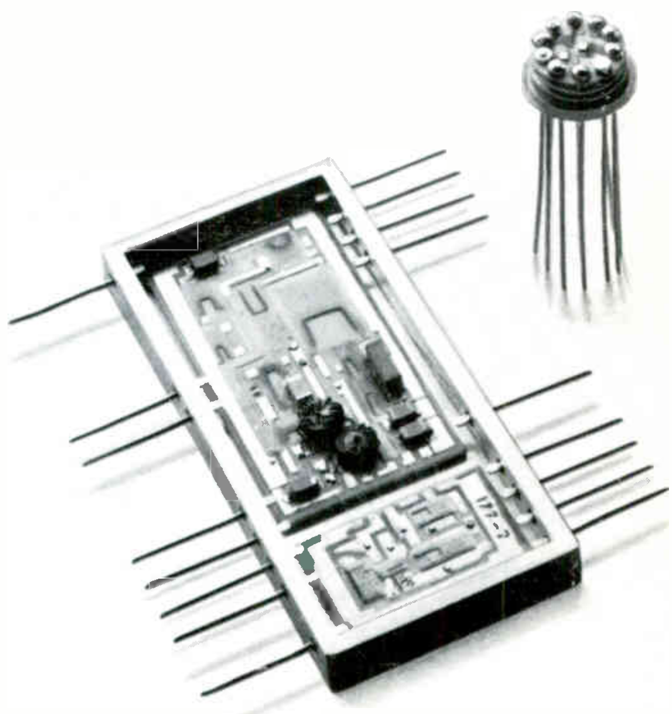
If they don't, that's where our experience and advanced hybrid techniques come into play. We can translate your design into a hybrid microelectronic module quickly, easily, *and* economically, because we don't have to waste time getting familiar with the problems.

Show us your system requirements. We'll come up with the right hybrid circuit to fill the bill.

That way we'll have a circuit we both like.

For more information, see your local representative. Sylvania Electronic Components, Hybrid Microelectronics, Waltham, Mass. (617) 893-9200, ext. 2400. SYLVANIA

GENERAL TELEPHONE & ELECTRONICS



Circle 77 on reader service card

We took Honeywell's 2206 Visicorder to Pike's Peak!

Where do you need to take one? To prove that our incomparable 2206 Visicorder goes anywhere, we connected it to something just as incomparable . . . a pair of Hart Javelin skis instrumented with STATHAM transducers. And skied Pike's Peak.

Because our oscillograph records up to 12 channels simultaneously, as well as two event channels, we were able to record several parameters incurred while skiing (see actual record below). Which means that no matter how unusual your oscillograph needs, our 2206 Visicorder can meet them. Wherever they happen to be.

Use it on a test bench. Mounted in an automobile. Or boat. Wherever portability's important! It's light-tight (with integral take-up) and records at frequencies from 0 to 13kHz. On 150 watts. Which means you can use an ordinary vehicle electrical system or separate batteries as your power source.

And the 2206 Visicorder uses a mercury vapor lamp for true ultraviolet recording. So, you get high writing speeds — over 40,000 in/sec. Better trace density. And more permanent records, with no chemical processing necessary. Plus, an optional signal conditioning amplifier package that fastens right to the Visicorder!

You don't have to take the 2206 Visicorder to Pike's Peak to get peak performance. You pick the place. Pick up the 2206 Visicorder. And see for yourself.

For more information, call or write Lloyd Moyer, (303) 771-4700, MS 222, Honeywell, Test Instruments Division, P. O. Box 5227, Denver, Colorado 80217.

Honeywell

Honeywell engineers sell solutions

LINEAR

Last month, we told you why we didn't make the "Super" Op Amp. We said that ideal op amps exist only in textbooks and real applications in the real world need a family of op amps to meet a family of requirements. Which got us into a discussion of our family of fifteen different op amps.

This month, we've got another op amp story. This one has a Moral:

EDITORIAL

You Can't Afford to Wait Until the Price Goes Down

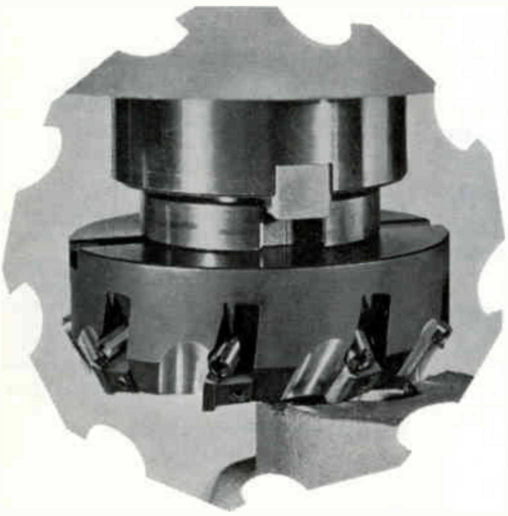
Once upon a time (5 years ago to be exact), Fairchild designed an Op Amp. It was called the μA709. It cost $64.00 and people bought them as fast as we knew how to make them. (Maybe even faster.) Some people didn't buy the μA709. They said the price was too high. And so, they built their systems the old way.

Then, as time passed, the popularity of the new μA709 grew and grew. And the price went down and down. So fast, in fact, that the companies who first used them were surprised. And happy. Their systems performed better and were more profitable than those of their more cautious fellows. Today, these companies are reaping the benefits of their foresighted decisions of those pioneer days.

Today, the μA709 sells for $1.90. MORAL? When you see a new LIC such as the μA725, μA741 or μA796, think of the lesson of the μA709. You can't afford to wait until the price goes down.

by the time you find out we're in electronics...

New power transistor packages from Ceramics Internatonal assure high strength performance in electronic circuitry.



VR/Wesson's new Whisper-Cut™ milling cutters bring a new dimension of smoothness and quietness to metal-removal tool performance.

and metalworking...

we'll be in something new!

■ Special materials technology is our business. And it takes us almost everywhere. Into established industries and newly emerging ones. To the borderline of man's imagination. Wherever environmental stress is a factor, Fansteel is important.

Our solutions come in many forms. To name a few: Precision forgings. Investment castings. Carbide cutting tools. Special metals. Electrical contacts. Composite structures.

We make more products than you imagine. And we're ready to put one (or more) to work for you now.

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Number One Tantalum Place
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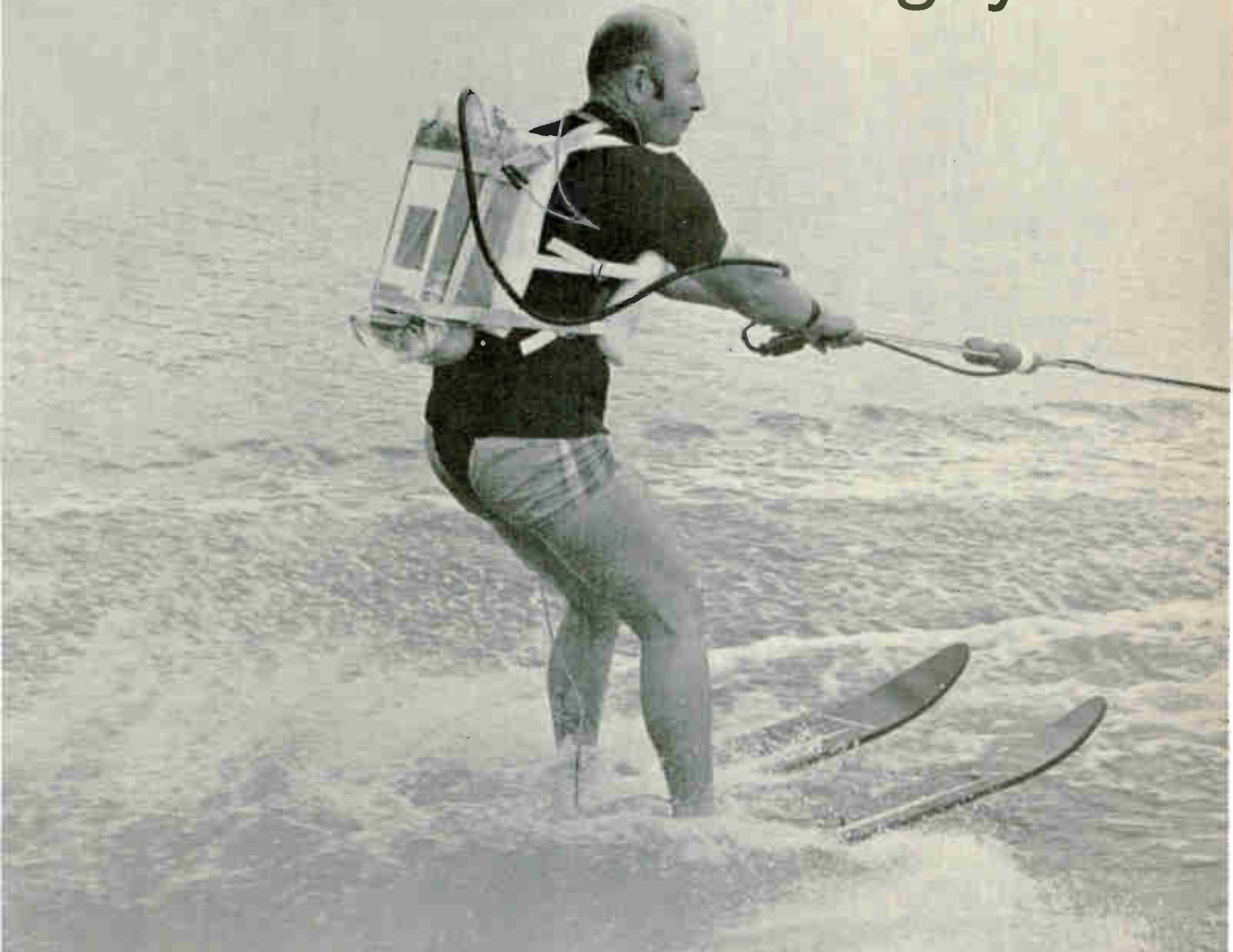
DIVISIONS: ADVANCED STRUCTURES • ELECTRONIC PRODUCTS • MECH-TRONICS • METALS • VR/WESSON

Sure. Century's oscillographs like to ski, as well as the next guy's.



For precision with maximum portability, you can't beat Century's Model 444 light beam oscillograph. That's why we took it water skiing.

Shown here, it's rigged to receive DC power from the ski boat, and to record data from strain gages attached to the right ski.

An exclusive feature of the 444 allows you to record up to six channels of data on heat stabilized paper, giving you a truly permanent record under any conditions, even when the record is being analyzed in direct sunlight.

No need telling the other advantages of a light beam oscillograph. Frequency response of the 444 extends up to 2000 Hz. You can drive it on 12 v. or 28 v. DC, or 115 v. AC.

If you're thinking about taking a rugged, high precision recorder to the field with you, plan on getting yourself a Century 444. If you don't need all six channels or maximum response, we can save you some bucks. Prices start at $1295.

At Century, we want to sell you an oscillograph, and we have an excellent range of capabilities in our product "family". When you ask for modifications, we respond quickly and with interest. We want to make life easy for you, and tough for our competitors.

Write us for more on the 444 — or a copy of our new short-form catalog on the Century family. Call or write Jim Davis at Century Electronics & Instruments, Inc., P.O. Box C, Admiral Station, Tulsa, Oklahoma, 74115, phone 918/835-9951.

Century Model 444 oscillograph.

Actual record from water ski run

Century

The Tough Recorder Guys

Circle 67 on reader service card

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

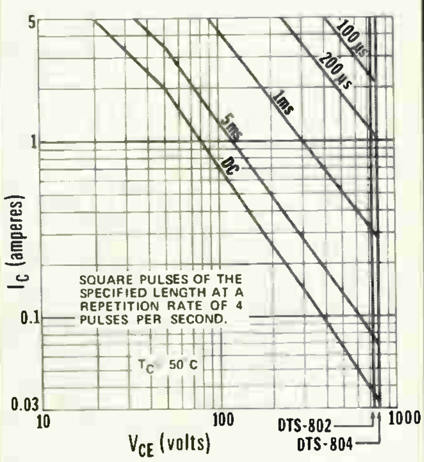
The Kokomoans' new DTS 802 and 804 NPN triple diffused silicon high energy transistors are here. You can order them from your Delco Radio distributors now in sample or production quantities. They were specially designed for high voltage inductive switching from rectified 3 phase 220 line, and magnetic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

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

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

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

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

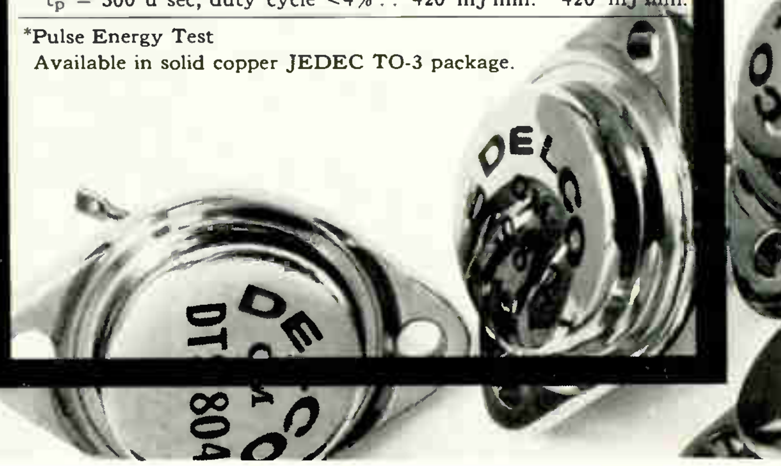


SAFE OPERATING CURVES

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

*Pulse Energy Test

Available in solid copper JEDEC TO-3 package.



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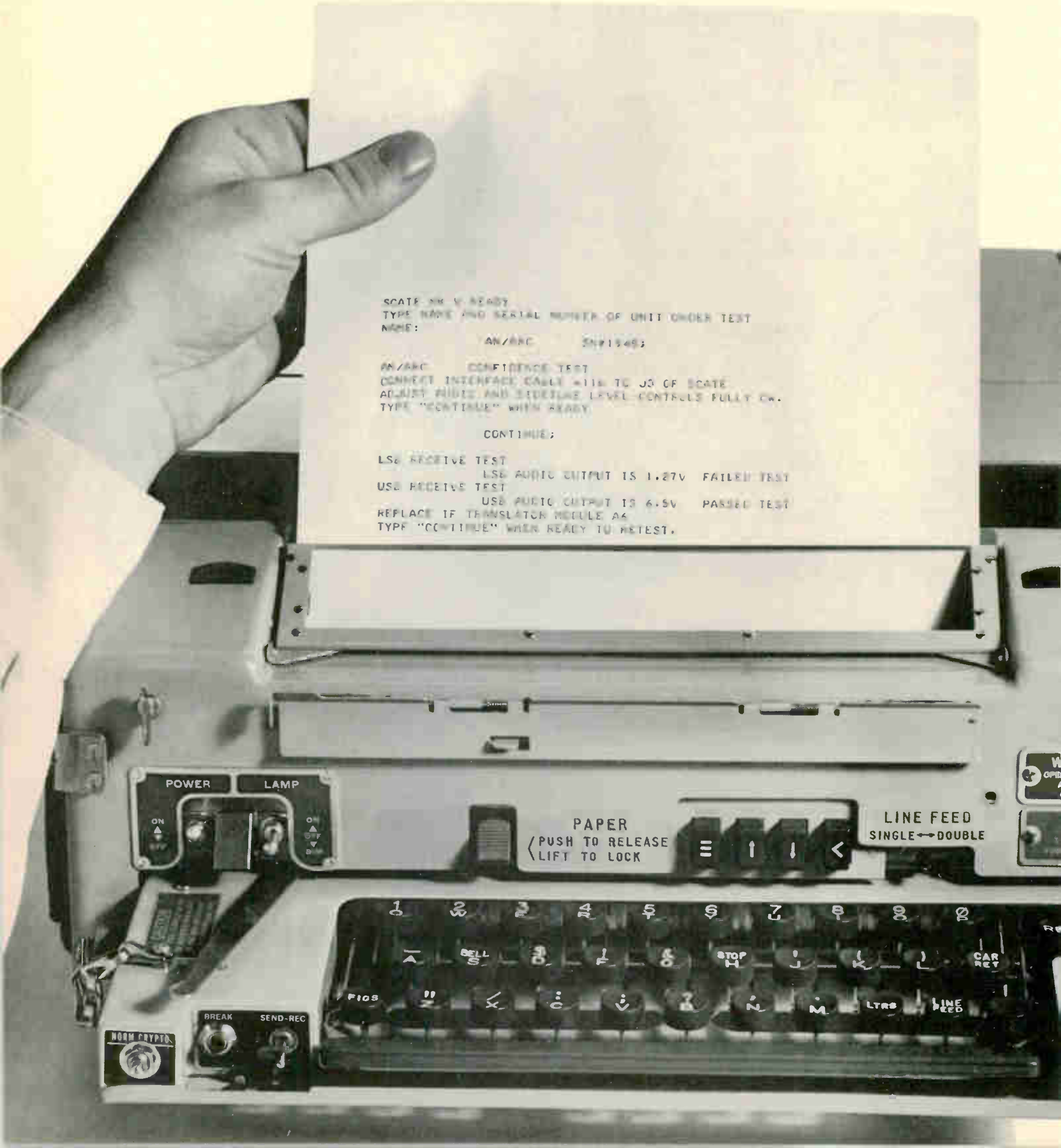
DELCO RADIO

DIVISION OF GENERAL MOTORS
KOKOMO, INDIANA

GM
MARK OF EXCELLENCE

Circle 69 on reader service card

Our new automatic test equipment tells you where your electronic system went wrong, and how to fix it. In plain English.



Each new generation of electronic systems used to bring along its own maintenance and support problems. Because each new type of electronic equipment needed new testing procedures, new training and some new test equipment.

For the Army, the problem is even greater. Because its field maintenance and support equipment has to be mobile. And it has to be relatively simple to operate.

That's where our SCATE® MK V comes in.

General Dynamics' Electronics division went to work on this problem: creating a computer-controlled automatic test system light enough to be mobile, simple enough to be operated without complex training, adaptable enough to be used for all the Army electronic systems into the mid-1980's.

The answer is SCATE MK V, a unique electronic diagnostic tool.

SCATE MK V talks English.

SCATE MK V talks your language. The man who operates it, in the field, needs no advanced training. If he can read or write English, he can be trained to use this equipment in a matter of weeks, not months.

Once an operator is trained, he does not have to know how the unit under test works. SCATE MK V already does. Its computer is programmed for that.

Because the program is in English and on line, the programming costs and time are reduced by as much as 50% compared to other automatic test equipment.

SCATE gets things down to size.

SCATE MK V is about one-third of the size of any similar existing equipment. It can be mounted in a portable shelter on the back of a truck. Or it can be delivered to the field by helicopter.

The reason for the smaller size of SCATE MK V is that its computer is used more extensively in the measurement function as well as the control function. This eliminates the need for special and redundant test equipment.

One answer for nine commodity areas.

The Army has identified a requirement for computer-controlled automatic test equipment (CATE) in nine commodity areas: radio communications; wire and carrier communications; army avionics; fire control equipment; engineering survey and map equipment; missile systems; combat surveillance; laser systems; and communications security.

SCATE MK V can be programmed to provide support in any of these materiel areas.

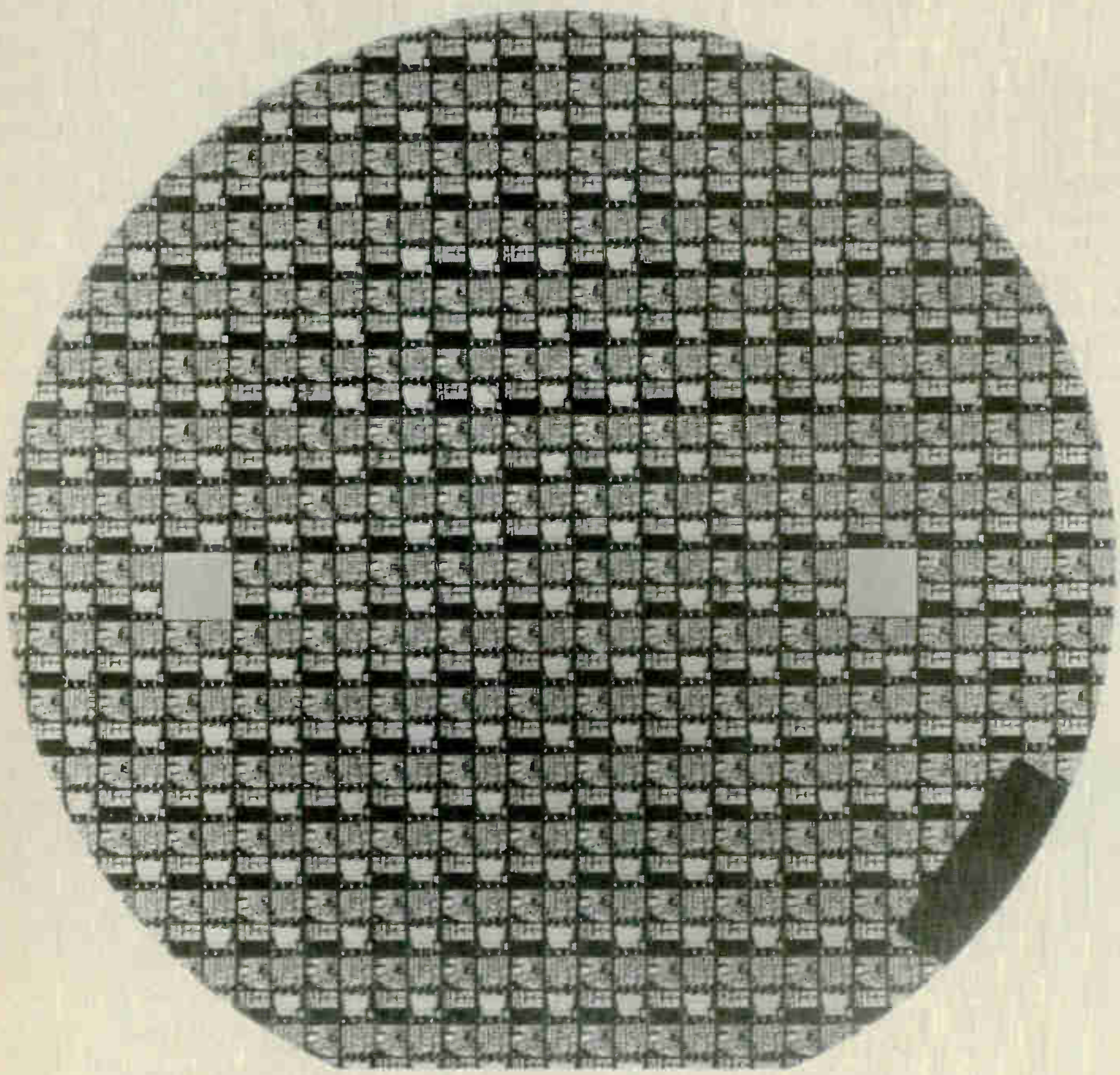
SCATE MK V is a good example of what we do best.

At General Dynamics we put technology to work solving problems from the bottom of the sea to outer space...and a good bit in between.

GENERAL DYNAMICS

Additional technical information is available on SCATE MK V on request. Write: General Dynamics, Dept. 850, 1 Rockefeller Plaza, New York, N.Y. 10020.

MUCH. MORE. MOS.



Layer any combination. Deposit any sequence. Use silicon dioxide, silicon nitride and polycrystalline silicon to build the most sophisticated MOS circuits. Even silicon gate technologies. No wafer handling. No removal from the reactor chamber.

The AMN-700 series vapor deposition systems. The first non-RF powered, high temperature, cold wall reactors designed to deposit quality dielectric films.

Unparalleled uniformity in film thickness on as many as twenty 2" wafers per station. Variation ±5% wafer-to-wafer within a run. Temperature range: 650° to 950°C. Typical properties of Si_3N_4 films deposited at 800°C are: etch rate (HF) 4-6 Å/sec; refractive index 2.0; deposition rate 100-500 Å/minute.

With depositions at 650°C, polycrystalline silicon at 0.5 micron thickness exhibits uniformity equal or better to ±10% with excellent surface characteristics and etchability.

Absolutely no RFI. That means complete compatibility with diffusion processing and testing operations. The AMN-700 series. Call collect for immediate requirements.

Applied Materials Technology, Inc., 2999 San Ysidro Way, Santa Clara, California 95051, (408) 738-0600 Telex: 34-6332 • 63 Route 206, Somerville, N.J. 08876, (201) 722-3300 Telex: 83-3439. In Europe: Advanced Semiconductor Materials, Wokingham, U.K.; Bilthoven, Netherlands; München, West Germany. In Japan: Kanematsu-Gosho, Tokyo.

e⁻ applied materials

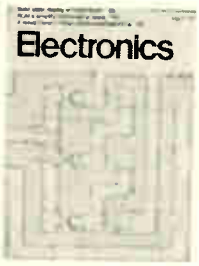
June 22, 1970

Article Highlights

Two-in-one CAD program offers flexibility at low cost
page 74

For years, circuit designers using computer aids had to go to large, costly programs to attain a wide variety of analyses, or accept the limitations of less costly systems. Now Syscap, a two-part program, offers both d-c and transient analyses and up to 80 times reduction of costs encountered in other systems.

Ion implantation offers a bagful of benefits for MOS
page 86



Though often regarded as just a method for improving switching speeds in MOS IC's, ion implantation is a much more versatile technology. In addition to providing easily controlled low-threshold voltage devices, ion implantation can be used to form depletion-mode load transistors in IC's, instead of the conventional enhancement mode load—with big gains in circuit speed and simplification of power requirements. The IC shown on the cover, for example, is a three-stage MOS oscillator with depletion loads; its 25-Mhz frequency is three times higher than similar enhancement-load units.

Speed limit is no barrier with associative memory
page 96

Thanks in large measure to new developments in plated-wire and semiconductor arrays, associative memories, which store and address data by content instead of address location, have moved out of the laboratory and toward production. Among their features are simultaneous processing of several operations, and a reduction in computer time and memory capacity required for bookkeeping functions.

Solid state controls head lineup for new color-tv sets
page 102

With economic uncertainty making many buyers a bit reluctant, color-tv manufacturers are putting their money on new solid state controls to bring up the sales charts. Electronic pushbutton tuning and automatic color correction circuits are among the features in new color-tv sets. Also slated for introduction are larger (25-inch) screens.

Coming

Liquid crystals shaping up

A different type of display technique, using the special opto-electric properties of liquid crystals, might provide the low-power, rugged, inexpensive replacements for today's crt, light-emitting diode, and gas-discharge displays.

←Circle 72 on reader service card

Two-in-one design program offers big-system flexibility with small-job costs

By E. Rivera, W. H. Dierking, R. Ranalli, and B. R. Bourbon,
Autonetics division, North American Rockwell Corp., Anaheim, Calif.

● Though circuit designers have used digital computers extensively in their major projects, progress in employing computer-aided design on a smaller scale has been slow. Applications for small, inexpensive CAD programs have been severely restricted, while broader programs are economical only in the larger design jobs. And long turn-around times, extensive listings of parts data, and rigid component-modeling boundaries in CAD programs also have curbed wider usage.

Now there's Syscap. Written for use with remote terminals linked to a CDC 6600 computer, Syscap—system of circuit analysis programs—is composed of two programs, Dicap for d-c analysis and Tracap for transient analysis. With Syscap, the designer can check worst-case d-c stresses, transient behavior, noise coupling, radiation effects, and the results of catastrophic component failures, all within his design schedule. And there's a bonus inside this versatile package—Syscap offers anywhere from two to 80 times lower computer costs than other CAD programs.

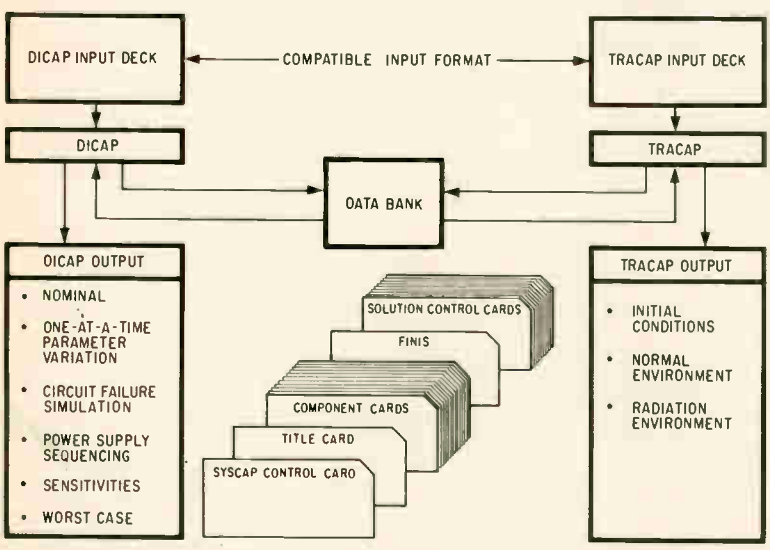
Savings depend on the amount of time to be simulated, compared with the smallest time constant in the circuit. With short time constants, if a long simulation time is required, many integration steps must be performed. This is where Syscap excels. Using a Sceptre-Syscap comparison as an example, a Schmitt-trigger circuit run through both programs resulted in 759 system seconds for Sceptre at 33 cents a second, or $250.80, while Syscap's run came to 30.8 system seconds, for $10.17.

With Syscap's internal device-parameter data bank, initial coding times run from 10 to 30 minutes. For a simple 15-node circuit, it is possible to code, perform nominal and worst-case d-c analysis, and obtain a transient analysis in one working day, instead of a man-week of breadboarding, setup, and testing.

Syscap's output format is tables and charts of voltages at each node. Also included are other internal circuit responses—voltages between nodes, various currents, and device power dissipations—determined by auxiliary equations written by the program.

Both Dicap and Tracap write nodal equations for the networks and solve them with the sparse-matrix technique: only non-zero terms are stored in the core memory. This approach permits efficient analysis of networks with up to 100 circuit nodes. Furthermore, the CDC 6600 permits two circuit simulations to exist simultaneously in the core memory and turn-around time for each one is reduced.

The Tracap program simulates the time response of a circuit to an arbitrary forcing function, which can be either a normal input signal or a power supply voltage, or could cover radiation effects. In the latter cases, Tracap models the primary photocurrents induced in all p-n junctions as a function of ionizing radiation.



Double pronged. Syscap is made up of two programs—Dicap for d-c and Tracap for transient and radiation analyses. Each uses stored semiconductor and passive-component data to analyze circuits.

In Dicap, six d-c analyses options are offered. Instructions are shown in parentheses:

- Nominal (NOMINAL)
- One-at-time parameter variation (DCONE)
- Circuit failure simulation (CFS)
- Simulation of power supply turn-on (SOPSTO)
- Sensitivity (SENSIT)
- Worst-case (W/C)

The NOMINAL analysis sets all ciruit parameters to their typical values and solves the circuit matrix. The NOMINAL option generally is used to check for input-data errors and as a quick check of circuit operation.

In the DCONE option individual parameters are varied; all others are held at their typical values. The parameter may be stepped up or down in constant sizes, or up to 19 different parameter values can be used successively.

The CFS option simulates catastrophic failures of circuit components and depicts their effects on circuit operation. In this option, transistors can be considered with opens at both the base-emitter and base-collector junctions, shorts at the two junctions, or with open and short and short and open emitter and collector junctions. Diodes, voltage sources, and resistors can be represented with both opens and shorts, and nodes can be considered both as shorted to another node or shorted to the reference node, ground.

The SOPSTO option simulates all possible worst-case power supply turn-on configurations. It takes all but two of the possible combinations of zero volts and nominal power supply voltages for all the power supplies up to seven supplies. It doesn't consider all voltages at nominal value or all at zero volts.

The SENSIT function computes the sensitivity of all circuit voltages with respect to each circuit parameter. Sensitivity is defined as the ratio of the normalized change of any output to the normalized change of a circuit parameter:

$$\text{Sensitivity} = \frac{\Delta V/VN}{\Delta P/PN}$$

where Δ V = change in some output, VN = nominal value of the output, Δ P = change in the circuit parameter, and PN = nominal parameter value.

The parameters are changed one at a time in increments of 0.1%. Any output-solution sensitivity greater than 0.05 is recorded for action by the designer.

The W/C option performs a worst-case maximum and minimum computation for each node and each auxiliary equation. Here, each parameter with a sensitivity-tolerance product (SENTOL) greater than 0.05% is set to its appropriate maximum or minimum value.

A parameter matching feature in the worst-case analysis allows the designer to specify parameters that track each other, such as the betas of two transistors on the same chip. It's unrealistic to consider, for example, worst-case situations where one beta is maximum and the other is minimum. Also indicated are any semiconductor device changes in state under a certain worst-case condition.

Three summary tables are printed: maximum and minimum node voltages occurring during the analysis, the same information for each auxiliary equation, and any overstresses that occur during worst-case analysis.

Syscap's built-in models of semiconductor components eliminate many possibilities of user error. The bipolar transistor model, a modified Ebers-Moll unit, simulates the cutoff, active, saturated, and inverted regions. Included are diffusion and depletion capacitances as a function of operating point; automatic junction breakdown and bulk resistance terms for both junctions; and transistor gain, variable with operating point with a normalized fourth-order polynomial to approximate the gain function.

Beta normal β_N is computed as

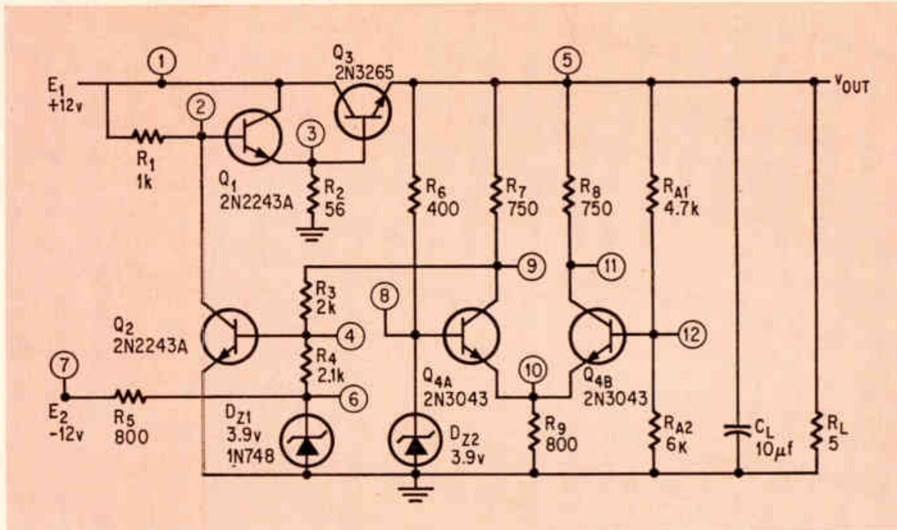
$$\beta_N = B_N\,[B_1 (\log I_{D2})^4 + B_2 (\log I_{D2})^3 + B_3 (\log I_{D2})^2 + B_4 (\log I_{D2}) + B_5]$$

where I_{D2} is the emitter junction current (the emitter terminal current minus surface leakage and alpha-inverse transistor action current) and B_N is the peak beta. The coefficients B_1 through B_5 are derived from a least-squares fit of empirical data. Beta inverse β_I, which seldom is specified by the semiconductor manufacturer, is obtained by applying a ratio to β_N with a constant B_6, which is either calculated from the one value of β_I that's sometimes given or estimated from data already gathered on similar devices. The equation for beta inverse is $\beta_I = \beta_N/B_6$.

The diode models cover diffusion and depletion capacitances as functions of operating point, bulk resistance,

Where to get Syscap

The Syscap programing system is maintained and supported by the Autonetics division of the North American Rockwell Corp. It is available at Control Data Corp. data centers through Cybernet, a nationwide communications system of data processing facilities consisting of CDC data centers and public and private remote terminals. If a Syscap user does not have access to a CDC 6600 data center, he may install in his own facility a terminal linked to Cybernet through telecommunication lines. Special arrangements can be made for many support services: special-purpose Syscap modifications, additional component models and component-part parameter data, training classes, and other consultation services.



What Syscap can do

▶ **Stress analysis:** Dicap provides d-c stresses for nominal conditions and worst-case conditions, and shows overstress caused by changes in power-supply levels. Tracap simulates component stresses from transient and duty-cycle operation.

▶ **Functional analysis:** Dicap produces the nominal and worst-case performance for a d-c circuit. Tracap generates nominal performance and, if the user sets parameters to their limits on the basis of the Dicap sensitivity test and his own engineering judgment, will indicate worst-case dynamic performance.

▶ **Radiation analysis:** Tracap determines the effects of ionizing radiation pulses and performs a neutron-effects analysis based on the worst-case analysis results. Degraded semiconductor-device properties due to neutron fluence are included.

▶ **Failure-mode and effects analysis:** For fault isolation, a catalog of potential component failures and related secondary overstresses, and the corresponding circuit-failure symptons are calculated.

▶ **MOS FET analysis:** Tracap analyzes large-scale integrated MOS circuits and shows the effects of variations in threshold voltage and other process parameters.

and surface leakage. Junction breakdown also is modeled; the zener diode is a special case.

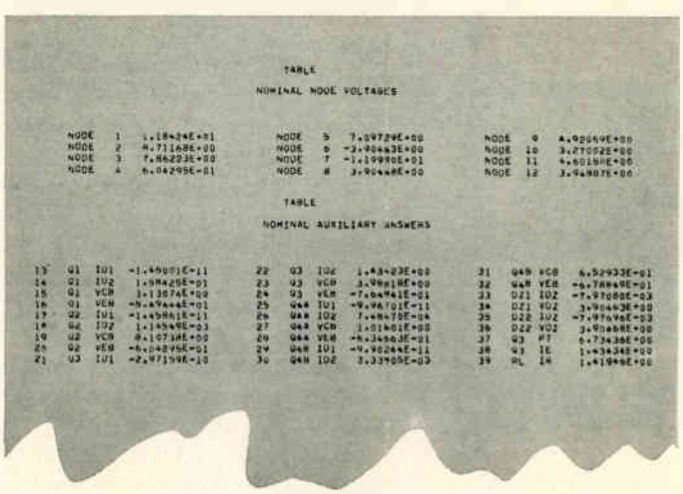
The Tracap model for four-layer devices (junction-isolated transistors, diodes of integrated circuits, and silicon-controlled rectifiers) consists of the transistor model plus a diode model for the substrate or isolation junction.

The field effect transistor model simulates metal oxide semiconductor and silicon-on-sapphire p- or n-channel enhancement mode devices. The FET unit simulates nonlinear output characteristics as a function of gate, drain, and source voltages. Also included for MOS devices are the body effect, in which the threshold voltage changes with variations in the source-to-body voltage. Reactive components are varied as a function of voltages and modes of operation.

Although the user has the option of entering MOS FET model parameters, he may instead put in basic process data and FET dimensions. The computer will use this information to set up the model parameters. Junction FET's can be modeled by adding an external voltage source and two diodes to the built-in MOS FET model.

The Tracap FET model simulates operation in the saturated region with a fixed slope. This saturated region slope varies as a function of the gate-to-source voltage, and the slope of the characteristics in the active region varies as a function of both the gate-to-source and drain-

Printouts. For the regulator, Dicap delivers nominal and auxiliary voltages, currents and powers, nominal states of the semiconductor devices, a worst-case summary, and a table of effects of component failures.



TABLE

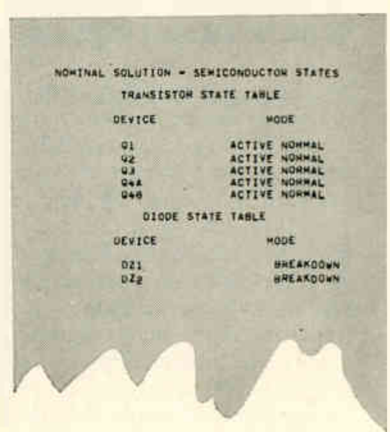
NOMINAL NODE VOLTAGES

NODE	1	1.18424E+01	NODE	5	7.09729E+00	NODE	9	4.92069E+00
NODE	2	4.71168E+00	NODE	6	-3.90463E+00	NODE	10	3.27002E+00
NODE	3	7.86223E+00	NODE	7	-1.19990E+01	NODE	11	4.60198E+00
NODE	4	6.04295E-01	NODE	8	3.90448E+00	NODE	12	3.94807E+00

TABLE

NOMINAL AUXILIARY ANSWERS

13	Q1	IU1	-1.44601E-11	22	Q3	IU2	1.43423E+00	31	Q4B	VCB	6.52933E-01
14	Q1	IU2	1.98425E-01	23	Q3	VCB	3.98018E+00	32	Q4B	VEB	-6.78849E-01
15	Q1	VCB	3.13074E+00	24	Q3	VEB	-7.64941E-01	33	DZ1	IU2	-7.97080E-03
16	Q1	VEB	-6.69444E-01	25	Q4A	IU1	-9.96701E-11	34	DZ1	VU2	3.90443E+00
17	Q2	IU1	-1.45861E-11	26	Q4A	IU2	7.48470E-04	35	DZ2	IU2	-7.97694E-03
18	Q2	IU2	1.14549E-03	27	Q4A	VCB	1.01401E+00	36	DZ2	VU2	3.90448E+00
19	Q2	VCB	8.10731E+00	28	Q4A	VEB	-6.34563E-01	37	Q3	PT	6.73438E+00
20	Q2	VEB	-6.04295E-01	29	Q4B	IU1	-9.90244E-11	38	Q3	IE	1.43434E+00
21	Q3	IU1	-2.47159E-10	30	Q4B	IU2	3.33905E-03	39	RL	IR	1.41944E+00


NOMINAL SOLUTION - SEMICONDUCTOR STATES

TRANSISTOR STATE TABLE

DEVICE	MODE
Q1	ACTIVE NORMAL
Q2	ACTIVE NORMAL
Q3	ACTIVE NORMAL
Q4A	ACTIVE NORMAL
Q4B	ACTIVE NORMAL

DIODE STATE TABLE

DEVICE	MODE
DZ1	BREAKDOWN
DZ2	BREAKDOWN

DICAP FREE FORM INPUT DATA

OICAP CONTROL CARO—NOMINAL, ITER=150
SERIES REGULATOR

Q1, NPN (B2, C1, E3) 2N2243A
Q2, NPN, (B4, C2, EG) 2N2243A
Q3, NPN (B3, C1, E5)P, IE 2N3265
Q4A, NPN (B8, C9, E10) 2N3043
Q4B, NPN (B12, C11, E10) 2N3043
DZ1 (A6, CG) 1N748
DZ2 (AG, C8) 1N748
E1 (+1, −G) 12, +5, −5, RS=.1
E2 (+7, −G) −12, +5, −5, RS=.1
RL (5, G) I, 5, +5, −5
CL (G, 5) 10U
R1 (1, 2) 1K, +5, −5

R2 (3, G) 56, +5, −5
R3 (9, 4) 2K, +5, −5
R4 (4, 6) 2. 1K, +5, −5
R5 (7, 6) 800, +5, −5
R6 (5, 8) 400, +5, −5
R7 (5, 9) 750, +5, −5
R8 (5, 11) 750, +5, −5
R9 (10, G) 800, +5, −5
RA1 (5, 12) 4. 7K, +5, −5
RA2 (12, G) 6K, +5, −5

FINIS

Regulator. Syscap, when applied to the d-c regulator circuit, is entered in the computer with the list of instructions shown next to the circuit. The commands show the device designation, its nodal connections, its value or its type number, and the input voltage sources with their series resistances.

to-source voltages. A variable combination of a current source and a dynamic resistance are used for d-c characteristics.

To illustrate Syscap's versatility, consider a d-c voltage regulator design, on page 76. Three types of analysis will be performed to highlight Dicap's usefulness: a nominal analysis, a worst case check, and an analysis of the reaction of the regulator to extreme conditions caused by catastrophic failure of components. Then Tracap will be used to check transient and radiation-environment performance.

The first step using Dicap is to provide a description of the circuit, with all nodes numbered, and to state, for each device in the circuit, the purchase tolerances or end-of-life parameter limits. Note that only minimal information is needed to describe the type of component, its position within the circuit, its parameters, and parameter limits. Coordinating circuit topology with a data bank of device parameters minimizes the input-coding time so all that's necessary, once the circuit has been described, is addition of a card to indicate the type of analysis desired. Creating the Dicap data deck ordinarily takes from 10 to 30 minutes.

Since a formal record or document of the results of a design or analysis generally is required, Dicap's printed output formats are designed for direct insertion into reports. The printed output is divided into two sections: the circuit node voltages and the dependent circuit currents, differential voltages, and power dissipations resulting from the auxiliary equations.

Another output of Dicap's nominal analysis option is a description of the state of each semiconductor device in the circuit. For example, the state shown for the two zeners, DZ_1 and DZ_2, is breakdown.

All resistors have been assigned 5% tolerance. But the semiconductor device information stored in the data bank allows for up to ± 500% parameter variations—transistor current gains, for example, vary from a maximum of 200 to a minimum of 40. These extremes, combined with resistor variations and unregulated input voltages, cause the widest possible swings of all circuit node voltages, power dissipations, and currents.

During the first run of the regulator's worst-case analysis, many worst-case condition combinations cause regulator output voltage to exceed the ± 5% tolerance specification. The results indicate that regulation was not achieved either because of situations where transistor Q_{4A} was saturated and transistor Q_2 was cut off, or because other combinations forced the differential amplifier into a state in which transistor Q_{4A} was cut off and transistor Q_{4B} was saturated. Here, then, tighter parameter tolerances would be needed to obtain the 5% worst-case regulation. (Note, however, that this example is presented only to emphasize Dicap's usefulness; no

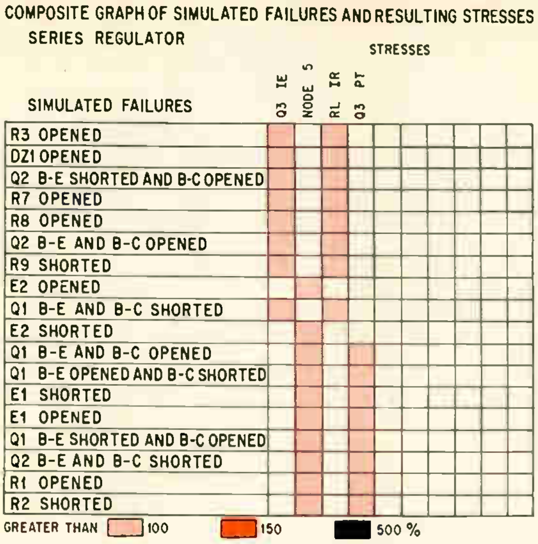
TABLE
SUMMARY OF WORST CASE NODE VOLTAGES

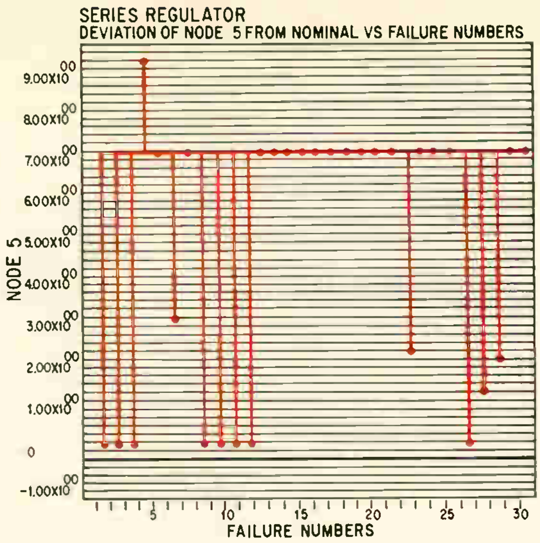
NODE NAME	NOMINAL VALUE (VOLTS)	MINIMUM VALUE (VOLTS)	MAXIMUM VALUE (VOLTS)
NODE 1	1.18424E+01	1.12308E+01	1.24520E+01
NODE 2	8.71168E+00	8.59284E+00	8.96881E+00
NODE 3	7.86273E+00	7.75099E+00	8.07627E+00
NODE 4	6.04295E-01	5.31339E-01	6.22566E-01
NODE 5	7.09729E+00	6.99300E+00	7.27244E+00
NODE 6	-3.90463E+00	-3.89418E+00	-3.91482E+00
NODE 7	-1.19990E+01	-1.13991E+01	-1.25989E+01
NODE 8	3.90448E+00	3.89950E+00	3.91129E+00
NODE 9	4.92069E+00	4.66505E+00	5.07065E+00
NODE 10	3.27002E+00	3.23829E+00	3.29003E+00
NODE 11	4.60160E+00	3.97902E+00	5.38670E+00
NODE 12	3.94887E+00	3.92767E+00	4.01382E+00

TABLE
CIRCUIT FAILURE SIMULATION
(GROUPED BY COMPONENTS)
SERIES REGULATOR

FAILED PART	MODE OF INDUCED FAILURE	TYPE OF OVERSTRESS	VALUE OF STRESS	ALLOWABLE VALUE
Q1	BASE-EMITTER SHORTED AND BASE-COLLECTOR OPENED	NODE 5MIN	62.0 MV	2.5 V
Q1	BASE-EMITTER SHORTED AND BASE-COLLECTOR OPENED	Q3 PT MIN	154.1 MW	1.5 W
Q1	BASE-EMITTER SHORTED AND BASE-COLLECTOR OPENED	Q3 IE MIN	13.2 MA	601.0 MA
Q1	BASE-EMITTER SHORTED AND BASE-COLLECTOR OPENED	RL IR MIN	12.4 MA	598.0 MA
Q1	BASE-EMITTER OPENED AND BASE-COLLECTOR SHORTED	NODE 5MIN	-4.0 MV	2.5 V
Q1	BASE-EMITTER OPENED AND BASE-COLLECTOR SHORTED	Q3 PT MIN	.9 MW	1.5 W
Q1	BASE-EMITTER OPENED AND BASE-COLLECTOR SHORTED	Q3 IE MIN	.0 MA	601.0 MA
Q1	BASE-EMITTER OPENED AND BASE-COLLECTOR SHORTED	RL IR MIN	-.8 MA	598.0 MA
Q1	BASE-EMITTER AND BASE-COLLECTOR OPENED	NODE 5MIN	-4.0 MV	2.5 V
Q1	BASE-EMITTER AND BASE-COLLECTOR OPENED	Q3 PT MIN	.9 MW	1.5 W
Q1	BASE-EMITTER AND BASE-COLLECTOR OPENED	Q3 IE MIN	.0 MA	601.0 MA
Q1	BASE-EMITTER AND BASE-COLLECTOR OPENED	RL IR MIN	-.8 MA	598.0 MA
Q1	BASE-EMITTER AND BASE-COLLECTOR SHORTED	NODE 5MAX	10.9 V	7.4 V
Q1	BASE-EMITTER AND BASE-COLLECTOR SHORTED	Q3 IE MAX	2.2 A	1.5 A
Q1	BASE-EMITTER AND BASE-COLLECTOR SHORTED	RL IR MAX	2.2 A	1.5 A
Q2	BASE-EMITTER SHORTED AND BASE-COLLECTOR OPENED	NODE 5MAX	7.9 V	7.4 V
Q2	BASE-EMITTER SHORTED AND BASE-COLLECTOR OPENED	Q3 IE MAX	1.6 A	1.5 A
Q2	BASE-EMITTER SHORTED AND BASE-COLLECTOR OPENED	RL IR MAX	1.6 A	1.5 A
Q2	BASE-EMITTER OPENED AND BASE-COLLECTOR SHORTED	NONE		
Q2	BASE-EMITTER AND BASE-COLLECTOR OPENED	NODE 5MAX	7.9	7.4 V
Q2	BASE-EMITTER AND BASE-COLLECTOR OPENED	Q3 [illegible]AX	1[illegible]	1.5 A
Q2	BASE-EMITTER AND BASE-COLLECTOR OPENED	RL [illegible]	[illegible]	1.5 A
Q2	[illegible]SE-EMITTER AND BASE-COLLECTOR SHORTED	N[illegible]IN	[illegible]	2.5 V
Q[illegible]	[illegible]E-EMITTER AND BASE-COLLE[illegible]OR SHORTED	[illegible]IN	[illegible]	1.5 W
[illegible]	[illegible]-EMITTER AND BASE-COL[illegible] SHORTED	[illegible]	[illegible]	601.0 MA
[illegible]	[illegible]-EMITTER AN[illegible] BASE-C[illegible] SHORTE[illegible]	[illegible]	[illegible]	[illegible]

Failure. The circuit failure simulation for the regulator produces a chart that shows the effects on important voltages, currents and powers, and one (right) of output voltage deviations due to the failures.





Major features of Syscap

Program-written auxiliary equations. Syscap will automatically compute many circuit responses other than node voltages: transistor currents and power; diode and resistor current and power; capacitor and inductor voltage and current; FET drain current and power; and voltage and current source current and power.

Simplified data entry. Syscap's input language can accommodate a variety of formats: a 1-megohm resistance, for example, can be stated either as 1 MEG, 1. MEG, 1.E+6, 1000K, 1000000, or 10EO5. Decimal points can be used but are not necessary and values can be entered with number suffixes or with standard exponent notation (EO5). Other suffixes are $T=10^{12}$, $G=10^{9}$, $MEG=10^{6}$, $K=10^{3}$, $M=10^{-3}$, $U=10^{-6}$, $N=10^{-9}$, $P=10^{-12}$.

Free-form data input cards. Syscap's structure is such that groupings are made of related data and an overall input data order is necessary. But exact column placement of the data is not required. Information must be coded in the following order: component name, device type (if required), nodal connections, auxiliary equation requests, and data specification.

Sparse matrix-solving techniques. Only non-zero matrix elements are stored and manipulated to reduce core storage requirements and speed up solutions.

Independent voltage and current sources. Voltage and current-controlled current and voltage sources are available. Current-controlled sources are set by current through a resistor; voltage-controlled sources are set by the voltage across any two nodes.

Component parameter data bank. Permanent storage of model parameter data for transistors, diodes, zener diodes, and transformer cores is available.

Linear transformer model. An ideal linear transformer model is available with Tracap.

Capacitor and inductor model. Tracap's capacitor model is represented as a capacitance with 10^{6}-megohm shunt resistance and a series resistance whose value may be entered by the user. An inductor is an ideal inductor with a series resistance set by the user.

Nonlinear convergence techniques. A modified Newton-Raphson iteration technique is used for its rapid convergence, allowing Syscap to compute a minimum number of matrix solutions. Modeled nonlinearities include the full range of semiconductor p-n junction voltage-current functions; bipolar transistor gain as a function of operating point; and FET dynamic output characteristics.

Diagnostics. Both Tracap and Dicap include diagnostic messages to help detect input data errors. For certain errors, the computer will assume a correction and perform NOMINAL or INITIAL CONDITIONS simulation.

Tracap restart. If a run is interrupted because it has exceeded a fixed computer time limit or because a long simulation is being divided into shorter runs, Tracap can be restarted without losing results from the first run. However, a radiation run may not be restarted if ionizing radiation or its effects still are present in the simulation.

Min/max store feature; Tracap can save the maximum or minimum value of a node voltage or auxiliary equation during a particular time period and print it out at the end of the run, together with the time when max or min occurred and the user-specified start and end times. This could be used for the maximum power dissipated in a transistor and its time of occurrence.

Integrate feature: With Tracap, the user can select output solutions to be integrated between specified time limits.

Stress check feature: Tracap can test selected output solutions for overstress conditions. It can present an equivalent rectangular pulse whose peak value is equal to the maximum value of the solution during the overstress period and whose area is equal to that under the actual overstress curve.

User-controlled termination. The user can stop a Tracap simulation if any output solution satisfies a predetermined criterion.

Increment feature. Though Tracap does not necessarily generate solutions that are evenly spaced in time, an increment feature is available to allow the user to obtain such solutions.

Postprocessing of overstress information. After making a run, Dicap produces tabular and graphical outputs of conditions of overstress that occurred during the run.

Automatic device state determination. Dicap and Tracap examine the terminal bias conditions of active devices and then, after a NOMINAL Dicap solution or an INITIAL CONDITIONS Tracap solution, tabulate the device states. This is done for both transistors and diodes; Tracap also does it for FET's.

attempt is made to optimize other properties of a good design, such as minimum power dissipation and temperature effects.)

To restrict the regulator transistors to the active state, and to maintain 5% regulation of the output voltage (node 5), resistors R_{A1} and R_2 and resistors R_3 and R_4 are changed from a tolerance of 5% to 1%. The characteristics of transistors Q_{4A} and Q_{4B} are designated as matched, so the parameter-matching feature option is used. With these changes, the voltage variation at the output of the regulator is approximately +2.47% and −0.067%—well within the ±5% regulation requirement.

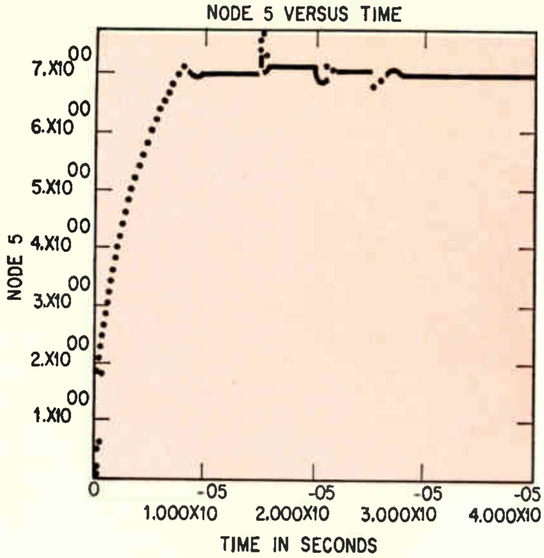
In this simulation, maximum and minimum values for each of the 39 regulator output solutions were obtained using only 42 seconds of computer time.

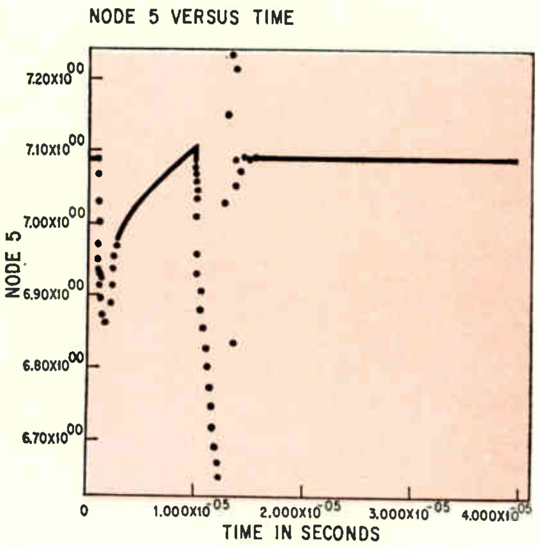
For a circuit-failure simulation, Dicap, in addition to being given the CFS instruction on the control card, must be told which component failures it is to simulate. Since failure of all components will be requested for this example, the words "QALL, DALL, FALL, RALL, STOP," must be punched on a card and added to the data deck.

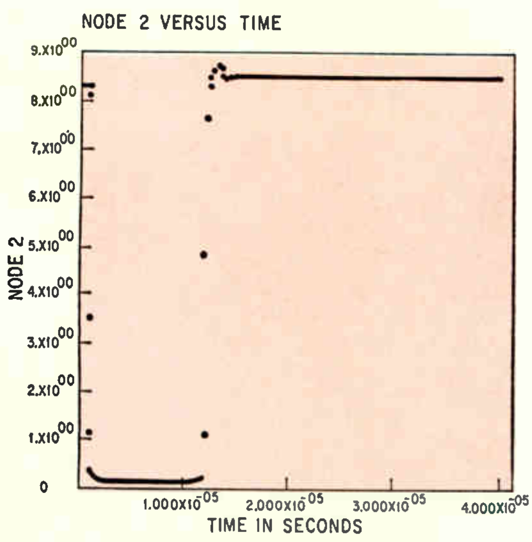
After each component failure is simulated, a complete description of the reaction of the regulator is assembled and printed out. The type of failure first is described, then is followed by a list of the overstresses computed as a result of that failure. Then all the node voltages are listed, with circuit auxiliary output solutions listed below them. After all failures have been simulated, a table is printed, as on page 77, summarizing all overstresses and related component failures.

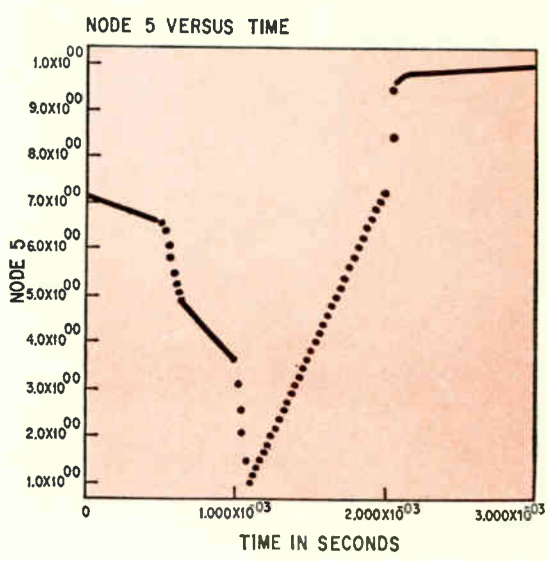
The CFS output chart, on page 78, indicates the effects on a circuit of simulated component failures. The chart is designed to graphically depict the component overstresses related to each failure. The shading of squares indicates the degree of overstress, beyond a rated value, to which each part has been subjected. The chart can be used as a circuit repair guide to determine which parts to remove in addition to those which have failed: overstressed parts may still function, but reliability could be degraded.

Writing of fault-isolation procedures may be expedited with another of the CFS graphical output charts provided by Dicap, on page 78. This chart plots voltage deviation of the output for each induced failure. Note









Transients. The regulator's transient turn-on curve (top) is calculated by Tracap, which also analyzes radiation effects. The middle curve shows output under radiation, the lower curve shows the voltage at the Q_2 collector, and the curve to the right shows the regulator voltages under linearly varying radiation dose rates up to 10^8 rad(Si)/second.

Tracap analyzes an inverter

To indicate how easy it is to use Syscap, Tracap was applied to the simple inverter circuit shown. Eleven statements, each listed on a separate input card, were read to the computer. The first indicates the desired amount of output printing and plotting:

CALC/PLT = 1, PLT/PRT = 1

Here the CALC/PLT ratio is 1, indicating that every calculated point will be plotted. Similarly, every plotted point will be printed, since PLT/PRT = 1. The next statement sets up the computer to accept data on the test circuit:

TEST CIRCUIT

The next three statements describe the circuit by identifying the component, stating its placement between numbered nodes, and giving its value. Active devices are described by stating the connections to the nodes and by giving the device type.

R1 (1, 2) 1K
R2 (3, 4) 330
Q1, NPN (EG, B2, C3) 2N2222

A description of the power supply follows, giving its positive and negative terminal connections to the nodes, its value, and its series resistance—0.1 ohm:

E1 (+4, −G) 7, RS = .1

The next statement enters information about the input signal: its nodal connections, its shape, its series resistance, its two voltage levels, and the duration of time in nanoseconds for each portion of the pulse—baseline, rise, top, fall, and end of section of interest:

E2 (+1, −G) PULSE, RS = .1, −1.5, +2.8, 100N, 10N, 500N, 20N, 1010NSEC

The circuit description is now complete:

FINIS

Then the computer is requested to plot the computed waveform for node 3 and node 1 on the same graph.

PLOT = NODE 3 + NODE 1

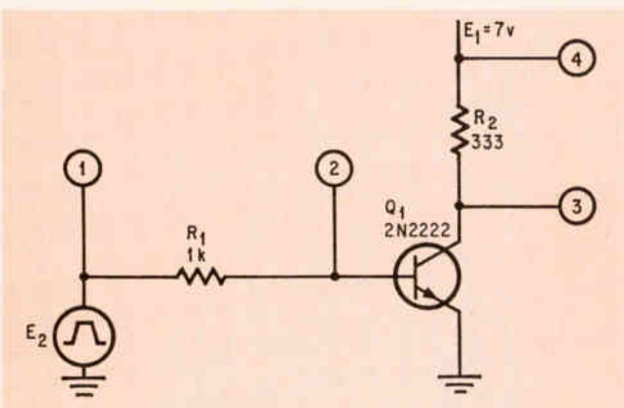
With the next instructions the computer begins to solve difference equations for the circuit with a time step size of 10 nsec and continues until 1,000 nsec of simulation time have been reached:

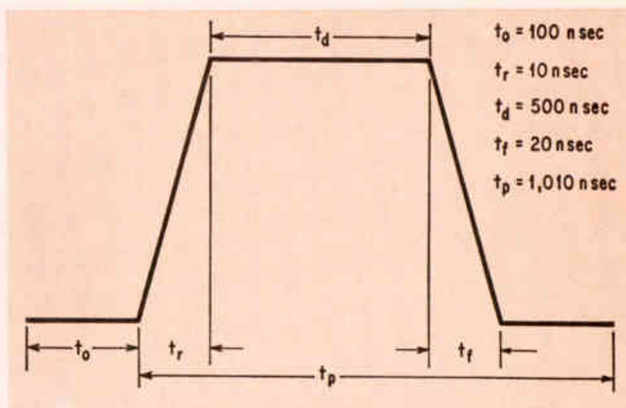
TIME = 10N, 1000N

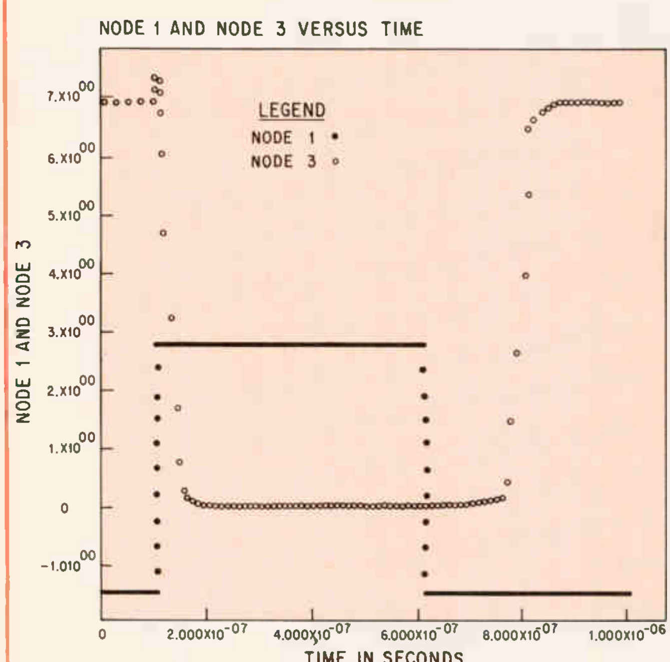
The final command asks the computer to calculate initial conditions with $E_2 = -1.5$ volts, and then use this as the circuit solution for time = 0.

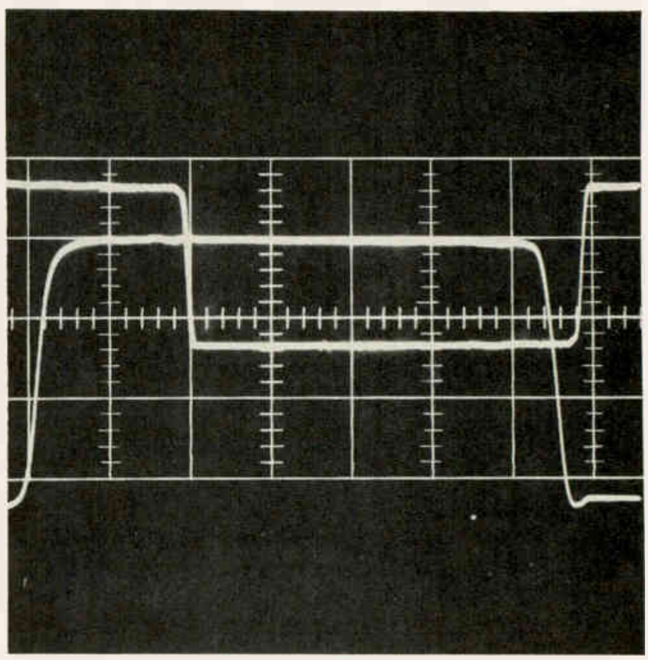
INITIAL = COMPUTE

The results of the Tracap simulation and analysis are shown, together with an oscilloscope display of the actual circuit response.









How Syscap pays off

Syscap Features	Advantages			Same features in		
	Lower Computer Cost	Lower Manhour Cost	Extended Capability	Ecap	Circus	Sceptre
Engineering-oriented input language		X		yes	yes	yes
Free-format data cards		X		yes	yes	yes
Component-parameter data bank		X		no	yes	note 1
Sparse matrix solving techniques	X	X		no	note 2	no
Sophisticated device models		X	X	no	yes	note 1
Superior nonlinear convergence techniques	X			no	no	no
Program-written auxiliary equations		X		yes	yes	yes
Restart capability (Tracap only)	X			no	yes	yes
Special user convenience features:						
Tracap						
Integrate function		X	X	no	no	no
Stress function		X	X	no	yes	no
Max/min function		X		no	yes	no
Output of user-specified intervals		X		no	yes	no
Dicap						
Extensive post-processing of results		X	X	no	NA	NA
Special graphical output		X		no	NA	NA
Both Tracap and Dicap						
Automatic device state determination		X		no	no	no

NA—not applicable
notes: 1. Stored model feature can be used for both device models and component parameter data.
2. Matrix packing is employed—equivalent to Syscap.

that for failure number 4, Q1 BASE-EMITTER and BASE-COLLECTOR SHORTED, the voltage at node 5 is a unique value, not even close to any of the others. This also occurs for failures 6 and 27, while 9, 22, and 28 all are quite close to each other in value. These unique voltage values can be used to isolate failed parts with simple d-c measurements.

The information on these charts also might help the designer to locate test points at circuit nodes exhibiting the largest number of unique voltage deviations. For those failures not exhibiting simple, unique voltage deviations, the designer can examine the charts and find unique combinations with which to isolate the failures. If the designer wants to determine transient turn-on stresses and stability as a function of load changes and unregulated supply-voltage changes, he can use Tracap. The control card must be changed in the input data deck, and several transient solution control cards must be added.

An important feature of the Tracap transient simulation program is the ability to vary bipolar transistor gain as a function of operating point. Most other analysis programs use a constant value of beta for all operating points. However, a constant beta model would have changed the simulation results in this transient simulation of the voltage regulator.

In the transient turn-on characteristics of the regulator on page 79, the importance of a variable beta may not be obvious. However, if constant betas were used, the regulated level would have been reached in approximately 2 to 3 microseconds, rather than in 10 μsec as is actually the case. Also, with constant betas, the peak current and power stresses may have exceeded stress levels. But, with variable betas, more realistic simulation of device operation is achieved with the associated current, and power surges and turn-on time.

Tracap can also predict operation of the regulator when exposed to ionizing radiation. The regulator was subjected to three levels of radiation—10^6, 10^7, and 10^8 rad (Si)/sec—and the response to each is shown in the plot on page 79.

In another simulation, radiation was varied continuously as a function of time, from 10^6, to 10^8 rad (Si)/sec. This was done to illustrate that radiation test results may not always be predictable because an allowable variation in the expected dose rate may completely alter the behavior of the circuit. For example, with a 9-μsec ionizing pulse that has an amplitude of 10^7 rad (Si)/sec, the circuit apparently regulates to 7 volts $\pm 5\%$. However, as shown on page 79, Q_2 is saturated for the duration of the pulse, and the apparent regulation is achieved from the primary photocurrent of the series element Q_3.

The initial dip in the output voltage curve on page 79, at about 1 μsec, is a result of the characteristics of the photocurrent generator. A depletion and a diffusion term are included in the photocurrent model; the diffusion portion is time-dependent. At the end of the radiation pulse (approximately 10 μsec), a second dip in output voltage is observed in the plot; this occurs because the radiation effects are diminishing, and the amplifier and inverter need time to recover from their saturated conditions.

Once the cause of the response is isolated, changes can be made to correct it. For example, at high levels of radiation, saturation could cause damage to the power-supply load. But a transistor that is non-functional except in the presence of radiation could be added to the circuit, with collector connected to the base of Q_3, base connected to ground, and emitter open. If this device were the same type as transistor Q_3, its photocurrent generation would cancel the effect of photocurrent generation in Q_3, thereby eliminating regulator saturation. ●

Designer's casebook

Designer's casebook is a regular feature in Electronics. Readers are invited to submit novel circuit ideas and unusual solutions to design problems. Descriptions should be brief. We'll pay $50 for each item published.

Zeners cut corners in MOS gate driver

By Roland J. Turner

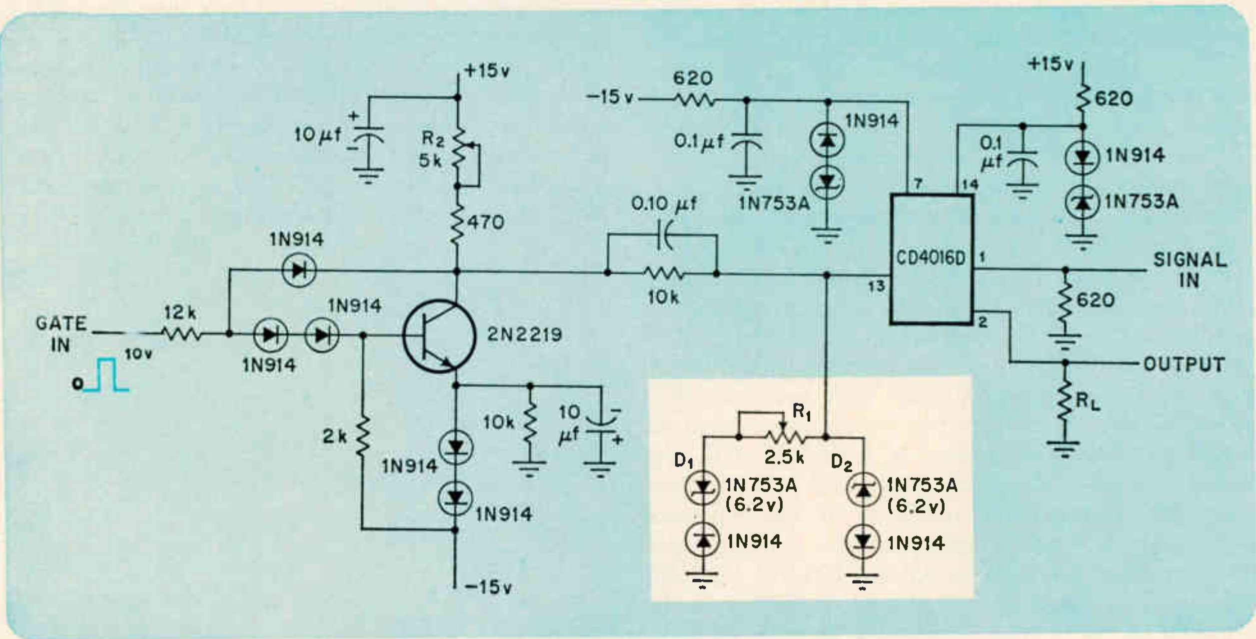
General Atronics, Philadelphia, Pa.

The availability of complementary-channel MOS sampling-gate circuits, such as RCA's CD4016D, earlier designated as the TA5460, provides the opportunity to increase the dynamic range of sample-and-hold circuits. But the drive circuits must be designed to take full advantage of C/MOS devices and achieve the reduced transients—the fundamental purpose of going complementary in this type circuit. A driver circuit was designed that achieves maximum transient peaks in the load that are 46 decibels down from the maximum gating amplitude, compared with transients as little as 20 db down without the circuit. Furthermore, the energy in such transients is very low—about 5 x 10^{-8} volts-second.

In an exponential drive waveform, the sudden changes of slope at the beginning of the rise and at the top of the pulse are the major sources of transients that could be coupled to the load through the gate-to-load capacitance. The drive waveform would be better if it had no slope discontinuities and if it had as low a turn-on and turn-off slope as possible, while still gating within the desired time interval.

Zener diodes with series resistance round off the corners of the drive waveform. In addition, a nonsaturating drive switch prevents direct feedthrough of the input waveform—a condition that would exist in a saturating switch driver due to the coupling from input to output.

The waveform at the collector of the nonsaturating drive, the 2N2219, switches from +15 volts to −14 volts and drives the zener-diode shaping network to turn off the CD4016D gate. The collector waveform has sharp corners that are softened by D_1 and D_2 so that a smooth transition is presented to the gate input. The two diodes also limit the input swing applied to the CD4016D to about +7 volts and −7 volts (6.2-volt zener plus forward drop for the 1N914). R_1 is varied to adjust the off-going transient, and resistor R_2 takes care of the on-going transient.



Corner softener. The zener diodes, with their series resistances, will soften the sharp edges of the drive waveform applied to the complementary MOS switch. This softening reduces the transients that appear in the output waveform and thus increases the dynamic range of the switch.

Exclusive-OR IC's serve for phase-locking tasks

By George S. Oshiro

Teledyne Systems, Los Angeles, Calif.

An exclusive-OR circuit can serve as a simple phase detector in a phase-locked loop. The circuit is insensitive to noise because the control voltage is averaged and noise pulses have low d-c components. And it can be used from d-c to about 5 megahertz.

The inputs to the quad-gate exclusive-OR IC are the output signal, f_0, and the reference signal to which the output is locked. The exclusive-OR circuit's output is high (logic 1) when the reference and output signals are in the same states.

The resulting train of pulses is filtered to extract its d-c component. The d-c is amplified to set the frequency of the voltage-controlled oscillator.

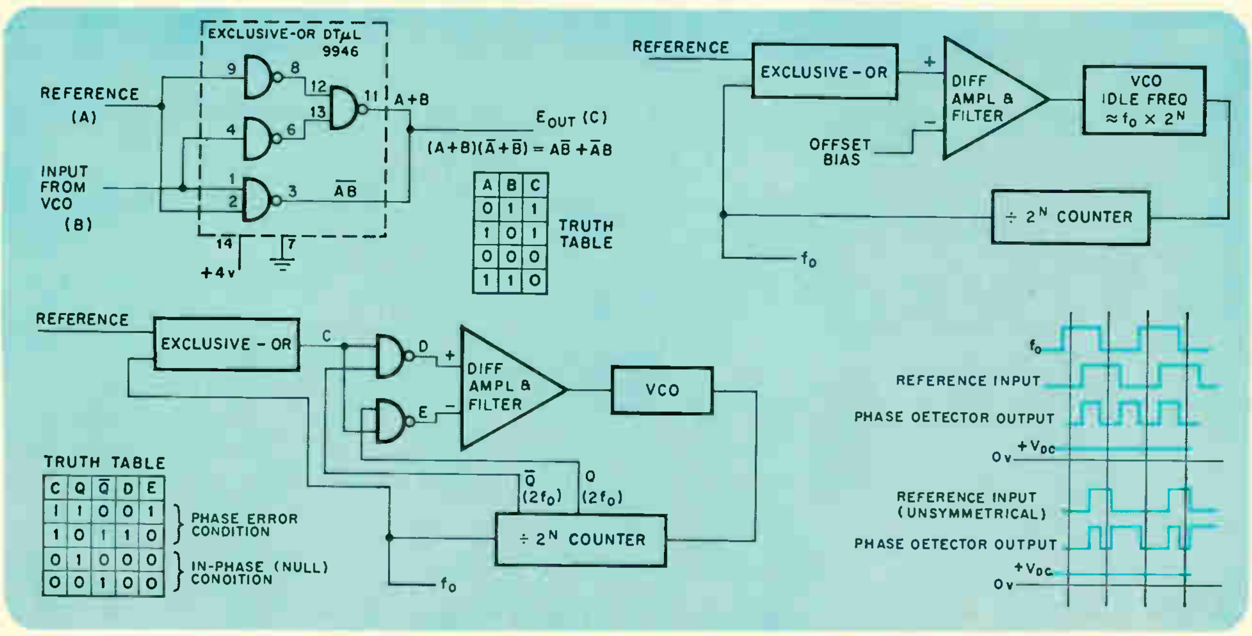
The d-c level corresponding to the desired frequency of the output is nulled out with an offset bias applied to the amplifier. Thus, when the output is at the desired frequency, the nominal, center-frequency voltage is applied to the voltage-controlled oscillator. If the output tends to increase in frequency, the exclusive-OR output increases its duty cycle; its d-c level increases, and this change in d-c voltage is transmitted to the VCO to decrease its frequency. Decreases in output frequencies are counteracted in a similar way.

In the circuit shown, the offset bias is set to make the reference and the output signals 90° out of phase—there will be 90° between the midpoints of the high part of the waveform. The VCO's frequency however, can be any factor 2^N times the reference frequency and must be divided down by the same factor to develop the output frequency. Thus the VCO's frequency can be higher than the reference, making design of the VCO easier.

With this scheme, the d-c component of the exclusive-OR output is independent of the reference's duty cycle, and thus small changes in the reference's symmetry are ignored if the reference signal frequency stays constant. Also, narrow noise pulses on the reference waveform are essentially ignored, since they will have only a small d-c component. However, because the offset bias is fixed, there can be a drift with temperature that would be interpreted as an error signal.

With two NAND gates added to the circuit, the drift problem can be eliminated because the outputs of the NAND gates will have similar temperature characteristics. In addition, this scheme provides an output that is in phase with the input.

With this setup, the truth table shows that when the exclusive-OR output is high—a logic 1—there is a phase-error condition. The exclusive-OR output will be high when the reference and the output signal are different, indicating that they are out of phase. When the exclusive-OR circuit output is low—logic 0—the reference and output are in phase and D and E are both low.



Locking it in. The exclusive-OR circuit compares the signal output with the reference and delivers a train of pulses whose d-c value sets the frequency of the voltage-controlled oscillator. With two additional NAND gates, the circuit provides an output in phase with the input.

Dynamic braking emf signals motor to reverse

John E. Bjornholt

Motorola Government Electronics, Scottsdale, Ariz.

For years, d-c motors have been braked by placing a resistance across the motor after power is disconnected. But the voltage generated as the motor slows also can be used as a signal to set up the motor drive circuit for the next sequence of events. For example, in a motor-driven antenna, the generated voltage is used to provide the necessary switching to reverse the connections to the motor, thus switching its scan direction.

In the circuit, K_1 is a latching relay—it has two coils that need only be pulsed to move the contacts to the opposite position, where they remain until the next pulse to the opposite coil. Assume that coil L_1 had been pulsed last and the contacts are as shown. The motor is turning clockwise.

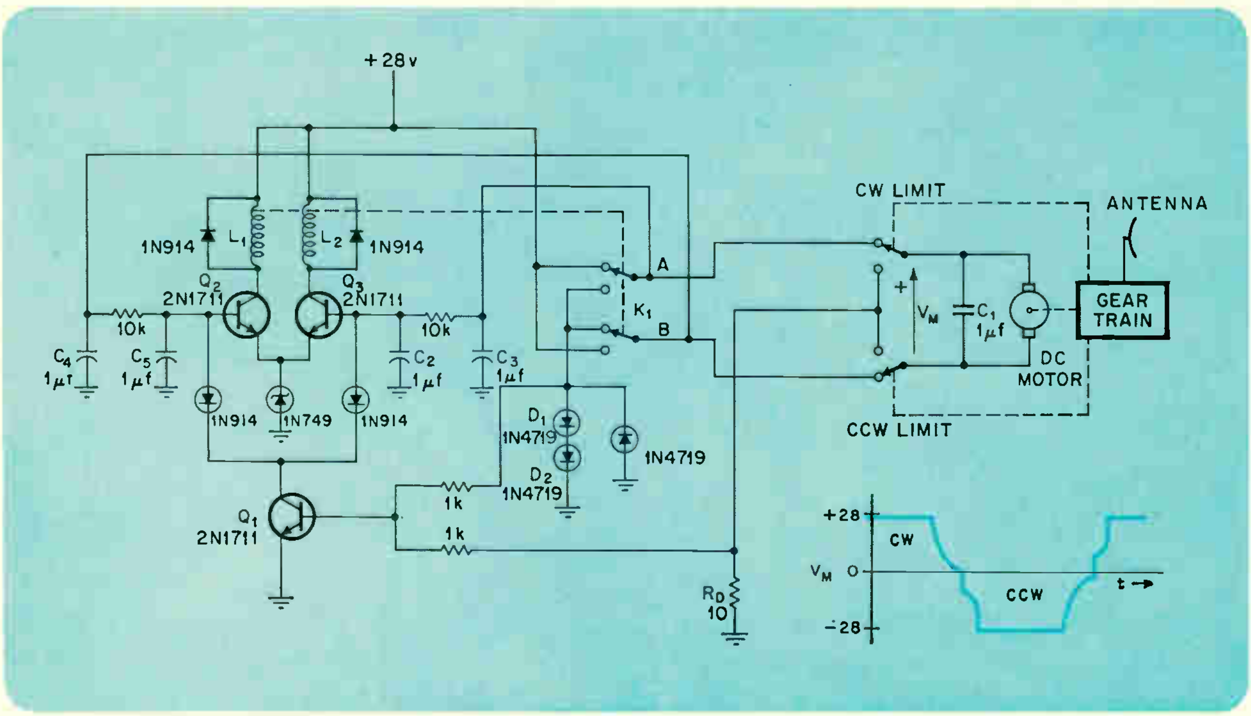
The motor is returned to ground through the diodes D_1 and D_2. The voltage across these diodes holds Q_1 on, which in turn holds both Q_2 and Q_3 off.

When the antenna reaches its limit, the cw limit switch is actuated, and the motor loses its 28-volt supply line. Inertia continues to turn the motor, but resistor R_D dissipates the inertial energy. The generated emf also is applied to the base of Q_1, holding it on. When the motor stops, Q_1 turns off and Q_3 turns on—the point A is still connected to the 28-volt supply through the switch.

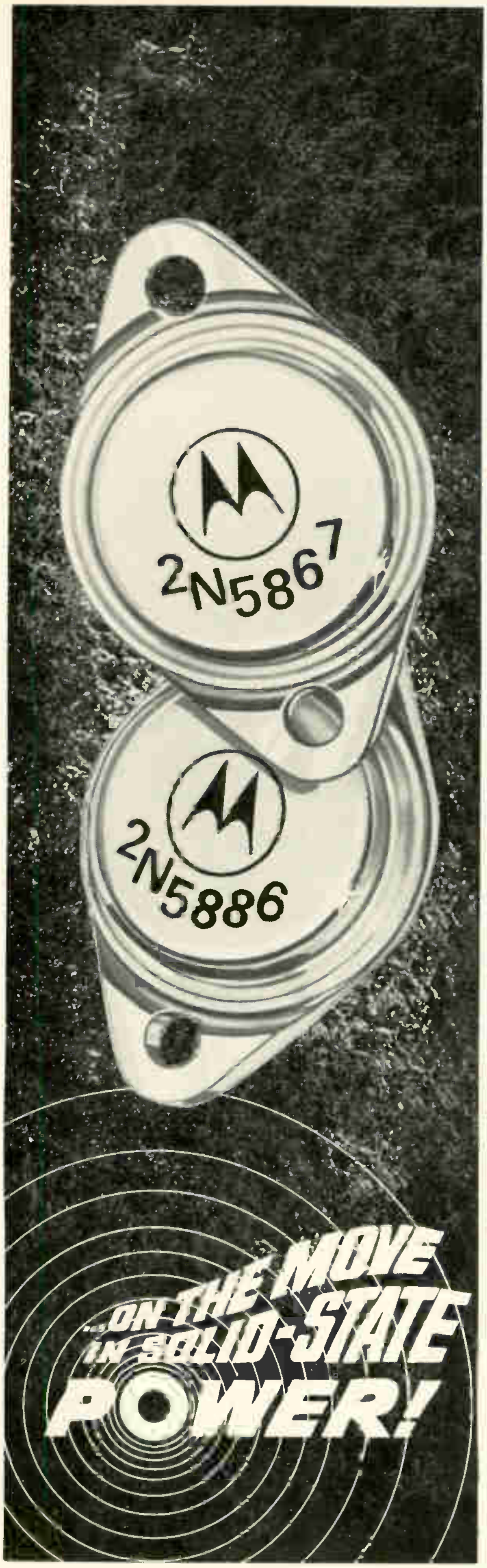
This energizes L_2 and switches K_1, which reverses the voltage going to the motor, causing it to reverse. After K_1 switches, point A is connected to ground, Q_3 turns off, and Q_1 turns on again as current flows through the motor and through R_D (the cw limit switch hasn't switched yet). Thus, resistor R_D not only controls the damping of the motor, but it also limits the starting current to the motor. However, R_D does limit the motor's starting torque.

As the antenna backs off its full cw position, the cw limit switch goes back to its former position and current again flows through D_1 and D_2, keeping Q_1 on. A similar sequence of events occurs when the motor reaches its ccw limit.

Capacitors C_2 through C_5 keep the circuit from falsely actuating the relay during the time the limit switches and relay contacts are in the transitional state, while C_1 acts as a commutation noise filter on the motor. The damping resistor's size depends on the size of motor, but as a rule of thumb, it may be set at twice the armature resistance.



Hitting the brakes. The damping resistor, R_D, dissipates the inertial energy of the motor when power is disconnected and also develops the signal to turn on Q_1 as the motor is slowing down. When the motor stops, Q_3 turns on and pulses the latching relay to reverse the connections to the motor.



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Type PNP	Type NPN	I_C (Cont) A	P_D W	h_{FE} @ I_C (min/range)	$V_{CE(sat)}$ @ I_C V	Rise & Fall Time µs	PRICE, 100-UP PNP	PRICE, 100-UP NPN
2N5867 2N5868	2N5869 2N5870	3	87½	35 @ 0.3A 20-100 @ 1.5A 5 @ 3A	1 @ 2A 2 @ 3A		$1.35 1.75	$1.25 1.60
2N5871 2N5872	2N5873 2N5874	5	100	35 @ 0.5A 20-100 @ 2.5A 5 @ 5A	1 @ 4A 2 @ 5A		1.60 1.95	1.40 1.75
2N5875 2N5876	2N5877 2N5878	8	150	35 @ 1A 20-100 @ 4A 5 @ 8A	1 @ 5A 3 @ 8A	1.0 @ I_C (max)/2	2.45 2.85	1.70 2.00
2N5879 2N5880	2N5881 2N5882	12	160	35 @ 2A 20-100 @ 6A 5 @ 12A	1 @ 7A 4 @ 12A		3.70 4.20	2.70 3.00
2N5883 2N5884	2N5885 2N5886	20	200	35 @ 3A 20-100 @ 10A 5 @ 20A	1 @ 15A 4 @ 20A		4.10 4.50	3.75 4.25

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Ion implantation offers a bagful of benefits for MOS

Better high-frequency performance is but one virtue of this new doping process; it also results in a broad range of low threshold voltages and makes possible new types of IC devices

By John Macdougall and Ken Manchester, *Sprague Electric Co., North Adams, Mass.*
and Robert B. Palmer, *Mostek Corp., Worcester, Mass.*

● Ion implanted MOS devices have been best known for their improved high-frequency performance over conventional metal oxide semiconductor IC's. But now device designers are learning that the ion-implantation process can produce even bigger performance dividends.

Not only do ion-implants yield consistently reproducible low thresholds, ranging below the standard 4 volts down to a TTL-compatible 1.5 volts, but the process permits fabrication of previously unrealizable IC's with devices such as depletion-mode loads and enhancement-type drivers on the same chip. This combination provides logic gates with speed-power products twice those of circuits with only enhancement-type loads.

What's more, ion implantation simplifies fabrication of n-channel IC's, heretofore rather tricky to make through diffusion methods, yet valuable because they are compatible with bipolar circuits. The n-channel allows complementary MOS IC's to be built that feature higher speed and lower power dissipation.

All this is possible because under the ion implantation process, dopants are introduced into the silicon IC wafer over a greater range of concentrations and with more precise control than is possible with diffusion techniques.

So far, the Mostek Corp., using techniques developed by the Sprague Electric Co. R&D Laboratories, has used ion implantation to manufacture—and sell commercially—several low-threshold IC's, including a dual 128-bit static shift register, a dual 256-bit dynamic shift register, and a 2,240-bit column-output character generator. These circuits operate at speeds comparable to other MOS IC's, but because of these ion-implanted channels, the Mostek devices have lower threshold voltages than are possible with the three other "low-threshold" MOS fabrication processes [*Electronics*, April 13, p. 118]. The threshold voltage, V_T, of ion-implanted IC's is 1.0 to 2.0 volts. The 1-0-0 process yields a threshold voltage of 2.0 to 3.0 volts, whereas silicon gate and silicon nitride techniques produce 1.5 to 2.5 volts.

Moreover, with ion implantation, it's possible to choose the threshold voltage. The threshold distribution can easily be shifted to any range the circuit designer considers optimum; it is not dictated by the process restrictions as it is in the other technologies.

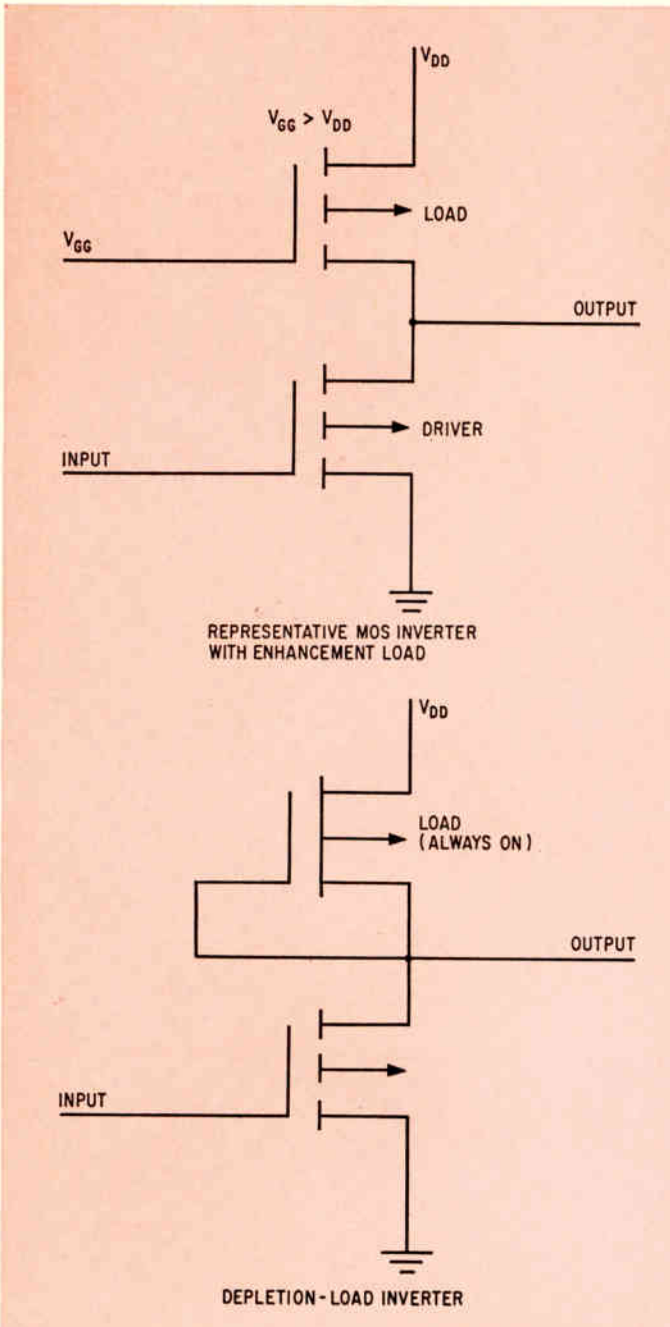
Ion implantation offers still other advantages over these processes. Consider the 1-0-0 process. A transistor fabricated on the 1-0-0 plane of silicon exhibits less fixed-surface-state charge density per unit area, Q_{ss}, than a transistor made on 1-1-1 silicon. Thus, all factors being equal, the 1-0-0 transistors would have a lower V_T as indicated by the equation

$$V_T = -\frac{t_{ox}}{Ke_o}(Q_{ss} + Q_B) + \phi'_{MS}$$

where t_{ox} is the thickness of the gate dielectric, K is the dielectric constant of the gate material, e_o is the permittivity of free space, Q_B is the charge per unit area within the surface depletion region at the onset of strong inversion, and ϕ'_{MS} is the effective difference between the work function of the bulk silicon and that of the gate metal.

Unfortunately, carrier mobility in a 1-0-0 transistor's channel is lower, resulting in slower switching. More seriously, the field-oxide threshold voltage—the value at which unwanted transistor action occurs between metal on the surface of thick portions of the oxide and the silicon substrate—is low. This means that there is a greater probability of parasitic turn-on, and yields therefore tend to drop. The field-oxide threshold typically is 15 to 20 volts in 1-0-0 transistors, against at least 30 volts in conventional 1-1-1 transistors and in silicon nitride, silicon gate, and ion-implanted transistors. On the credit side, the 1-0-0 approach to low

Before and after. Conventional load device in MOS inverters is an enhancement-mode transistor (top). Ion implantation permits fabrication of depletion-mode load transistors (bottom). For equal power dissipation, the depletion load switches at least twice as fast as the enhancement load. In addition, the depletion load requires only one power supply, freeing chip area for other functions and simplifying equipment design.



V_T does use standard, well-understood processes.

The silicon nitride approach, which employs a sandwich of Si_3N_4 and SiO_2, reduces V_T because the dielectric constant of the Si_3N_4-SiO_2 combination is greater than that of SiO_2 alone. This decreases V_T about 1.5 volts below that of the standard process. Moreover, the field-oxide threshold voltage remains high.

However the nitride process complicates fabrication: extra steps are required, and the two dielectric materials may etch at different rates. More seriously, some manufacturers have had difficulty because the threshold voltage of a transistor with a Si_3N_4-SiO_2 dielectric can shift, depending on the method used to form the gate structure. The disadvantage can be overcome, but at the cost of greater process complexity.

Then there's the silicon gate process. Here doped polycrystalline silicon is used as the gate electrode instead of the usual aluminum, thus reducing the work function between the two materials in the V_T equation. The reduction amounts to about 1 volt—more if a Si_3N_4 layer is interposed in the dielectric. The silicon gate also decreases parasitic capacitance and thus significantly speeds up circuit operation.

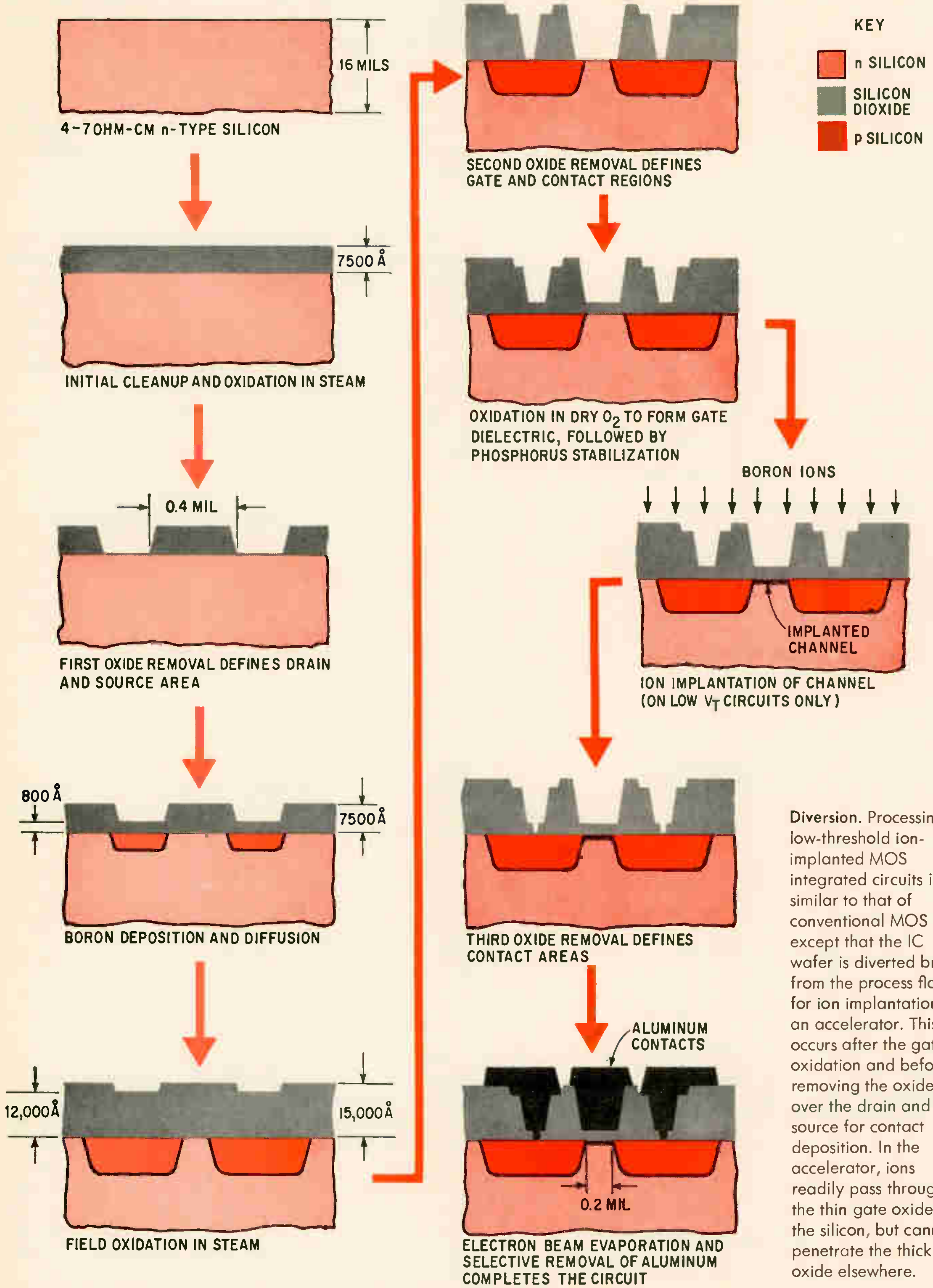
The principal disadvantages of the silicon-gate process are that it employs critical deposition and etching steps that are both more numerous and quite different from the standard sequence.

Ion implantation can reduce V_T by reducing the charge per unit area in the equation. This is accomplished by implanting ions into the MOS transistor's channel region, as shown on the following page. Virtually any threshold voltage below the 4 volts typical of the standard 1-1-1 process can be obtained in this manner. Moreover, IC's with ion-implanted channels have the highest ratio of field-oxide threshold to device threshold of any circuits available.

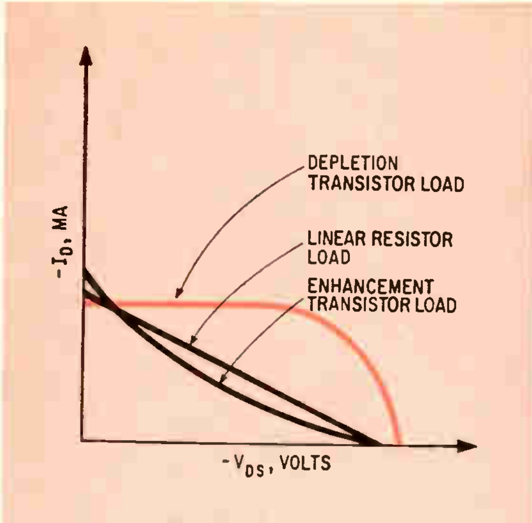
The implantation method does not require any additional deposition, photomasking, or etching steps that incur yield loss. And the same masks that are used in the standard MOS process also can be used in the ion-implanted channel technique; wafers that are to be fabricated for low-threshold voltage simply are diverted from the standard process flow after gate oxidation. Then they're ion-implanted and are returned to the normal process flow.

Sprague-Mostek's ion implantation techniques differ from those used at Hughes Aircraft Co., another firm that's closely identified with implantation. Mostek only implants the channel region [*Electronics*, May 25, p. 125], whereas Hughes employs ion implantation in conjunction with a self-aligning gate structure to form part of the drain and source regions. Since the gate doesn't overlap the source and drain, parasitic capacitance is reduced and switching speed is substantially improved.

The next step at Mostek will be to manufacture ion-implanted IC's with depletion-load transistors as well as the usual enhancement-mode driver transistors on the same chip. This is simply an extension of the ion-implanted channel process used to achieve low V_T: the channel of the load transistors on the IC are implanted with a slightly higher dosage of ions to make them operate in the depletion mode instead of the conventional enhancement mode. As a result, the IC's will operate with at least twice the speed of similar circuits that have enhancement-mode loads.



Diversion. Processing of low-threshold ion-implanted MOS integrated circuits is similar to that of conventional MOS IC's, except that the IC wafer is diverted briefly from the process flow for ion implantation in an accelerator. This occurs after the gate oxidation and before removing the oxide over the drain and source for contact deposition. In the accelerator, ions readily pass through the thin gate oxide into the silicon, but cannot penetrate the thick oxide elsewhere.



Above the line. For most drain-to-source voltages the depletion load provides more drain current than either the "ideal" linear resistor load or the enhancement load.

The first depletion-load circuit will be a 4,096-bit read-only memory that is completely transistor-transistor-logic compatible—even with the TTL power supply. A single TTL +5 volt power supply will be all that is needed to power the depletion-load MOS ROM; no interface components will be needed.

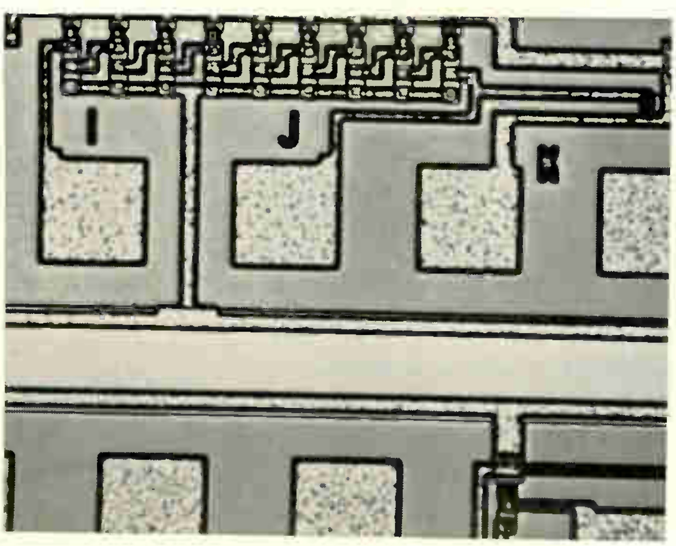
The desirability of using a depletion-mode device as a load has been recognized, but it was impractical to make them on the same chip as enhancement-mode transistors with diffusion techniques. For one thing, a depletion load calls for very light counterdoping of the load transistor channel. In fact, the concentration is so low that the dopant can be absorbed by the gate oxide at the high temperatures needed for growing the gate oxide. However, this doesn't occur under ion implantation because the gate oxide is grown before counterdoping; the ions are implanted through the gate oxide.

The main difference in operation between enhancement- and depletion-mode transistors, of course, is that the former is off at zero voltage on the gate, whereas the latter is on. The use of the new device greatly improves switching speed.

To understand the improvement, consider a representative MOS inverter circuit, as shown on page 87. This circuit, in its standard, commercially available form, invariably incorporates an enhancement-mode transistor as the load, as well as the driver. Suppose that the driver has just turned off. Then the load transistor will turn on if its gate voltage, V_{GG}, is greater than the threshold voltage of the load device, and the voltage at the node joining the driver and load will rise to a value V_{DD} (the drain voltage) minus the threshold voltage. Thus, if V_{DD} were 10 volts and V_T were 2 volts, the node voltage would rise to 8 volts.

Now consider the depletion-load inverter circuit on page 87, made possible by ion implantation. Because this device is always on, it's not necessary to apply a separate voltage to the gate, which therefore can be connected to the node. Since the gate-to-source turn-on voltage remains fixed during the switching transient, there is always a conduction path through the device, and the voltage at the node pulls up to V_{DD} much faster than it does in the enhancement load circuit. The depletion-load circuit reaches a useful output voltage in about half the time.

In terms of the time constant of the inverter circuit's resistance and capacitance, the enhancement-mode transistor load takes 18 time constants to switch from 10% to 90% of the output voltage, whereas the depletion load takes only 1.5 time constants to achieve the same output level. The depletion load is even faster than a purely resistive load, which would take 2.2 time constants to achieve this level. In practice, the 90% output voltage is not required, and the typical speed improve-



First string. String of nine depletion-load inverters on this test chip has a total propagation delay of about 200 nanoseconds, about half that of standard enhancement-load inverters. Large square areas at bottom are contact pads.

Short guide to MOS terminology

Enhancement-mode transistors show no channel conductance at zero gate bias. Forward bias increases the charge carriers in the channel and enhances channel conductance.
Depletion-mode transistors are those that exhibit substantial channel conductance at zero gate bias. Application of a reverse gate bias depletes the number of charge carriers in the channel and reduces channel conductance.
Ion implantation is a technique for doping a silicon wafer. Ions of the proper dopant, such as phosphorus or boron, are accelerated to a high energy—40,000 to 300,000 electron-volts—and bombard the silicon wafer target. The ions' penetration depth in the silicon is determined by their energy. In those chip areas where ion implantation isn't wanted, an aluminum mask or a thick (12,000-angstrom) oxide absorbs the ions.

It's highly desirable to have enhancement-mode driver transistors and depletion-mode load transistors in p-channel MOS inverters. However, it wasn't feasible on a single chip until ion-implantation techniques came along. With precise control of the amount of dopant in the driver channels, depletion-mode devices now can be fabricated on the same IC chip as enhancement-mode transistors.

ment is more like a factor of two or three over enhancement loads.

As shown at top of preceding page, the load line for the depletion load always is above that for a purely resistive load, which in turn always is higher than the load line for the enhancement mode. Thus, the depletion load gets to a given voltage level faster.

Aside from speed, the depletion load has another very important advantage: it requires only one power-supply voltage, which can be the +5-volt TTL supply. This simplifies system design and also makes for more efficient utilization of chip area; since a substantial amount of metalization is omitted, additional area becomes available for logic functions. Physically, too, the depletion load device requires less space than an equivalent enhancement-mode device: the area of the depletion load channel is well under half that of the equivalent enhancement load.

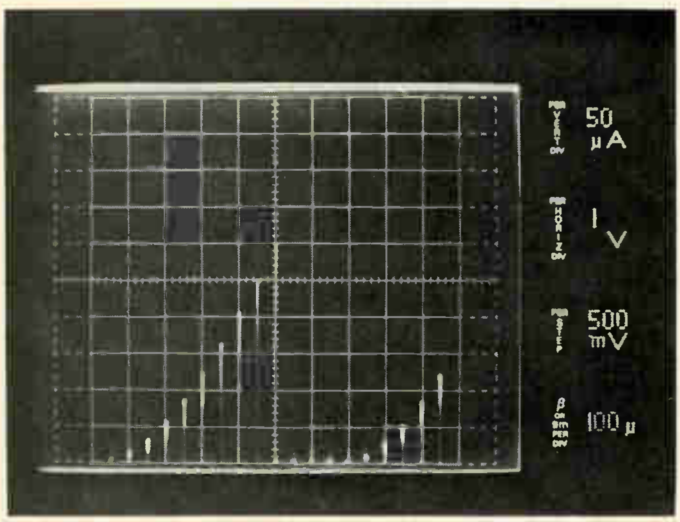
In the future, Mostek plans to exploit ion implantation in conjunction with some of the other recent developments in MOS technology such as silicon nitride dielectrics, the silicon gate, n-channel circuits, and complementary circuits. The n-channel IC's appear particularly attractive because they are faster than p-channel devices and have greater functional density. Since the current carriers in the n-channel MOS transistors are electrons, and have roughly twice the mobility of holes at normal field intensities, the n-channel transistors have about half the on resistance of corresponding p-channel devices. This decreases the time constant and allows an n-channel device to turn on in about half the time.

In addition, both n-channel and bipolar devices operate at positive bias voltages. This similarity of voltage sign significantly reduces the MOS chip area required for output buffers to interface directly to TTL.

The advantages of n-channel over p-channel IC's as yet haven't been realized because n-channel devices fabricated on high-resistivity (10 to 15 ohm-centimeter) p-type silicon are inevitably, because of the low doping level, depletion-mode circuits: they're always on. This is fine for loads, but not for drivers. And if low-resistivity (1 ohm-cm or less) material is used to effect enhancement devices, mobility is so low that there is little speed advantage over p-channel.

However, ion implantation allows use of high-resistivity substrates to build enhancement-mode devices because the process can be controlled to give a shallow surface region in the channel of increased p-type dopant concentration.

Even these future applications don't exhaust the possibilities of the ion implantation process. Meanwhile, the low-threshold and depletion-load IC's made possible by this powerful technique provide an immediately useful introduction. ●



On and on. Unlike the enhancement-mode transistor (right), drain current versus gate voltage characteristic for the ion-implanted depletion-mode transistor load (left) is always in the on region in the voltage range that normally would be applied. (The horizontal center line represents 0 volts.) The depletion load behaves exactly like an enhancement load with a battery in series with the gate. This equivalent of an integrated battery both increases speed and eliminates the gate supply voltage normally required.

Electronics guide

Major 1970 confe

July

International Electromagnetic Compatibility Symposium
July 14-16
Grand Hotel
Anaheim, Calif.

Conference on Nuclear & Space Radiation Effects
July 21-23
University of California
San Diego

August

Conference on Radiation Effects in Semiconductors
August 24-28
State University of New York, Albany

Western Electronic Show & Convention (WESCON)
August 25-28
Sports Arena, Hollywood Park
Los Angeles

Electronic Materials Technical Conference
August 30-September 2
Statler-Hilton Hotel
New York City

September

Association for Computing Machinery Conference
September 1-3
New York Hilton Hotel
New York City

Society of Photo-optical Instrumentation Engineers Technical Symposium
September 14-17
Convention Center,
Anaheim, Calif.

G-AP International Symposium & Fall USNC/URSI Meeting
September 14-17
Columbus-Sheraton Hotel
Ohio State University
Columbus

Electro-Optical Systems Design Conference
September 22-24
Coliseum
New York City

Electron Device Techniques Conference
September 23-24
United Engineering Center
New York City

Details on reverse side.

rences: July-December

October

1970 Government Microcircuit Applications Conference: GOMAC
October 6-8
U.S. Army Electronics Command
Fort Monmouth, N.J.

International Telemetering Conference
October 13-15
International Hotel
Los Angeles

Ultrasonics Symposium
October 21-23
Jack Tar Hotel
San Francisco

Electronics & Aerospace Systems Convention (EASCON)
October 26-28
Sheraton Park Hotel
Washington, D.C.

International Electron Devices Meeting
October 28-30
Sheraton Park Hotel
Washington, D.C.

November

Northeast Electronics Research & Engineering Meeting (NEREM)
November 4-6
Sheraton Boston Hotel, War Memorial Auditorium
Boston

Magnetism & Magnetic Materials Conference
November 15-19
Diplomat Hotel
Hollywood Beach, Fla.

Engineering in Medicine & Biology Conference
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With associative memory, speed limit is no barrier

Advances in plated wire and semiconductor arrays gave the impetus that moved associative memories out of the lab and toward production, and thus offering designers the advantages of simultaneous processing of data

By Jack A. Rudolph, Louis C. Fulmer, and Willard C. Meilander
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● Spurred by new developments in plated wire and semiconductor arrays, associative memories for computers have left the conceptual stage and moved into operational hardware. Associative memories—which store and address data by content rather than specific address location—must be made of elements that can process data as well as store it. With the advent of plated wire and semiconductor arrays, these functions can now be implemented in a relatively simple and economical manner.

Associative memories have another valuable characteristic: they will process several operations simultaneously, thus alleviating the strain of designing high-speed systems that are already pushing the limits of transmission line propagation time.

Addressing by content also reduces the amount of computer time and memory capacity required to keep track of constantly changing locations. These nonproductive housekeeping and bookkeeping chores have taken up an increasing proportion of time and capacity as hardware technology has advanced. The advantages of associative memories are sufficiently important that they have kept an increasing number of researchers busy over the last 14 years.[1]

Furthermore, the development of plated-wire and semiconductor arrays permits the extension of the associative memory concept to associative processors, which handle matrixed data in much the same way as large parallel processors, such as the Illiac 4 at the University of Illinois.

An associative memory in its simplest form contains:

- An array of storage elements, with nondestructive readout (NDRO) capability.
- A comparand register that specifies the content by which desired data is recognized.
- Logic circuits that perform the exclusive-OR comparison.
- A match/mismatch register, which is an array of flip-flops connected to the storage elements through sensing amplifiers.

A computer doesn't need an address code to keep track of words stored in an associative memory. Instead, the computer specifies the content of the words it needs —and out come the words, wherever they were stored.

Usually the matching data itself is of little value, because it's already available in the comparand. But a match on all the bits of a comparand may indicate that other desired data is available in another memory for which the associative memory serves as a control or index; or a match may indicate that some event has occurred that requires responsive action. Or a search may be made for words a few of whose bits match a corresponding few in the comparand. In a pure associative memory, the few bits used in a search can be any of the bits in the word, at the programer's option; the unused bits are masked. A variation is a content-addressed memory, containing words with both associative and nonassociative bits; following a search through the associative portion, a readout of the matching words yields both associative and nonassociative parts.

For example, an associative or content-addressed memory could contain the entire payroll record for a company. One memory word per employee would contain name, job title, wage rate, deductions, personal data, and so on. From such a memory, in a single cycle, a computer could call for the payroll records of all employees who make $17.82 a week; all the records would be found at once, regardless of how many of them there were.

To accomplish this, the identifying information—$17.82 in this case—is placed in the comparand register. Logic circuits compare each bit of the comparand with the corresponding bit in all the words of the memory. One strobe pulse per comparand bit produces output signals for all matching bits; flip-flops in the match/mismatch register store these signals.

Therefore, the contents of the match/mismatch register at the end of a series of strobe pulses in successive bit positions indicate which words in memory matched (or mismatched) the word in the comparand register. Hence, all words in the memory are simultaneously compared, on a bit by bit basis, with the comparand word, and the words that respond, if any, are indicated by the state of the word flip-flops.

Suppose, for example, a small associative memory containing four words of four bits each is to be searched

This is the 19th installment, and the 41st article, in *Electronics*' continuing series on memory technology, which began in the Oct. 28, 1968, issue.

for a match, as shown below. Initially, all four flip-flops in the match/mismatch register are turned on. The first strobe pulse compares the first bit position of all four words with the first bit in the comparand. In three of the words shown, there is a match in the first position; this match blocks the strobe's passage through the exclusive-OR logic. But since there's a mismatch in the first word, the strobe pulse gets through the exclusive-OR and resets the first flip-flop. This takes only a few nanoseconds—equal to the strobe pulse's duration plus the propagation time through the array.

Immediately after the first comparison a second strobe pulse tests the second bit positions in all four words. This pulse also finds a mismatch in the first word, and the logic would have turned off the first flip-flop had it not already been off. Furthermore, there is another mismatch in the fourth word, so that its flip-flop is now turned off.

At the third strobe pulse, a match is found in the first and fourth words, but since mismatches were previously found in these words, their flip-flops remain off. Meanwhile another mismatch is found in the second word, so its flip-flop turns off too. This leaves only the third-word flip-flop on. And since the fourth strobe pulse doesn't find another mismatch in the third word, the third flip-flop stays on. Thus, the contents of the match/mismatch register show that the third word matches the four-bit word originally placed in the comparand register.

The time required to search the entire memory for a match or mismatch with the comparand word depends on the number of bits in the comparand and the rate at which the bit-by-bit strobe takes place—typically the rate is 100 to 300 nanoseconds per bit. Search time, ignoring cable propagation delays, is independent of the number of words stored in the memory. And it's this factor that permits the orders-of-magnitude smaller execution time of, for example, file search routines.

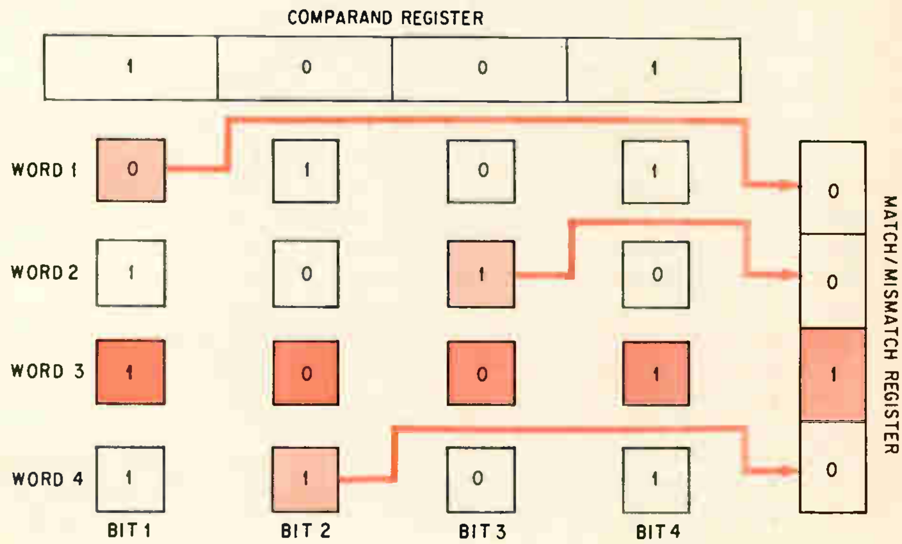
However, large memories usually have longer cables whose lengths vary to a greater degree than those in small memories; these factors affect search times. To minimize this problem, a memory is divided into modules and the cables routed to achieve identical lengths.

Before information can be written into an associative memory, some indicator is needed to show which locations in the memory are either empty or contain unwanted data. One indicator is a bit position in each word to represent the status of that word. For example, a 1 could show that the data is still required and a 0 that the location is available for new data. The write operation is then preceded by a single-bit search to find an empty location for the word to be written.

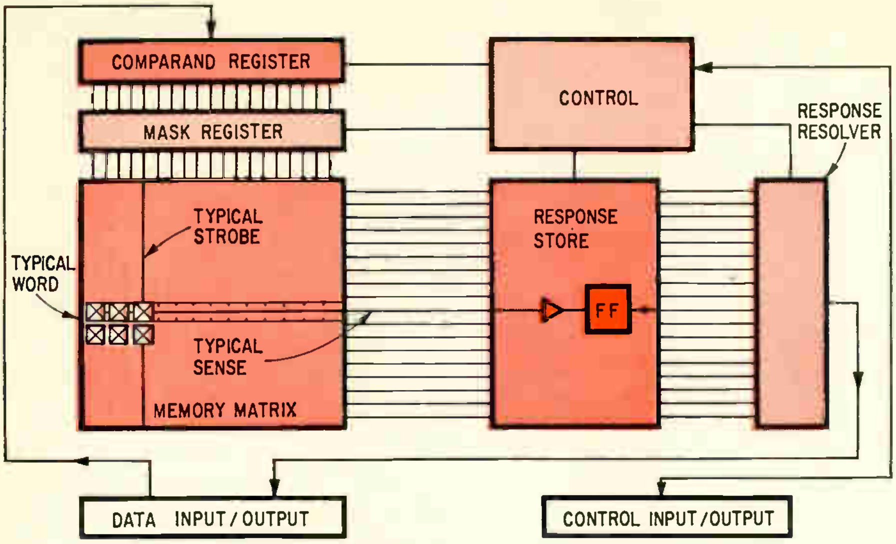
Thus, the programer need not know exactly where or how big the empty spaces are. His data simply disappears into the memory; when he needs it, he calls for an associative search. Likewise, he can store the data in any order, because the associative search takes place on all words simultaneously. Thus, the associative memory eliminates the time that conventional machines must spend sorting data for storage and restructuring dynamically changing data files.

Every associative memory discussed up to this point—including the content-addressable memory—has been essentially only a single-function memory: that is, it searches only for those words that exactly match the comparand.

However, adding a few more features produces an even more useful associative memory design. In the diagram on the next page, the response store contains the sense amplifiers and match/mismatch register for all words in the memory. Additional circuitry, in the response resolver, scans the states of the flip-flops in the match/mismatch register at the end of a search operation to produce the desired results. These might



Match. In this simplified associative memory, four successive strobe pulses compare the four bits in the comparand register one at a time with bits in the memory array. At the start, all positions in the match/mismatch register contain 1; every mismatch found in the array (light color) resets the register position corresponding to that word to 0. After four strobe pulses, only the third position of the match/mismatch register still has a 1, showing that only the third word in the array (dark color) matches the comparand.



System. Basic associative memory contains an array of storage elements, a comparand register, and a response store (dark color). Additional functions can be performed if a mask register and additional logic and controls (light color) are added.

include a count of the number of matches or mismatches instead of a mere indication of them. Thus, a program may not need information about individuals who make $17.82 a week, but rather how many employees there are at that rate to determine the cost of increasing their salary to $22.04 a week. Or, having identified a word that is to be processed, the response resolver can control the reading out of the word, either serially through the response store, or in parallel. Serial readout is much slower, of course, but, depending on the system that the associative memory is linked to, it may be suitable for a particular application.

Additional features permit still more flexibility. For example, the mask register permits a search to be performed only on selected bits in the comparand, not the whole comparand, as mentioned previously. With the mask register the programer defines which fields or portions of the comparand he wishes used in the search. Or a search could locate all words whose numeric value is greater than the comparand, or less than it. Furthermore, both types of searches could be combined in a between-limits search if a second comparand register were used; this would locate all words that are numerically between two values.

In terms of the previous example, a search for an exact match of selected bits would be necessary to locate those employees with a given salary. Likewise, a search for numeric values greater than the comparand could locate employees who were taller than 6 feet; a less-than-comparand search could locate those who had been working for the company less than 18 months; and a between-limits search could learn who among the work force had more than one year of college but less than four.

Modifying the response store permits the execution of more complex instructions: for example, "Find all employees with red hair who make between $20 and $25 a week and have been working here more than 35 years."

Several associative memories have been built and tested. A few of these were part of classified projects, so that a complete list of all associative memories built to date is not available. But the table on page 100 contains a representative listing.

The largest of these, shown at right, is the 2,048-word unit developed in 1968 by the Goodyear Aerospace Corp. for the U.S. Air Force's Rome Air Development Center. This ferrite-core unit executes 15 kinds of searches on its 50-bit words, and it can perform 31 operations related to the memory's interface with RADC's Control Data Corp. 1604B computer. The entire instruction set has been incorporated into the 1604B software.

In associative memories, as in most other memories, the speed, cost, and maximum word length are affected by the kind of memory element used. But in associative memories, the cost is greatly increased by the electronic circuits connected to each word. This is perhaps the main reason why these memories aren't mass produced.

Some experimenters have attempted to build associative memory elements made of cryotrons and planar metallic films. However, magnetic ferrite elements—either simple toroids or multiaperture devices—have proven most successful in associative memories large enough to function in a computer system. However, these elements are limited in speed and dissipate considerable power.

At Goodyear Aerospace, however, both high speed and low power dissipation have been recently achieved with a special type of plated-wire array. In conventional types, current in a "strap" that passes once or twice around a group of parallel wires generates data-read pulses from all the wires at once—one bit from each wire. But in the Goodyear approach, because search operations are performed one bit at a time on corresponding bits in the memory, the strap carried the strobe signal instead of a word-readout signal. Thus, the associative plated-wire array organization is orthogonal to the conventional array, as shown on page 100. In this arrangement, successive bits in a single word are stored along a single wire rather than in corresponding positions in adjacent wires.

This rearranged organization creates a serious write-disturb problem—the effect on a particular bit position when a write operation is repeatedly performed on an adjacent bit position. Conventional arrays suffer less from this problem. To write a word in a conventional array, current is switched into a single strap and into all the wires—in one direction to write a 1, and in the opposite direction to write a 0. Stray magnetic fields from the strap tend to affect bit positions under adjacent straps, particularly when the write operation is repeated. In conventional arrays the design of the straps, and of keepers—a layer of magnetic material on top of the straps to regulate the magnetic field's dispersion—effectively eliminate write disturb.

In Goodyear's associative memory, on the other hand,

Special functions in practice

Several companies have tinkered with associative memories to perform control functions in conventional computers. Recently, for example, a small associative memory of 64 words by 16 bits was incorporated experimentally into an IBM 360 model 40 computer to regulate the memory space made available to time sharing users. Another experimental project at IBM used a 124-by-64 associative memory for fast code-pattern identification in a performance monitor and data reduction processor. But closer to practicality is the 64-word associative memory in the Burroughs computer that serves as a control unit for the Illiac 4 parallel processor. This memory performs an instruction look-ahead function.

In commercially available machines, the "cache" memory in IBM's 360 models 85 and 195 has certain associative properties. The Control Data Corp. also is reportedly using a small associative memory for internal bookkeeping in one commercial machine; so was the General Electric Co., at least up until its recently announced merger with Honeywell, Inc.

a write operation involves current in many straps and in only one wire. All the straps together present much stronger stray fields that affect many bits in many wires; and again, the effect is accentuated when a similar pattern is rewritten many times using the same straps. As in conventional arrays, attention to strap and keeper design has overcome the problem; Goodyear also uses special wide-tolerance plated wire.

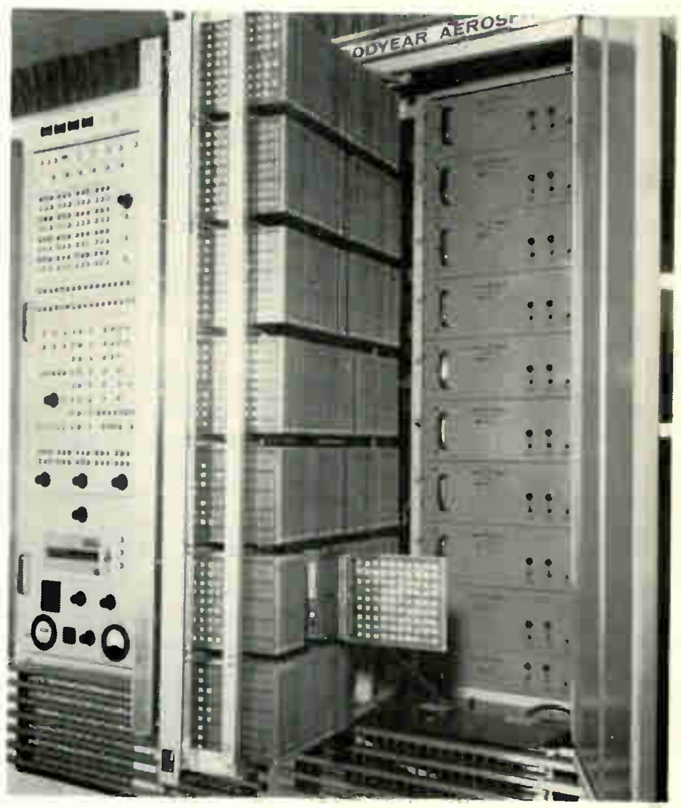
Even though the plated-wire array offers advantages, this technology for associative memories will eventually yield to large-scale integrated circuits, even for large memories. Relatively small semiconductor associative memories—up to 64 bits—are available today, but they haven't yet been incorporated into memory systems of substantial size. They'll become practical for large associative systems about the same time as they become practical for large address-oriented memories.

The cost per bit for associative memories is greater than that for conventional memories. A prototype ferrite-core associative memory containing about 100,000 bits can be fabricated for $3 to $5 per bit; in production, the cost might drop to $1.50 to $2 per bit. Plated-wire associative memories, on the other hand, range from less than $1 per bit in prototypes containing 1 to 10 million bits to 15¢ or less per bit in production by 1972. But this is still much higher than the price for conventional ferrite-core and plated-wire memories, which now cost only 5¢ to 10¢ per bit.

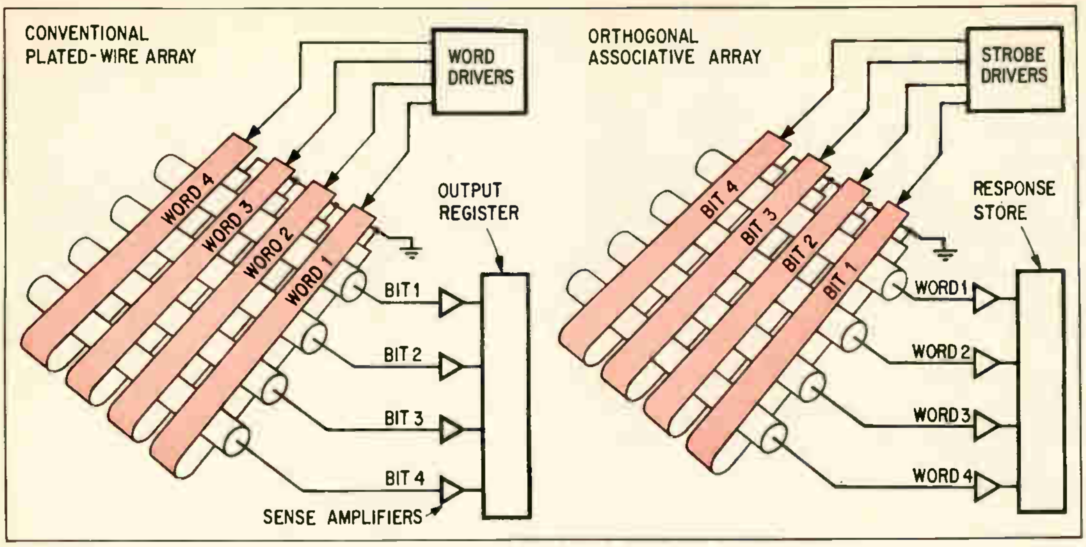
The main reason for higher cost is that the associative memories require logic circuits at each word, whereas conventional memories need only drivers and amplifiers for each bit of one word. For example, the big associative memory built by Goodyear for RADC contains 2,048 words of 50 bits each; the memory requires 2,048 essentially identical logic circuits in its response store. But a conventional memory of equal size would require only 50 sets of drivers and amplifiers. Also, an associative memory's response store and resolver make the memory a kind of small computer that can execute a variety of complex instructions. This capability is intrinsically more expensive than mere storage.

However, this price differential isn't so great if the total operating system cost is considered. Associative systems require simpler software and save time when searching through a file for data of a particular type.

These higher costs, in the past, have limited the appli-



Big fellow. Largest practical associative memory built to date is this unit at RADC, containing 2,048 words of 50 bits each.



Orthogonal. Associative capability is obtained from conventional plated-wire array by reversing the roles of drive strap and wire. Conventional array (left) has one word per strap; each wire carries corresponding bits in different words. Associative array (right) has one word per wire; straps sample corresponding bits in different words.

cations of associative memories. But today, plated-wire technology has already brought the cost down substantially, and semiconductor technology promises to bring it down even further—generating new interest in associative memories and development of new applications. These generally fall into four classes:

- As a peripheral device, which is connected like tape drives, magnetic disk units, and so on.
- As a special-function memory, apart from the main memory—rather like a special scratchpad or accumulator.
- As the main memory of a computer.
- As an associative processor.

Except for a few special cases, an associative memory connected as a peripheral device would not be cost effective. Several studies[2] indicate that input/output subroutines take up more time transferring data between the computer and the memory than do the operations within the memory itself. The subroutine can't keep the associative memory busy. Goodyear's big 102,400-bit memory at RADC is connected as a peripheral, but RADC provided a direct access channel between the two memories to keep the associative memory from getting bogged down in the main memory's subroutine.

As a special-function memory, the associative memory would be introduced into the design of the computer as a hard-wired portion of the control system to perform a single function with great efficiency. For example, the memory could be part of a processor's executive system; or if a program demands more than the available main-memory space, the associative memory can handle the swapping of program "pages" between the main memory and a drum or other bulk-storage unit. [See also "Special functions in practice," p. 99.]

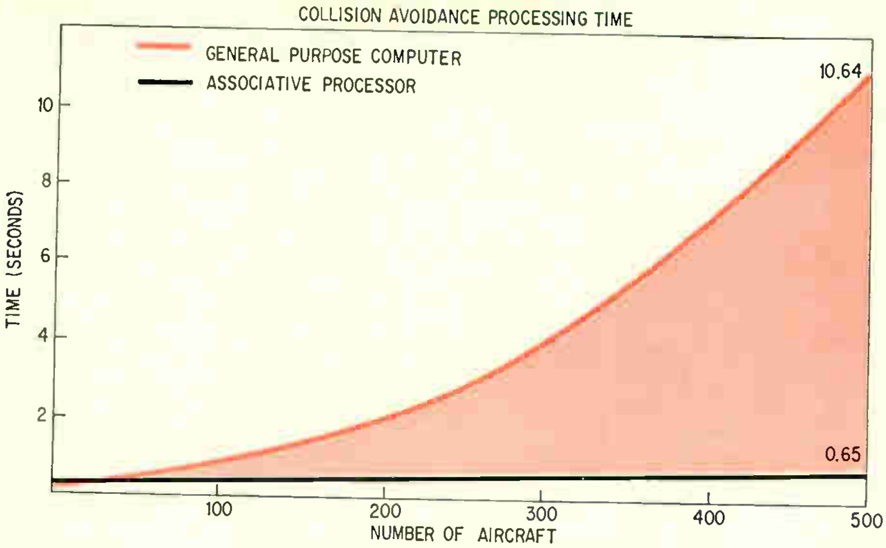
As a computer's main memory, the associative memory would have to be exceptionally large by today's standards. It would also probably be most feasible in content-addressable form rather than as a pure associative memory. But, as yet, it's never been tried—partly because it would be very expensive, and partly, perhaps, because of the large present investment in address-oriented system software, little of which could be easily transferred for use in such a system.

Perhaps the most significant use of an associative memory would be as an associative processor. This application requires the match/mismatch logic to be modified to include arithmetic capability at every memory word. Such a processor would be considerably more versatile than a conventional computer that executes one instruction at a time on a single pair of data items. And for some tasks, it could approach the capability of a large-scale parallel processor.

The basic associative memory, in such a processor, performs not only logic search operations, but arithmetic operations as well. Each word in the modified associa-

Delivered Associative Memories (partial listing)

Year	Customer	Contractor	Associative storage device	Memory size	Associative searches	Interface
1963	Dept. of Defense	Scope Inc.	Multiaperture ferrite device (transfluxor)	1,024 words × 24 bits	Exact match	I/O channel
1963	U.S. Air Force, Rome Air Development Center	Stanford Research Inst.	Linear split-C cores	1,100 words × 281 bits	Exact match	Special device
1964	U.S. Navy Bureau of Ships	Goodyear Aerospace	Multiaperture ferrite device (MALE)	256 words × 30 bits	Exact match; Greater than; Less than; Between limits	I/O channel
1965	U.S. Air Force, Avionics Laboratory, Wright-Patterson Air Force Base	Philco-Ford	Multiaperture ferrite device (Biax)	1,024 words × 48 bits	Exact match	I/O channel
1968	U.S. Air Force, Rome Air Development Center	Goodyear Aerospace	Biased logic Ferrite core (Biloc)	2,048 words × 50 bits	Exact match; Greater than; Less than; Maximum; Minimum; Next higher; Next lower; Between limits	Direct memory access to computer
1970	Air Force Avionics Lab	Texas Instruments	MSI-MOS	128 words × 50 bits	Exact match	Special device (classified)



Margin. Because an associative processor can check out the current status of many radar tracks at once, it can predict the likelihood of collisions in an area containing hundreds of aircraft soon enough to permit action to avoid collision. A conventional computer, on the other hand, is hard pressed simply to predict collisions before they actually occur.

tive memory together with the word's related electronic circuits—which are somewhat more complex than those required for the basic associative memory—can be programed for specific tasks. The circuits could, for example, add the contents of two fields of a word and store their sum in a third field of the same word. The addition is executed serially by bit, and would, therefore, be much slower than in a conventional computer, which adds bits in parallel. But the same "add" instruction is executed in the modified associative memory simultaneously on all words in the memory, or on any selected set of words; therefore, the average add time is inversely proportional to the number of words in the set.

Since the operation of an associative processor involves more writing than a basic associative memory would the Goodyear plated-wire design with its high speed, low power, and resistance to disturbs is particularly useful in an associative processor.

In one associative processor, built by Goodyear for the U.S. Air Force Material Laboratory, at Wright-Patterson Air Force Base, the time required to add two 12-bit fields is 20 microseconds. This is very slow compared to today's high-speed conventional computers; however, this design would be capable of executing the same command on up to 3,000 words simultaneously. This yields an effective add time for the set of as little as 7 nanoseconds per word. Since each word in an associative processor is both its own data store and arithmetic unit, it's economical to have rather long word lengths; in Goodyear's design the words are 256 bits long.

Perhaps the associative processor's first task would be in a command-and-control data processing system. Such systems characteristically execute the same computer program identically on every member of a large set of data; and new data entering at extremely fast rates continuously replaces the old data. Furthermore, all the data must be processed in real time. Thus, such a system inherently takes advantage of the associative processor's parallel processing capability and extremely high execution speed.

A typical example of such a system would be in multiple target tracking in radar systems; another would be conflict prediction in aircraft traffic control systems. Both systems involve large quantities of data in the form of radar target tracks, which are continously changing. In an associative processor, all the data concerning a single target track can be stored in one memory word. The processor handles every track simultaneously by the same algorithm; thus, in the collision avoidance problem, it enjoys a speed advantage of 16:1, as shown above, over the conventional approach, which processes each track separately and sequentially. In simple target tracking the advantage over conventional machines may be as high as 2,000:1. ●

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Solid state controls head new color-tv lineup

Set makers are pinning their hopes on semiconductor devices and controls, as well as new 25-inch screens, to overcome growing buyer resistance

Electronics' staff

● Television-set makers this year will be trying to combat economic uncertainty and increased buyer resistance with a potpourri of useful all-solid state automatic controls. Manufacturers are hoping that such features as electronic pushbutton tuning, automatic color correction, and motorless remote-control tuning will lure cash from tightening purses. And makers feel balky buyers will be enticed by new, larger (25-inch) screens.

The vacuum tube hasn't quite given up the ghost in tv sets. Tubes in high-voltage circuits still are cheaper—and power-supply regulation requirements less stringent—than transistorized units. But solid state devices are taking over an increasing number of functions in many sets, particularly in applications where special circuits, low power, and portability are required.

One example of the trend toward use of solid state devices is the top-of-the-line RCA 2000 color set, where 11 integrated circuits perform such functions as automatic fine tuning, audio detection and amplification, and remote-control switching. Most makers to date have used only one or two IC's as audio i-f amplifiers. Both RCA and Motorola are building all-solid state receivers, and Sylvania will introduce one this summer with a new type of 25-inch tube.

Sylvania will market a set with a number of firsts for U.S. manufacturers, including varactor diodes that are used to make tuning uhf channels as easy as for vhf. Easier uhf tuning will be an FCC requirement after May 1, 1971. Sylvania uses four i-f stages, against the usual three in most other sets; the lower gain in varactor-diode tuners necessitates the additional stage. And the tuner isn't mechanically coupled to the tuning knobs, so it can be located at some more convenient position in the set other than the front. A FET r-f amplifier is used in both vhf and uhf tuners because it has better noise characteristics and cross-modulation products than bipolar transistors.

In hybrid sets, where both tubes and transistors are used, everything but the deflection and high-voltage circuits have gone the solid state route. The vertical oscillator and the vertical output, the horizontal oscillator, horizontal output, and the damper are the only tubes remaining. Although these circuits have been transistorized in the all-solid state sets, they raise the cost by $200 above the hybrid sets.

The Japanese are still leading the way in all solid state designs for their small-screen sets. Toshiba, which appears to be the last holdout for tubes among major Japanese set makers, says its hybrid designs are more reliable than the all solid-state receivers. Although it claims that the horizontal-output vacuum tubes can withstand picture-tube arcing better than transistors, it probably will be only a matter of time before Toshiba joins the all solid-state ranks.

Pushbutton electronic channel selection eventually may replace the detented tuning knob, but until this year, only one U.S. manufacturer—RCA—had offered this feature—and only in the deluxe model 2000. Now, Admiral and Sylvania will offer it in sets coming out this fall.

Two electronics tuning methods are being used: diodes that simply switch preset tuned circuits for each channel, as in RCA's 2000, and varactor-diode tuners, where diode capacitances are varied with a d-c voltage to resonate with fixed inductances in each circuit at the proper channel frequency. Both Admiral and Sylvania are going the varactor-diode route.

Admiral's tuner will cover only the vhf channels, but Sylvania's will cover both vhf and uhf with two separate varactor-diode circuits. It won't be necessary to switch bands under the Sylvania setup; an array of buttons will cover all the vhf and uhf channels.

Varactor tuning. The varactor-diode tuners (uhf is at the left; vhf is at right) supplied to Sylvania by the West German firm Hopt KG are compact and can be located at the most convenient position within the set because they are not mechanically coupled to the channel select knobs.

Sylvania buys its tuners from Hopt KG of West Germany and the push-button tuner-switching mechanism from Saba, General Telephone & Electronics' West German subsidiary. Hopt varactor-diode tuners have been used throughout Europe for several years, which brought Sylvania to Hopt's latest version, thus becoming the first U.S. company to use a European-made tuner. However, obtaining suitable varactors still is a major problem. Unless the diodes have high Q's and uniform voltage-capacitance characteristics, tuners will suffer from drift and poor tracking, especially in the uhf tuning section.

Because of the pushbutton address system, the electronic tuners cost the set makers about twice as much as the conventional tuners, and consumers will have to pay at least $50 more for this convenience. However, tuner companies predict the price differential will drop to around $20 in about three years.

The old-fashioned "muscle" that turned potentiometer shafts in remotely controlled tv sets is being replaced with a "brain" in the form of MOS FET circuits. These circuits produce the continuously variable voltages that previously were derived from motor-driven potentiometers to set up circuits to control color tint and audio level.

Building on a concept introduced by Motorola in 1968 [*Electronics*, June 10, 1968] and refined by RCA [*Electronics*, May 25, 1970], Sylvania's new remote system features motorless control of color, tint, and volume, but not channel selection and the power on/off function. Command signals of a different ultrasonic frequency for each function are generated in the hand-held remote-control unit. Then they're picked up, amplified, and energize a neon lamp. As shown on page 104, the lamp, when off, isolates and thus maintains the charge on the memory capacitor. The voltage across this capacitor, which will determine the desired amount of color, tint, or volume, provides the input to the MOS FET source follower. The MOS FET's output voltage is continuously variable from the viewer's remote-control set as long as the buttons are depressed.

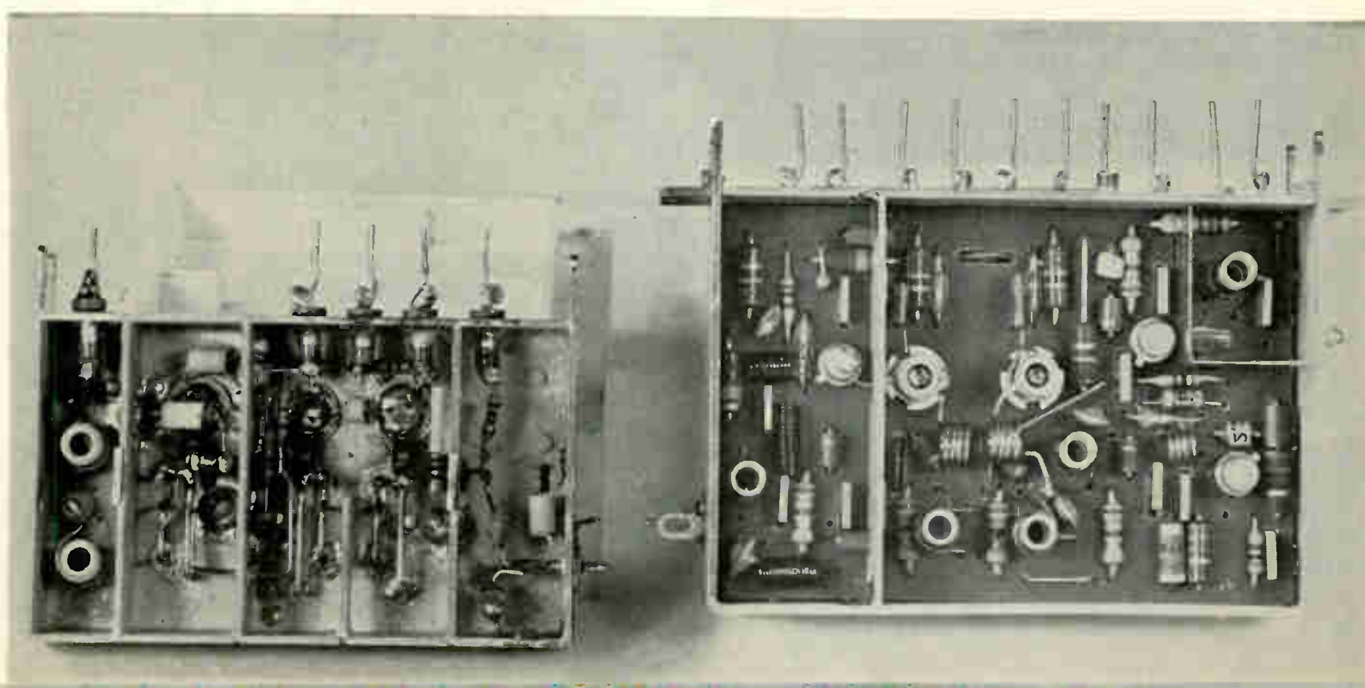
For example, a remote command to decrease the amount of color produces an a-c voltage exceeding 100 volts peak at the resonant frequency corresponding to this command (43.25 kilohertz). The positive peaks are clipped by a shunt diode. The negative peaks turn on the neon lamp and then the memory capacitor charges through the diode connected to the negative supply. A color-increase command reverses the operation: a similarly high a-c voltage is generated by the 34.25-khz resonant circuit, the negative peaks are clipped by the shunt diode, and the positive peaks fire the neon lamp. The memory capacitor then charges from the positive supply.

The net charge on the capacitor depends on how long the viewer depresses the remote pushbutton. This charge then determines the MOS FET output, which sets the signal level in the color circuit.

The remote frequencies for the on/off power relay and the channel selection drive motor also are applied to similar resonant circuits. A multivibrator drives the relay-controlled on/off switch, while a silicon-controlled rectifier applies power to the channel-select drive motor. A muting circuit attenuates audio when the SCR fires and steps the drive motor.

Because flesh tones tend to vary with small changes in scene lighting and transmission, color tv's must maintain good tones. Magnavox devised the first workable automatic tint circuit [*Electronics*, August 4, 1969]; now there are many variations of the total automatic color circuit.

Hitachi has its own version, called APS (automatic picture setting). Automatic interlock of color, brightness,



Now, if we only had five heads . . .

A five-screen color television set that also reads out time and temperature digitally was the big attraction at RCA's distributor preview in Las Vegas.

Dubbed the Showcase 70, the set has a 25-inch viewable diagonal color screen plus four 8-inch black-and-white monitors. Though RCA has no immediate plans to market the set, the company is expected to integrate its features in production models.

Basically, the set is a five-in-one receiver with five separate tuners, i-f's and video circuits. The viewer can watch color screen while keeping track of other stations over the monitors. Two monitors can be set to any channel. A third monitor shows the programing on the main color screen in black and white, while the fourth monitor will, upon command, switch stations every three seconds to look at what else is offered.

tint, and contrast is controlled by a single pushbutton. After the viewer sets the combination to his preference, the automatic interlock maintains the settings.

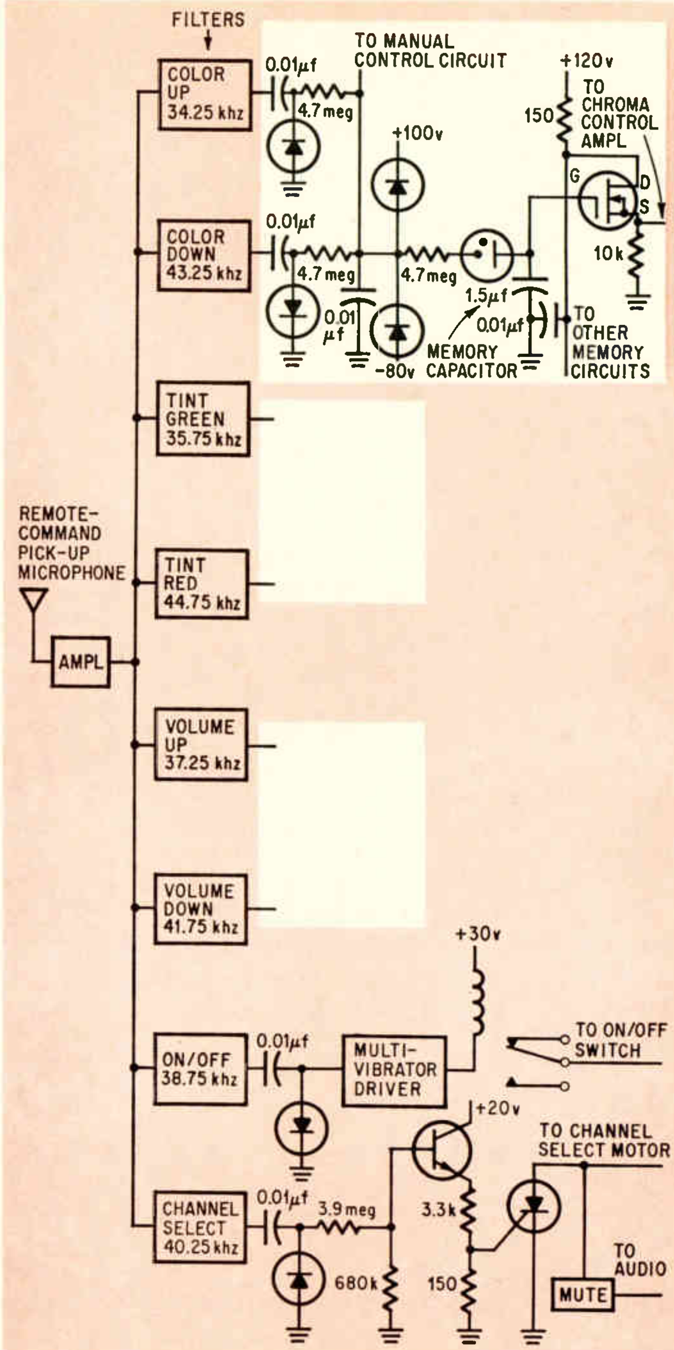
Another variation is GE's One-Touch color scheme that combines automatic fine tuning and tint control as a single function. Color is determined by the phase difference between the color signal and the reference burst. GE provides two phase shifting networks that allow the viewer to adjust phase relationship to yield the most realistic flesh tones. A front-panel control is set to one of three positions. This, in turn, sets up a phase-lead circuit at 0°, 15°, or 30° for the B-Y signal and a phase-lag circuit at 0°, 5°, or 10° for the R-Y signal as shown on page 105.

The subcarrier reference signal for the B-Y and R-Y demodulators is generated using the transmitted eight cycles of the color burst with a ringing crystal filter, rather than the phase-locked oscillator used in other sets. GE says that the passive crystal filter approach offers better reliability than phase-locked oscillators because of the fewer active components needed. And since the color subcarrier disappears when the burst is removed, a natural color-killing action is obtained that eliminates the circuits required with the phase-locked approach. Finally, crystal filters have better phase stability—the filter can only assume the phase of the input, while the phase-locked oscillator can be disturbed by sideband information and noise.

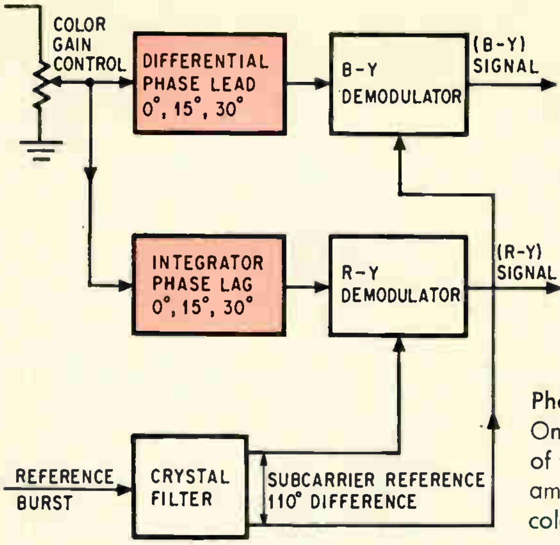
Small screen tv's—16 inches and smaller—are still the pace-setters in sales. The Japanese makers dominate this segment of the market, while the American manufacturers have been concentrating on larger, brighter screens.

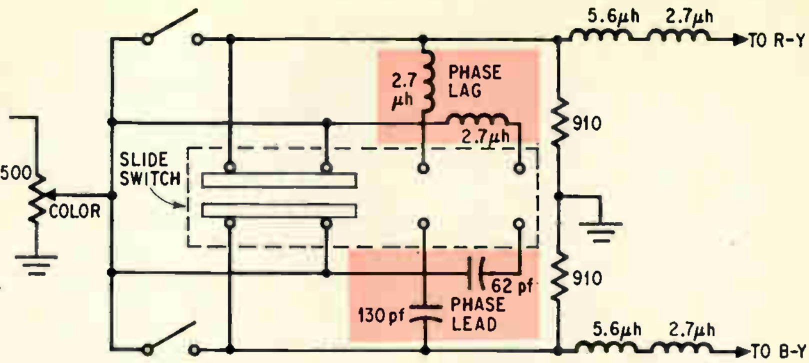
However, by last year, picture-tube makers had just about squeezed every lumen of brightness out of the color crt. They improved the phosphors, designed a more efficient electron gun, and developed the black-matrix technique, in which each color dot is surrounded by black masking to absorb ambient light yielding improved contrast and a brighter picture. [*Electronics*, June 23, 1969, p. 52]. So chances are that this year, the accent will be on bigger—rather than on brighter—tubes.

Corning Glass, which makes practically all of the envelopes for domestic picture tubes [*Electronics*, June 9, 1969, p. 137], is supplying some impetus. Corning



Down with pots. The MOS FET memory circuit replaces the motor-driven potentiometers used in earlier circuits for remote control of color, tint, and audio level. The resonant circuit responds to a signal from the remote control unit and turns on a neon lamp, which allows the memory capacitor to charge and thus control the MOS FET output voltage.





Phase setter. The General Electric One-Touch color control can be set to one of three positions, which determines the amount of phase shift introduced in the color signal.

has developed a 25-inch viewable diagonal envelope with a 90° deflection angle and square corners, and has been supplying it to the industry in production quantities since at least last fall. Several companies, including Admiral, GE, Sylvania, Philco, and RCA, are said to be pretty well stocked in this new tube size, even though dealers have been lukewarm about it because of a large inventory of 23-inch sets.

This will almost certainly be the year in which Philips, the big Dutch electronics firm, will introduce its 110° color tube in a tv set [*Electronics*, June 9, 1969, p. 137]. The company has not yet revealed its marketing plans for this potentially thinner set, saying only that although the set is in an advanced stage of development, it may not be introduced on the U.S. markets this fall.

But competitors feel certain that a 25-inch viewable diagonal 110° tube will appear in color sets designed for European PAL broadcast standards by August or September. It's estimated that the 110° tv sets will sell for an additional $60-$75 on the booming German color-tv market.

In a recent national membership survey, the product safety committee on tv fire and smoke of the National Electronic Association, a group of service dealers and technicians with headquarters in Indianapolis, Ind., has concluded that about 4,000 sets catch fire yearly. But it found no relationship between fire frequency and any particular brand of sets.

Manufacturers have taken some steps to reduce fire hazards. Here are some design changes stated for 1971 sets:

▸ General Electric uses a bimetallic thermal cutout to turn off the set in the presence of excessive heat that could cause a fire. The only problem is that it turns the receiver back on when the set cools sufficiently, so the overheating condition could recur.

▸ Flyback transformers, the major culprits in fires, have been made fire retardant. Both GE and Sylvania are using a special fire-retarding encapsulant around the flyback coil, and at least one company, Sylvania, is now making its own flyback transformer, according to Don Schuster, Sylvania's chief engineer, "so that we can give it a 100% quality check."

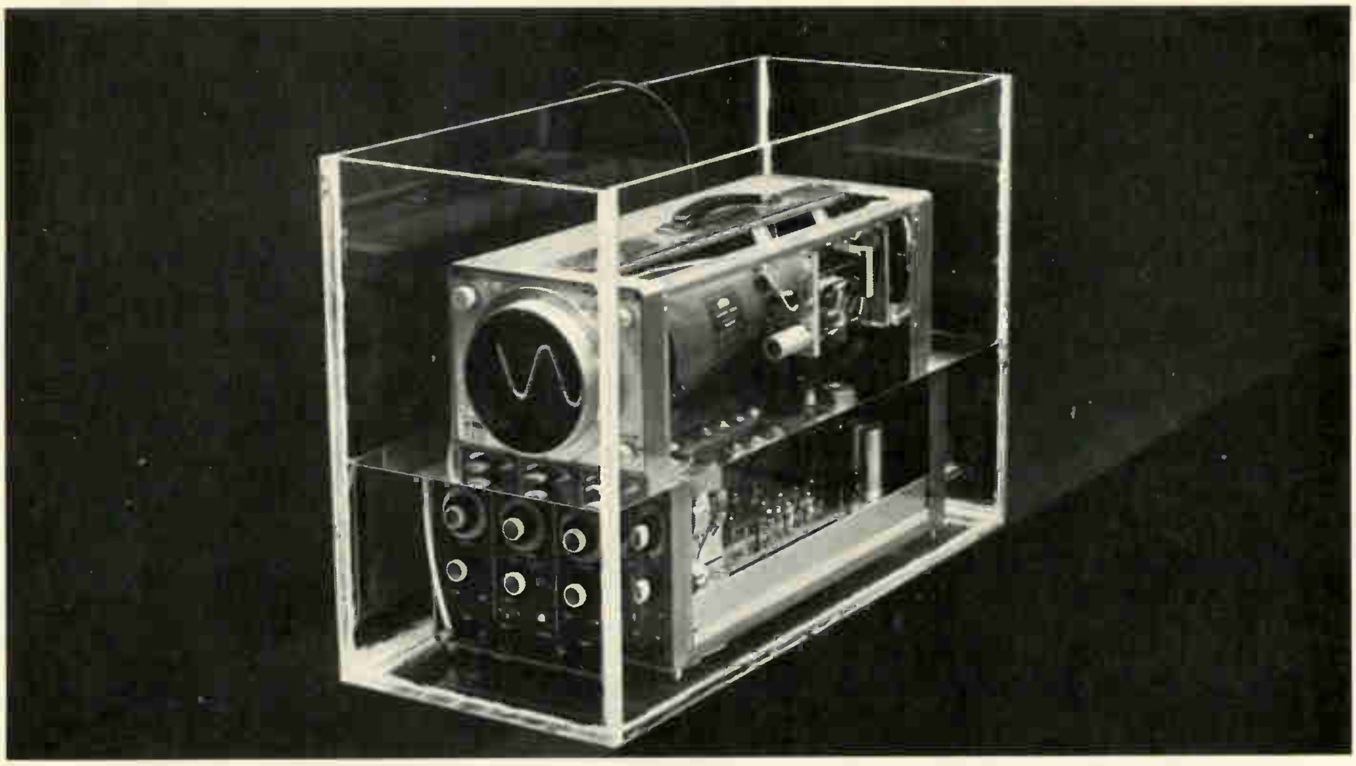
▸ Solid state high-voltage triplers are now being used in both hybrid and solid state sets. They replace the heat-generating horizontal output tube as well as the high-voltage rectifier.

Excessive radiation caused by the high-voltage regulator, high-voltage rectifier, and the picture tube itself also is a growing concern among set makers.

Where solid state voltage multipliers and transistorized horizontal stages are not used, the manufacturers are installing special steel shields to reduce X radiation. GE, for example, uses a barium-loaded neoprene shield around its high-voltage rectifier tube as well as a steel barrier for the regulator tube.

The remaining offender, the picture tube itself, isn't getting off scot free, either. Corning Glass is reportedly developing a new glass with a strontium-90 faceplate that can operate at voltages up to 32.5 kilovolts without emitting any measurable radiation. The glass used in present picture tubes must be operated below 28 kv to stay within the allowable radiation levels—0.05 milliroentgen per hour above background radiation measured two inches from the set.

Meanwhile, some set makers, notably Sylvania, RCA, and GE also have included a high-voltage hold-down circuit to keep high voltage from exceeding the safe level because of improper adjustments. Sylvania, for example, uses a voltage-dependent resistor to limit high voltage. The circuit is tied in with the horizontal oscillator to knock the oscillator out of synchronization if the high voltage exceeds its preset limit. ●



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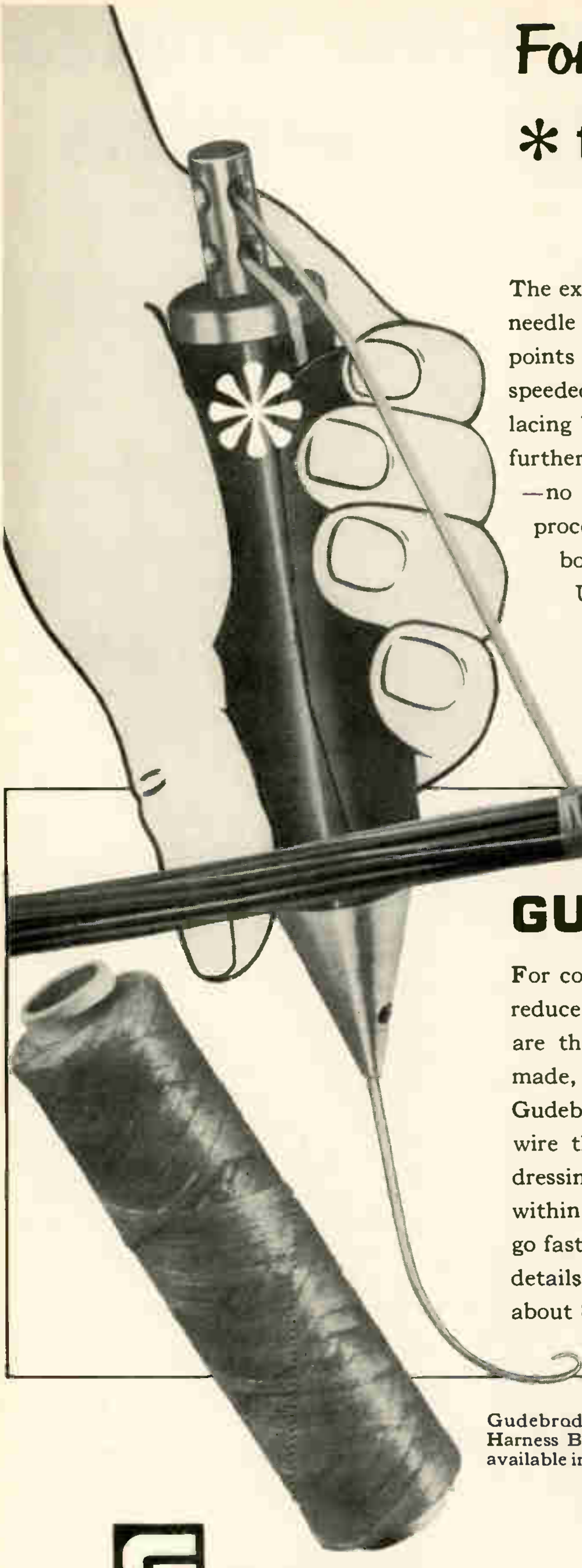

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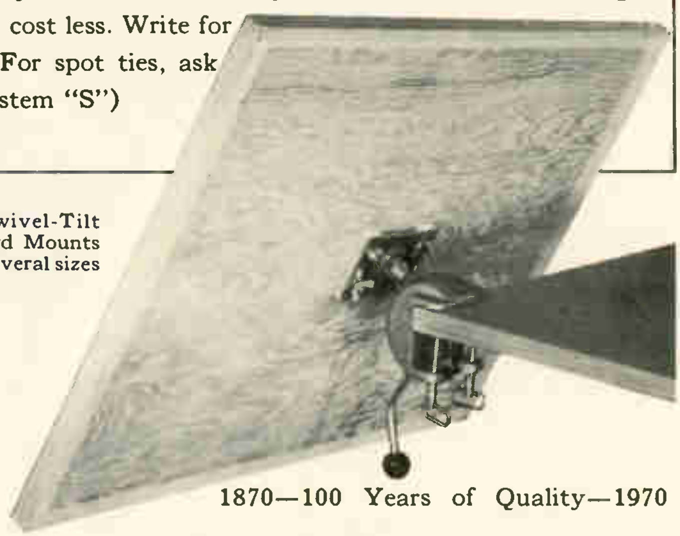

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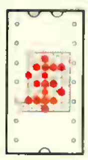

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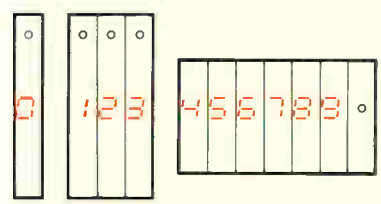

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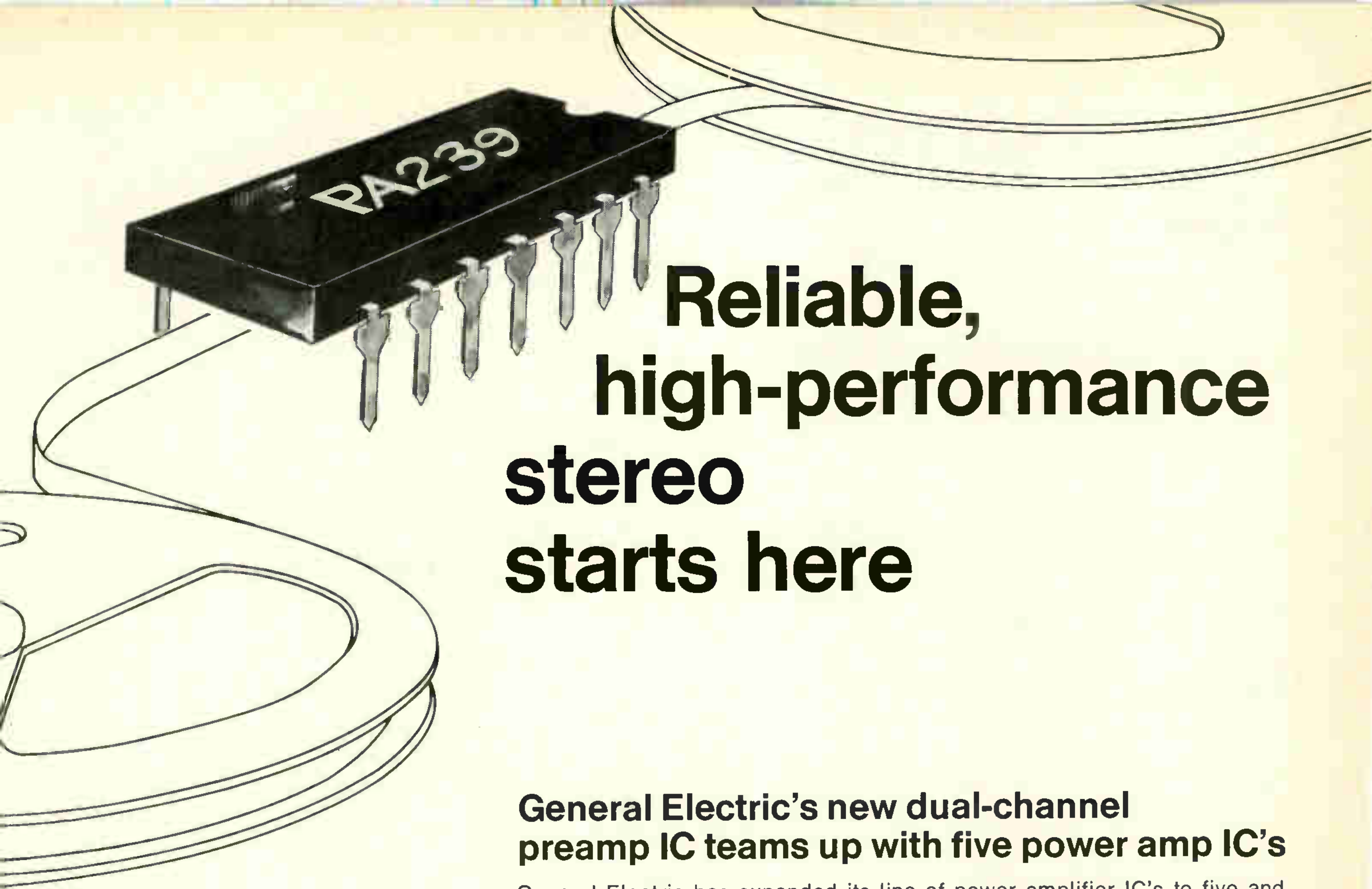

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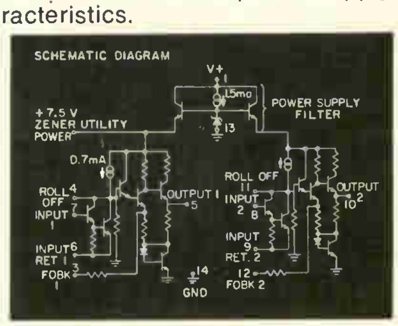
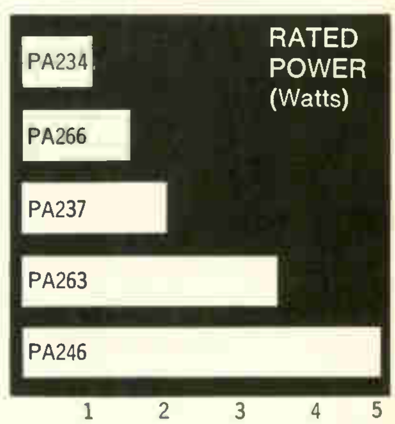


Circuit diagram—PA239



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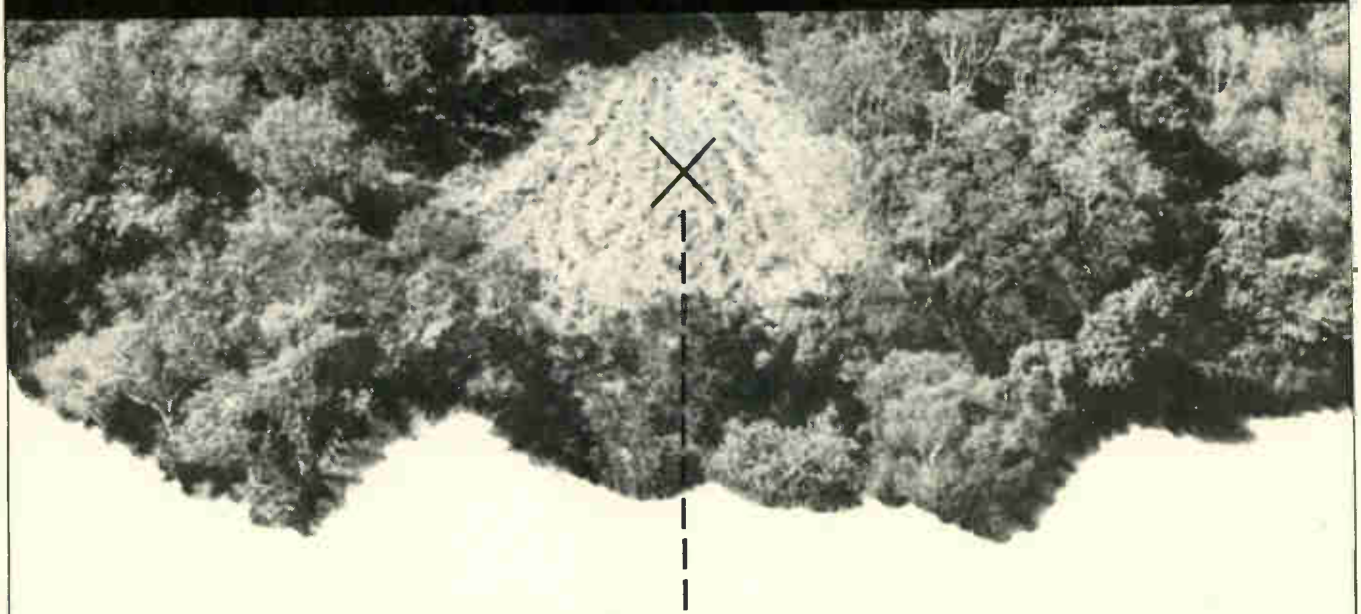

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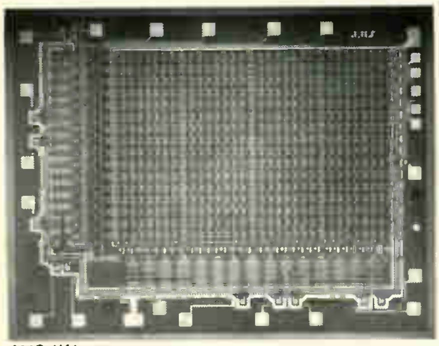

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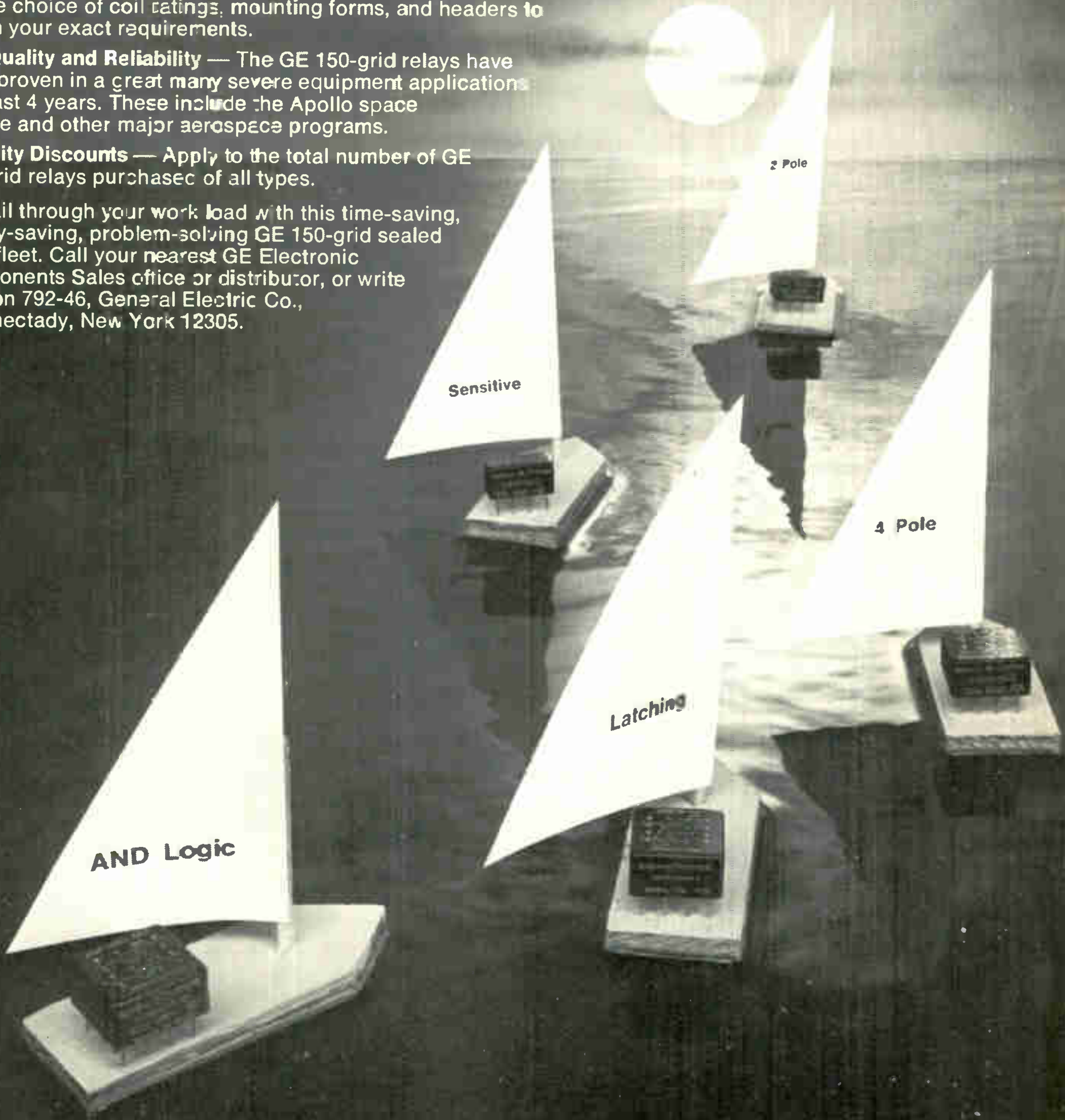

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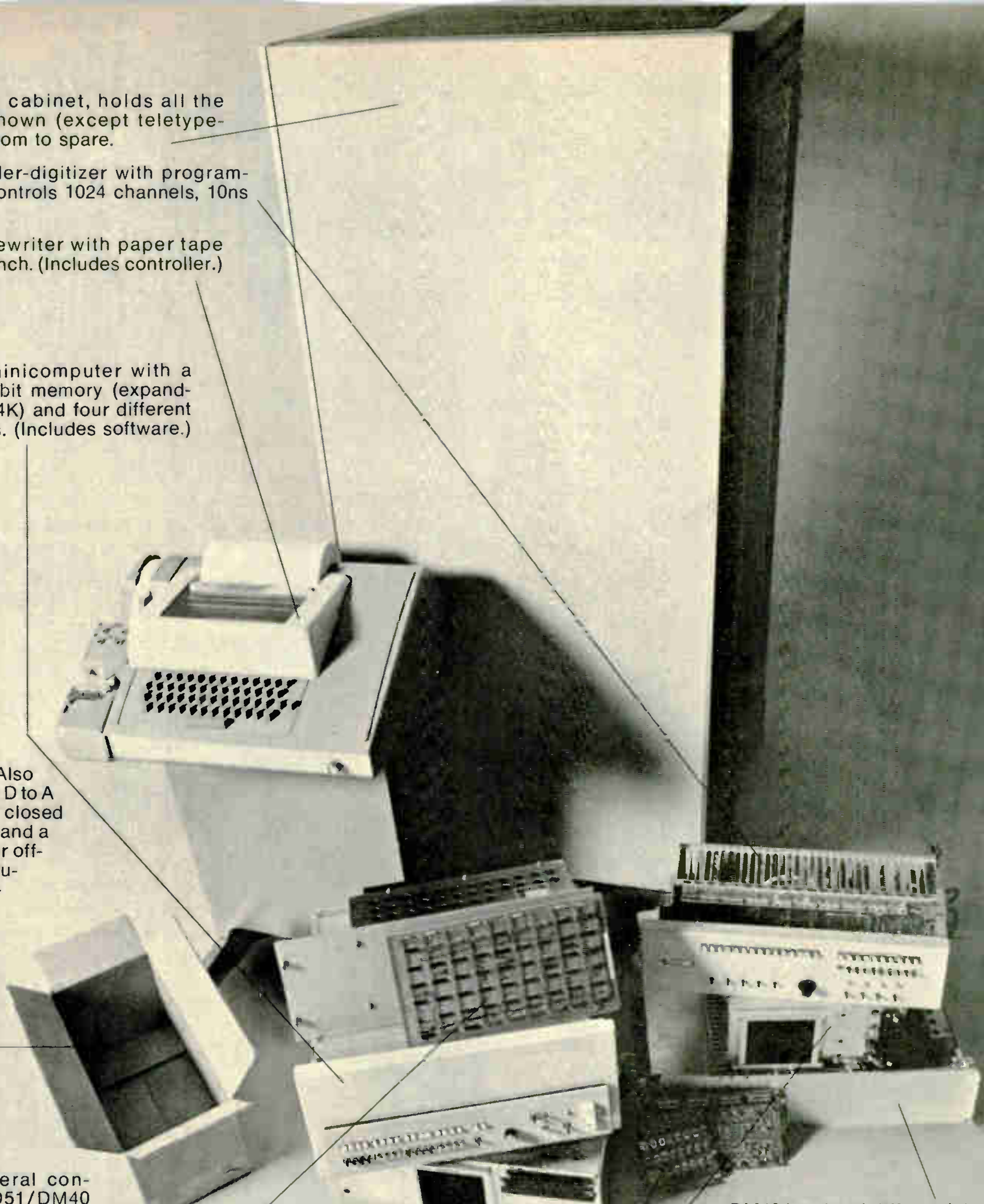

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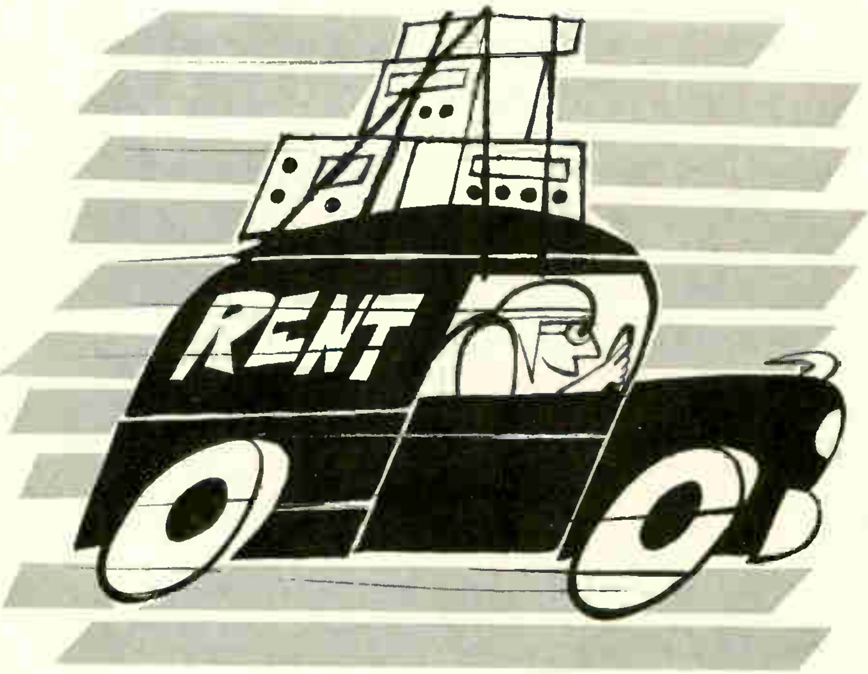
Instrument rentals pick up speed

Though market is tiny, variety of available instruments is growing; recession and tighter budgets spark appeal of rental arrangements

By Owen Doyle

Electronics' staff



As a business, it's barely making a ripple. What's more, many engineers haven't even heard of it, much less used it. But renting instruments for short periods—say a few months—is catching on with more and more engineers who find it difficult, if not impossible, to obtain money to buy equipment during this period of tight budgets. Growth factors are the increasing availability of instruments for rent and the declining cost of renting.

If the instrument rental business does catch on the way the rental firms think it will, some big changes are in the wind in instrument design and sales. One factor fueling sales of some instruments is short product life. More and more users may decide to rent gear because of rapid obsolescence: digital voltmeters, for example, become obsolete after only about two years now, admit makers.

The president of one instrument rental firm, Edward Herman of Rental Electronics Inc., actually feels instruments as we know them will soon disappear. In their place, he predicts, will be a "scientific terminal" that will perform all test functions. Users, he says, will buy the terminal mainframe and then rent plug-ins for specific jobs.

Another rental-inspired change may be the emergence of an important and respectable used-instrument market.

Instrument makers are beginning to take the rental business seriously. Most are studying rentals, and several are quietly making some of their wares available for rent.

The instrument rental pitch is simple and alluring: why throw away a lot of cash buying something that's needed for only a few weeks or months; it's cheaper to rent it. And almost any instrument can be rented, it's claimed. That's not quite so, but the rental firms certainly have come a long way from the early 1960's, when the only instruments rented were Tektronix oscilloscopes and some Hewlett-Packard meters and signal sources. Now, not only are more types of instruments available for rent, but they come from most of the makers. The rental houses still are sticking with "middle-of-the-road" general-purpose types, such as amplifiers, counters, filters, scopes, power supplies, and test chambers. It's difficult to rent and make money on infrequently used instruments, they maintain.

Business at the rental houses is good and promises to get better. Continental Leasing Corp., for example, has seen its rental income soar from $87,500 in 1965 to more than $2 million last year. However, it's still a small business compared to the giant instrument sales market. It's doubtful that total instrument rentals reached $8 million worth of business in 1969, a negligible figure compared with the $1 billion worth of instruments sold.

Returns. Customers find rentals appealing for a variety of reasons. Some engineers, particularly those with many defense contracts, need instruments for short projects. "Say you've got a little job where you have to make swept-frequency measurements," says Craig Goetsch, manager of the test equipment center at New Jersey's Lockheed Electronics Co. "And the instrument costs $4,000, and the total price of the job is $4,000. You can't get a return on equity that way, so the only thing you can do is rent it for a week or a month or so."

Others, such as division managers, rent much-needed equipment while they go through the red tape of justifying a purchase to top management.

Pack Rat. Others who are taking an interest are property administrators, whose status, says Rental Electronics' Herman, is being upgraded. The new administrator, he points out, is somebody who'll take a critical look at the practice of buying an instrument, using it once, and then sticking it on the shelf. Carl Harshbarger, Rentronix' general manager, agrees that the emerging importance of financial people will help his business. Every engineer, observes Harshbarger, has a "pack rat instinct to own everything he uses."

Right now, the test-instrument business is dominated by five companies, each with an inventory worth between $1 million and $5 million. Continental and Rental Electronics, the largest firms, do business all over the country; Electro Rents concentrates on the West Coast; Rentronix and Scientific Leasing Services Corp. are active in the East.

One complaint leveled at rental houses is that items in their catalogs may not be on their shelves for immediate delivery. The companies are reluctant to either buy a specific instrument at all or buy large quantities unless they're certain of getting their money back on it. As a result, a customer may find that all of the particular instruments he wants are out on rent. And some houses put everything they can think of in their catalog, and then wait until they get an order for a specific instrument before they buy it.

Conservatism. This conservatism gives rise to another complaint: rental houses only stock instruments the customers already have. Rarely used gear, such as tape decks and certain high-accuracy meters, don't appear in the catalogs. "The biggest complaint against the rental companies," says Lockheed's Goetsch, "is that they don't like to handle this stuff. If you're in the electronics business, you have a Tektronix scope, you have a generator, and you have the basic tools. You're looking to rent the one-of-a-kind things that you can't justify buying."

James Kistner, director of materials for Itek Corp., echoes this complaint. "There's not as great a variety available as we would like," he says. "Custom and semicustom instruments are hard to rent; it's better to rent from the makers in this case."

However, when what he wants is available, Kistner has nothing but praise for the instrument houses. "We find rental service generally excellent," he says. "We get good terms, instruments are available, and service is good."

Not everyone is as satisfied with rates as Kistner. Typically, the rental rate is 10% of an instrument's price for a one-month rental period down to about 6% for six months.

But prices are on the way down. Electro Rents recently slashed rates on some of its catalog items; the popular H-P 5245L counter slid from $250 a month to $200. And Rentronix has just announced across-the-board cuts ranging up to 30% for six-month rentals.

Rental houses get high marks for the quality of the gear they rent. Colby Kelly, purchasing agent at General Radio Co., reports that rented instruments arrive in good condition, an observation that seems to be general.

No junk. An important and ambitious outgrowth of renting, resale, is under way at Equipment Marketing Co. (Emco), an arm of Rental Electronics. Emco and other used-instrument houses say their biggest obstacle is overcoming a war-surplus image problem. "Anybody who's ever had dealings with used-equipment people has always had to handle junk," says Lou Sabetty, Emco's electronic manager. "When we sell something, we expect to sell it in a plastic bag, completely refurbished and reconditioned, and with a 30-day guarantee. The fellow won't have to dig through a pile of scrap to find what he'd like."

But rental companies may be hard pressed to hold onto their present markets. Instrument makers, though largely noncommittal, are interested in the business.

Most makers offer a rental deal if a customer asks for it. "We don't promote it," says Thomas Odderstall, Monsanto Electronic Instruments' manager of marketing. "But as a convenience to the customer we certainly will." Some firms admit to a more active interest. For example, feasibility studies are under way at Systron-Donner Corp., while Telonic Industries Inc. recently started a rental program. In March Beckman Instruments Inc. announced that any instrument in the division's line was available for rent at rates that run to about 7% of price per month. Beckman is in the rental business, says Charles Dill, manager of electronic systems, "because of the rapid expansion of the rental business and of the dominance in it of some other companies' equipment."

But the two shoes the rental companies keep waiting to hear drop belong to H-P and Tek. A Continental official claims that H-P will move into the rental business when the volume reaches $25 million. And Herman says that H-P is "test marketing a rental package". However, Alfred Oliverio, H-P's electronics group marketing manager, denies any such interest. "It's not a trial thing at all," he says. "What it boils down to is that we're willing to accommodate a customer under some conditions. We haven't really gotten involved in any rental activity at all."

As for Tek, there's speculation that the Oregon firm is thinking of using its new 7000 series of scopes in a buy-the-mainframe and rent-the-plug-in's program. However, Frank Elardo, Tek's assistant U.S. marketing manager, says his company will sell only "fully operable products." But he doesn't rule out renting: "a manufacturer could certainly do as good or a better job than rental companies in serving customers' rental needs. We are constantly assessing these needs, but have no plans as yet."

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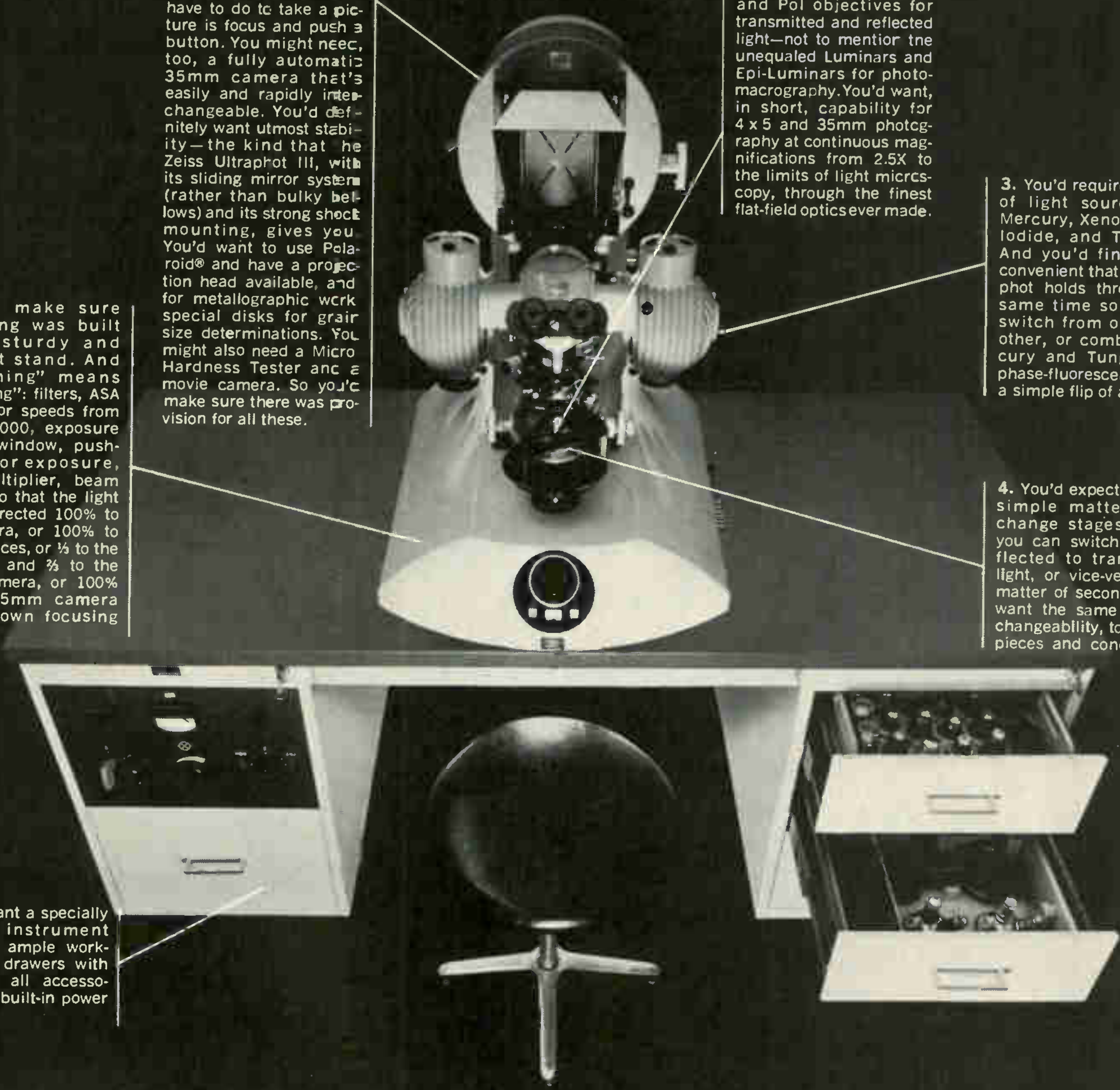
What would you ask for in a complete Photomicrographic and Photomacrographic Lab?



1. The first thing you'd ask for would be an easily operated 4 x 5 camera system. You'd want it to be completely automatic —exposure, film counting, frame-imprinting, everything—so that all you have to do to take a picture is focus and push a button. You might need, too, a fully automatic 35mm camera that's easily and rapidly interchangeable. You'd definitely want utmost stability—the kind that the Zeiss Ultraphot III, with its sliding mirror system (rather than bulky bellows) and its strong shock mounting, gives you. You'd want to use Polaroid® and have a projection head available, and for metallographic work special disks for grain size determinations. You might also need a Micro Hardness Tester and a movie camera. So you'd make sure there was provision for all these.

2. You'd insist on the highest quality optics—in other words, Zeiss optics. And you'd want them to be *completely* interchangeable with those on any other Zeiss microscope you may have or plan to add. So you'd have available to you the world's widest line of Planapochromats, Planachromats, Plan-Neofluars, Neofluars, Ultrafluars, Achromats, Epi-planS, and Pol objectives for transmitted and reflected light—not to mention the unequaled Luminars and Epi-Luminars for photomacrography. You'd want, in short, capability for 4 x 5 and 35mm photography at continuous magnifications from 2.5X to the limits of light microscopy, through the finest flat-field optics ever made.

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Engineers find recession hits them where it hurts

Some EE's, facing demotions and cuts in salary, travel, and entertainment are reappraising their own financial status; many put off major purchases

Pushing steadily upward through the ranks of laborers and blue-collar workers, the heavy hand of recession is reaching toward electronics engineers, too. And to many the squeeze is becoming severe. The less fortunate are out looking for new jobs, while some engineers have been demoted to technician-type positions. Others have suffered pay cuts or were promised raises that weren't delivered.

Even those who weren't laid off or demoted haven't escaped the recession unscathed. Poor business conditions have entailed smaller entertainment budgets and embargoes on trips to technical conferences. At the office, they're having to put up with longer working hours and smaller clerical staffs.

At home, many engineers have gone through an agonizing financial reappraisal. The new car will have to wait, and so will the stereo rig. Wives have been told to shop at budget markets. Some EE's, caught flat-footed by a layoff, have had to float personal loans to tide them over.

The people most affected, of course, have been clerks, technicians, and junior engineers. But even senior people haven't been spared. One ranking engineer who put in 20 years with Sperry Gyroscope was bounced and had to take a job in the Camden, N.J., area, some 90 miles away. "I visit my family in Long Island on weekends," he relates. "During the week I live out of a furnished room.

"Companies make grave mistakes when they try to save on the salaries of their senior engineers," he says. "We can churn out two or three times the work of the juniors, and with today's starting salaries as high as they are, the differential isn't that great. My old company is probably losing more money than it's saving."

An East Coast radar engineer who was shifted from his job when a contract expired notes: "I've got 16 years of design experience and I'm doing a job that they could train a chimpanzee to do." His new responsibilities amount to keeping track of all valuable equipment in the plant.

A West Coast avionics engineer—one of the lucky ones—stayed with the company during a 50% cut in staff and held the same job. "But I had to take a 10% pay cut, which brought me back to the salary I was making four years ago. With prices the way they are, that really hurt," he asserts.

According to a New England semiconductor engineer, "Quite a few people here have been getting less money, but some take the option of getting laid off with severance pay instead of being downgraded in pay and status to a level

Prodigal son

The worsening business climate also has adversely affected foreign engineers who came to the U.S. for better opportunities. Yet, while these brain-drainers aren't exactly stampeding back home—partly because they can't always get foreign companies to pay travel and removal expenses—some have returned, and others are thinking about it.

A case in point is Roger Hallett, a 30-year-old engineer who went back to Britain last September. Hallett spent three years in the U.S. with Bell Aerosystems Co. in Buffalo, N.Y., where he designed low-frequency circuits for use in accelerometers for the space program. He now works for Ilford Ltd., a film and photographic materials company. There, Hallett designs low-frequency circuits for use in film production control equipment.

"My wife and I always intended to return to England, but the cutback in spending on space brought us back rather sooner than we'd intended," says Hallett. "My job with Bell just fizzled out through lack of orders," Hallett relates. "I was offered temporary work on defense equipment but I couldn't get enthusiastic about it and I would have been made redundant eventually, anyway. American companies are ruthless when it comes to redundancy. If I could have gotten acceptable circuit design work somewhere else, say in California, we would have stayed, but there was very little on offer. I would have taken circuit design work in any field, but I didn't want to move into some other activity, say development or maintenance.

"We didn't have to suffer any reduction of living standards while we were in America due to inflation, though we came back before it got really bad. We saw the recession coming, realizing that Americans would cut back on space spending once they reached the moon."

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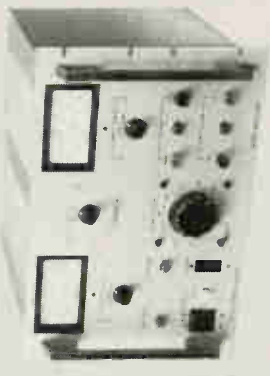

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where more problems are likely to occur. This is especially true of long-term people."

He figures some people will live on their unemployment insurance for a while, but says others have nothing to fall back on. He knows of some laid-off people who had no money in the bank, and others who had all their liquid resources tied up in declining stocks. Two men had to take out bank loans just before they were laid off in order to tide themselves over.

Hardest hit is the military side of the business. George Rounsaville, manager of military products applications at the Stewart-Warner Electronics division in Chicago, says, "Regular raises aren't coming about. What would have been a year's wage increase will be stretched out to cover as much as 15 to 17 months now."

One middle-management engineer at a small Washington company notes that business administrators are more vulnerable than engineers in his organization, excepting those with highly specialized backgrounds. And according to one personnel placement manager, a number of engineers with such specialities as radar and sonar, for example are still walking the streets. "As some of the work changed, they just weren't able to fit in," he explains.

According to one East Coast semiconductor engineer, the recession has triggered engineers into finding jobs in other fields. "They generally go into more consumer-oriented businesses, such as insurance. Maybe they've been thinking of it for years but they needed a catalyst—like seeing their career plans torpedoed or stretched out."

Home economics. Many engineers at other companies have had to tighten their belts at home. One Southern avionics engineer complains, "We have five kids and aren't buying much of anything except the necessities these days. My salary just isn't keeping up with inflation. We usually rent a trailer each summer and go off on a vacation. This year we're not going anywhere."

An East Coast engineer says his family decided to buy carpeting instead of air conditioning this year because "we felt we'd be getting better value for our money." Nick Kovell, a communications engineer for Westinghouse Air Brake Co., says his family postponed buying a stereo and is going to fewer movies.

Others with high living standards also have had to compromise. Notes one West Coast executive, "My wife and I sit down and ask ourselves whether we can meet the bills, and I make a pretty good income even for the aerospace industry. But we recently gave up our country club membership because we couldn't pay new assessments and higher membership fees." He now drives a three-year-old compact to work, and his wife manages with an aging six-cylinder station wagon.

A young Ph.D. who does avionics systems engineering in Atlanta reports, "The recession's impact is coming mostly in my psychological outlook. I feel a nervousness and a sense of uncertainty about the future. I've thought about looking around, but like a lot of other engineers I want to stay in the same city. I'd like to teach, but the schools around here are completely staffed—and so are the companies. I hear the data-processing firms in this area that use instructors are flooded with applications from engineers who want to teach."

Aggravating the problem are overtime cancellations by some companies. A Boeing engineer claims, "Overtime authorizations—even on the supersonic transport work, which we're pushing hard—require an act of God." Most engineers don't try to raise additional cash by moonlighting. According to a West Coast aerospace engineer, "The jobs are already being done by guys who were laid off. Besides, we haven't the time now that we operate with smaller staffs."

And not only is it tough for those who leave, but it's not easy for those who stay. One digital systems design specialist at Airborne Instruments Laboratories in Deer Park, N. Y. says the heaviest burden falls on the senior people who stay on. "Before, I handled just one project," he notes. "Then a few months ago I was consulting on projects at four different locations within the company." Because he's spread thinner, he can't follow up on his designs as much as he'd like to,

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For laid off engineers: a bad trip

Getting the word that you're surplus and your job is being wiped out is bad news, no matter how nice your boss is about it. For some engineers, it can be a unique experience. A physicist got the ax twice from his company; a logic designer perhaps received too much advance warning, and Long Island areospace engineers don't even get a chance to catch their breath.

The physicist has been laid off twice in six months by his firm—a Southern California aerospace laboratory. The first time, he was told by his boss to take a month off with no pay until funds could be found to continue the electric propulsion research he was working on. He was rehired, but the new money turned out to be less than the lab expected, so the physicist was laid off again after four months of work. After a month "on the beach," he was rehired when a secretary in his department was let go. Her annual salary covered his pay for another three months. But once this money runs out, the physicist expects to be furloughed for a third time.

The logic designer, working in the New York area, is certain about the future of his job—his company plans to close the doors at the end of its fiscal year. A program manager with 16 years of experience, the designer doesn't know what to do. He's paying off a big mortgage and unemployment insurance would not even cover his county taxes and car payments. He hesitates to start looking for a new job, knowing just how scarce jobs are.

For some engineers, the way they are being laid off can be an unfortunate and traumatic experience. Listen to an engineer tell how it's being done at a Long Island aerospace firm: "Your supervisor calls you into his office and he tells you that you're surplus. Then, along with a guard, he escorts you to your desk and tells you to carry what you can out the door. They'll send you the rest. That's the way it is, short and sweet."

he explains. "I have to delegate more of the responsibility for building and trouble-shooting systems."

Even the number of telephones has been cut back at some companies, and engineers relate complaints of frequent busy signals. One Seattle communications engineer claims someone unsuccessfully tried to get him by phone for two days.

The squeeze also affects purchases of new materials and equipment. George Glenfield, an engineer at Varian's Bomac division says, "All capital equipment expenses are being looked at hard, and need additional approval to make sure they're really necessary and not redundant."

Donald Herling, manager of the antenna laboratory at the Hallicrafters Co. in Chicago, admits that it's tougher to buy equipment, but claims, "If you really need it, the company will get it. The main impact of budget cutbacks has been to kill lower-priority projects."

Fringe benefits also have suffered; most companies have slashed their entertainment budgets. One West Coast aerospace engineer says, "I usually have a preliminary chat with customers first to determine if I should ask them to dinner. And then I don't take them out but instead invite them home for cocktails and dinner."

Entertainment may suffer somewhat, but tuition aid programs remain intact at most companies. A West Coast aerospace engineer notes that at his company, "not many engineers attempt to get advanced degrees. Older engineers don't have the time, and you don't see many younger engineers around any more," he says.

One company, the Digital Equipment Corp., located in the Boston area, actually has liberalized its tuition plan by removing its $450 ceiling. And a New England semiconductor manufacturing firm will pay tuition even for an engineer who has been laid off, provided he contracted for the course while he was employed. However, at least one company, a Southern avionics firm, now requires engineers who attend classes either on or off company premises to make up all time lost from their jobs.

Perhaps the most visible cutbacks have been in travel. A manager at a Southern avionics firm complains, "I've had to stop attending almost all of the conventions and technical meetings I made in the past. In fact I missed the IEEE convention. I understand it only had about 40,000 attendees, instead of the usual 60,000 or so."

An East Coast semiconductor manufacturer allows a few engineers to attend meetings, but expects them to brief those who stay behind. In the Boston area, an IEEE spokesman says the shows and the lecture series are feeling the pinch. Some manufacturers are canceling booth space because of poor attendance.

Varo Inc. in Texas has suspended its policy of getting all professional people to attend at least one important meeting a year. At Varian's Bomac division, engineers now travel tourist instead of first class. And on the West Coast, one manager of military and space systems takes a hard-nosed approach: "I insist that an engineer going on a week-long trip leave on Sunday morning so that he arrives at the customer's office Monday morning. And he doesn't start for home until after 5:30 p.m. on Friday."

The same manager says the drop in attendance at meetings does have a bright side. "I now tend to go for a specific paper or session, so I've been forced to be more selective."

One result of the recession has been to make engineers more politically aware. Bomac's George Glenfield reports, "There's serious concern among our engineers over what direction this country is taking. Action by the Federal Government to stop inflation is not apparent. Engineers are finding out that fiscal policies are directly related to their jobs."

Reporting for this article was done by Ralph Selph in Los Angeles, Gail Farrell in Boston, Marilyn Howey in San Francisco, Ray Connolly in Washington, Mike Payne in London, Ray Bloomberg in Seattle, Bob Lee in Chicago, Marv Reid in Dallas, Fran Ridgeway in Atlanta and Steve Lowman in Pittsburgh. Additional reporting came from New York editors. Bill Bucci put the report together.

←Circle 126 on reader service card

Design house finds 'one for all' can apply to custom memories, too

One plan offers a memory maker lower costs if other manufacturers can use its design; a price and performance guarantee comes with it

By Lawrence Curran
Electronics' staff

Memory design houses traditionally stand jealous guard over customers' proprietary rights. But the alert management of Technology Marketing Inc. discovered that many companies don't object if their custom-designed memories are manufactured and used by others. In the process, TMI found a way to reduce costs for some customers and also turn a profit for itself.

The young Santa Ana, Calif., firm offers customers two options: the usual exclusive design contract and a lower-priced version. Under the latter arrangement, other companies can manufacture essentially the same memory developed for someone else. These licensees don't pay development costs, but instead give TMI a license transfer fee.

Started little more than a year ago by Robert Lowry and George Wells, TMI probably is unique in the industry because of its guarantee, which it feels rivals Sears Roebuck's. TMI promises "satisfaction with the job" and assures customers that they can manufacture the specified memory in their own facilities at the quantity prices agreed upon. The company says it will foot the bill for excess development and manufacturing costs.

Lowry and Wells, either of whom acts as company president on any given day depending on the nature of the negotiation, only found out in the last few weeks that their customers don't always care whether or not they have exclusive ownership of the memory systems TMI designed for them. Lowry believes that TMI's policy of licensing the same design to more than one company will account for the major portion of future business.

He feels most customers, usually

Young oldtimers

Even though he's only 36, George Wells, the technical half of the Lowry-Wells team that heads Technology Marketing Inc., goes back to the early days of core memories. He was a circuit designer in RCA's computer group from 1958 to late 1961. In that year, he visited and worked with engineers at Telemeter Magnetics Inc., in Culver City, Calif., on designing a formidable memory project for which the firm was subcontractor to RCA. This was a 1.5-microsecond unit, and the 30-mil-diameter cores—and all the associated tooling and stringing techniques—had to be developed for it. At the time, 50-mil cores were the smallest in general use.

One of the now-prominent "names" then affiliated with Telemeter Magnetics was Trude Taylor, who left in the summer of 1961 to create Electronic Memories Inc., now Electronic Memories and Magnetics Corp.

Because Telemeter Magnetics was one of the first commercial core-memory companies in the United States, and because Wells recognized its potential, he was receptive when officials of the Southern California firm asked him to come to work for them. He started there in January 1962, just after the company was sold to Ampex Corp., and became its Computer Products division. Wells kept in touch with Taylor, however, later joining Electronic Memories to handle core memory systems.

He resigned from the post in 1968, and Lowry, then associated with System Design Associates, lured Wells to his company, which later spawned Microdata Corp. and its minicomputer-manufacturing subsidiary, MicroSystems Inc. SDA was a consulting company, and Wells developed the group's memory system design business, including the memory for MicroSystems' Micro 800 minicomputer.

Lowry says the computer's memory was ready before the rest of the machine, and SDA officials felt the memory could be sold. But this would have conflicted with SDA's charter as a consulting house. The memory consulting activity was set off separately, and Wells and Lowry eventually parted amicably with SDA-Microdata to form TMI. They got a running start in the memory design business with a $250,000 backlog from SDA.

Lowry's path shows fewer turns than Wells's. Now 42, he was the first salesman on Decision Control Inc.'s payroll back in June 1963. The firm was sold to Varian Associates, becoming Varian Data Machines in June 1967. Lowry was director of International Marketing when he left to join SDA in January 1968. He and Wells started TMI in March 1969.


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computer manufacturers, will agree to let their designs be used elsewhere because they don't want to sell memories. Since they save money by manufacturing their own memories in house, they don't object to TMI selling the same design two, three, or four times over. In such cases, all TMI has to do is to design different custom interface hardware.

Under the licensing arrangement, TMI covers development costs, then charges each customer a manufacturing license-transfer fee to partially offset the considerable documentation that accompanies TMI-designed memory prototypes. The license-transfer fee will range from $10,000 to $20,000, Lowry says. Then each customer pays TMI a royalty on every system it builds. This will be set up on a sliding scale—possibly $200 for each of the first 100 memories built, $175 for each of the next 100, and so on until a fixed limit is reached.

The recent switch to the license-royalty arrangement could kick TMI's sales upward. But it won't affect the number of totally new designs TMI will undertake, about 12 to 20 a year. Four months is the average cycle time for a custom design, and TMI can handle about five at a time, with three in final checkout simultaneously.

No production. TMI has no intention of manufacturing any memories itself. "What puzzles many customers," Lowry says, "is that we turn them off quickly when they ask us to manufacture their memories." The price quotes on a job are so thorough that customers often assume TMI is seeking the production contract as well as the design contract.

Lowry feels there's good reason not to be a manufacturer, particularly of standard memory systems. First, computer memories have graduated from the days of small quantity orders to the point where orders for thousands aren't unusual and TMI doesn't ever want to do more than $1 million a year in memory design sales; it wants to be selective enough to maintain quality design, its stock in trade. Lowry says. "The black art is gone from memory design," he asserts. "It takes experienced people, but it's now a science."

Exclusive customer ownership arrangements will account for the bulk of TMI's projected 1970 sales of $660,000 since the licensing royalty arrangement is so new.

No extras. If TMI exceeds its estimated development costs in its price quote, there's no extra charge to the customer, and if it costs the customer more than TMI has estimated to manufacture the memory in quantity, TMI will make up the difference. To date, most jobs have come in 6% to 8% below TMI's estimate. "This is because 94% of the manufacturing costs derive from materials whose prices are known" Lowry reports.

"We felt the industry was ready for a company that would assume full responsibility for what it does," Lowry asserts. "We guarantee client satisfaction. There are no qualifications, and we have to make it right if he's not satisfied. This philosophy dictates selectivity."

Since most customers anticipate volume production, TMI's designs must use readily available parts to insure simplicity of manufacturing and good reliability. The firm insists that there must be at least two sources for components in its designs, and it takes an active role in negotiations for such major items as core stacks to prevent cost overruns. TMI advises customers not to string the cores themselves but to let the core supplier do it, and provide the circuit boards and decode diodes. Thus, Lowry says, TMI customers can get custom stacks as completely tested assemblies that can be bought from multiple sources. TMI also favors completely pluggable core stacks without the backplane wiring that makes for additional labor charges and possible error.

The package TMI offers includes not only the design specifications and prototype models but all the documentation needed for the customer to turn the job over immediately to his manufacturing facility. TMI will use the customer's symbology, drafting standards and numbering release system on the customer's own title block vellums, if desired. TMI also will document the core stacks using, say, the Ampex, Electronic Memories and Magnetics, or Ferroxcube symbology and numbering release system, including their suppliers' testing procedures. Then TMI's customer

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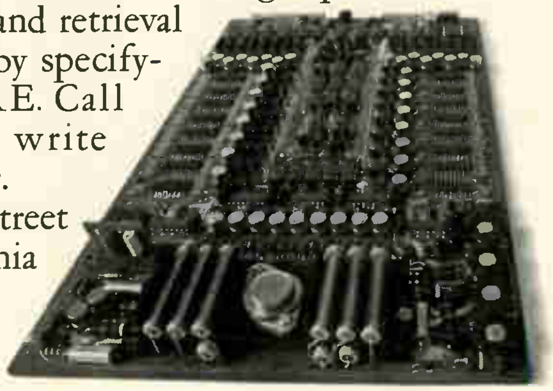

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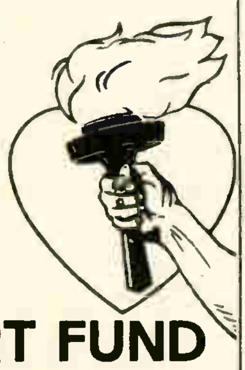

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can turn the prints over to any of a number of stack makers for immediate production. There's no production-delay wait for drawings to be converted to another format.

ECL, too. While most of TMI's designs have been core memories, Wells has designed a system for Standard Computer Corp. in Santa Ana, Calif., that employs emitter-coupled logic. This is a 2½-dimension, 10-million-bit memory used in Standard's own IC-7000 computer and sold separately by the firm for use with IBM's System 360, models 65, 67, and 75. Using 20-mil cores, the unit has a full cycle time of 700 nanoseconds; with 18-mil cores, the cycle time is cut to 500 nsec.

"We were looking for TMI to put us into the memory business and they did it," says Standard's David Keefer, vice president for research and development.

Wells cites these TMI goals: in a three-wire, 3-d system with volume production, "we're looking at an 800-nsec cycle time"; in a 2½-d system, Wells says, 500-nsec speeds are easy to attain with cores or semiconductors, and future cores will increase that speed.

"In a three-wire, 3-d system," Wells says, "the cost of the memory is the same whether the cycle time is 900 nsec or 2 microseconds, but the power supply cost is greater for the faster memory. Also, speeds of 900 nsec dictate moving air for cooling, a cost and noise item. Most manufacturers will trade speed for lower cost."

TMI has designed memories for several minicomputers, including the 1-μsec, 400-word-by-18-bit system for Raytheon Computer's model 704; a 1.6-μsec, 1,000-or 4,000-word by eight-bit system for Monitor Data Systems' new model 708 machine; and a 4,000-word by 16-bit memory for the Ruggednova, the military version of the Nova, made by a Data General Corp. licensee. TMI also designed a 2-μsec, 2,000-word by 18-bit memory for a large industrial data base system made by Data Pathing Inc., Sunnyvale, Calif., and is designing the memory for Omnicomp Computer Corp.'s new Omnus-1 minicomputer. Omnicomp also is in Santa Ana, Calif., and expects to introduce the machine later this year.

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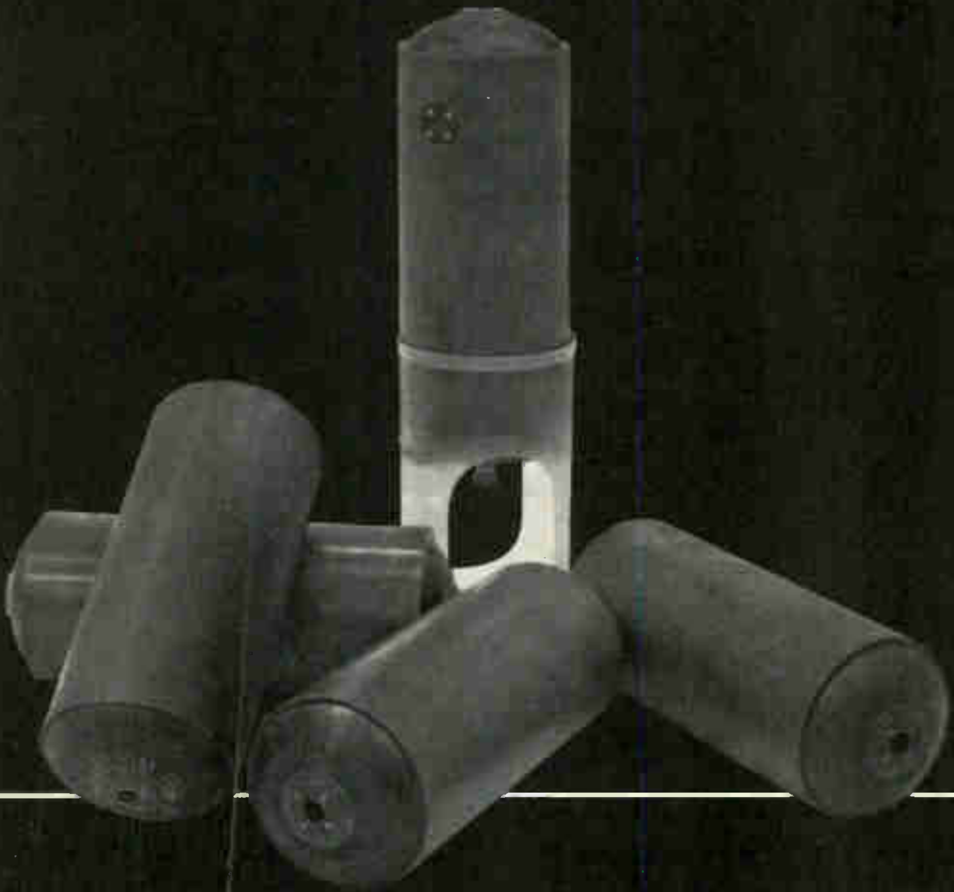

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A widening market for MOS: Industrial monitoring and control

Data communications system is built around two MOS/LSI chips which allow measurement, analysis, and routing of 16 discrete functions

By Stephen Wm. Fields
Electronics' Staff

The dream of almost every engineer is to find some gap in a market and then develop a device or system to plug it. That's been the scenario for George Larse. Late last year, George Larse and the others who have since formed the Larse Corp. did a market research study on digital data communications systems and learned that the need for remote monitoring and control equipment for industrial applications was growing at a tremendous rate. They maintain that existing equipment for this market does not make use of the latest technology—MOS/LSI [*Electronics,* June 8, p. 14]. Thus the Larse Corp. was formed with the goal of manufacturing digital systems employing MOS/LSI for the industrial market, which Larse believes will reach $100 million in 1971.

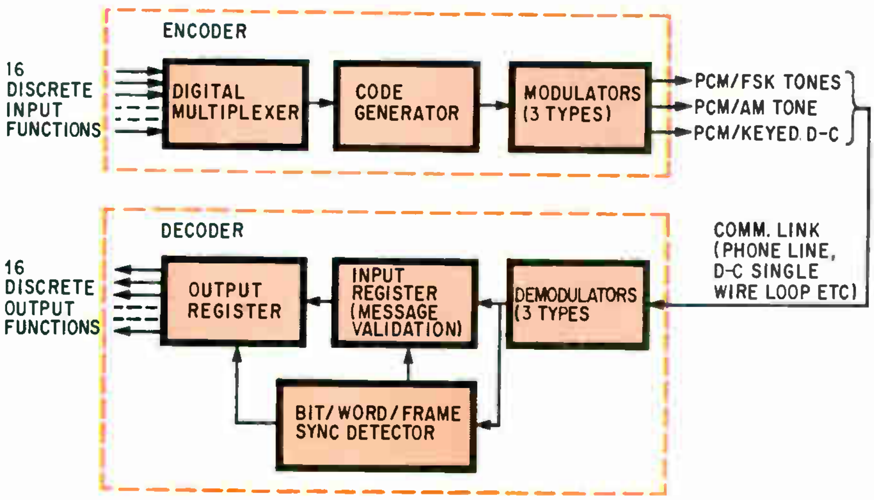
In the industrial automation market, Larse includes process control systems, industrial telemetry and remote control, computer based automation systems, traffic and transportation control, and plant operation data systems. His approach was to design two MOS circuits to be the basic building blocks for a systems family. The two circuits are a multiplexer-encoder-transmitter, called SEN and a receiver-decoder-demultiplexer designated REDE. Each monolithic chip measures about 125 mils square and performs the functions of about 1,500 discrete transistors.

Although the monolithic chips are the heart of the system—they are systems themselves—Larse says they will not be sold as separate devices. "We are not in the semiconductor business, nor are we in the systems business; we are supplying system building blocks," he maintains.

Thus, a basic digital data transmission system includes a SEN and a REDE. The SEN allows measurement of 16 discrete functions (on/off, open/close, high/low, etc.). The SEN also can arrange this information to be transmitted serially in binary form over a communications link to a remote REDE unit. The REDE unit analyzes each of the 16 function messages to guarantee reception of data without errors. Then it routes each function bit to its proper output line. In a typical application, a discrete function may be a switch that is normally open (binary zero) and which would close to indicate an alarm condition in some industrial process.

A time-division multiplexer in the SEN samples each input circuit in sequence at a programable rate, producing a serial train of binary-coded digital pulses which then are transmitted over a single communications channel. Prior to transmission of each data word, which comprise the 16 discrete functions, a code generator on the SEN chip inserts sync bits into the data stream so that the REDE unit can properly sort out the data bits and feed them to the correct channel.

The complete coding system is based on an original code devel-



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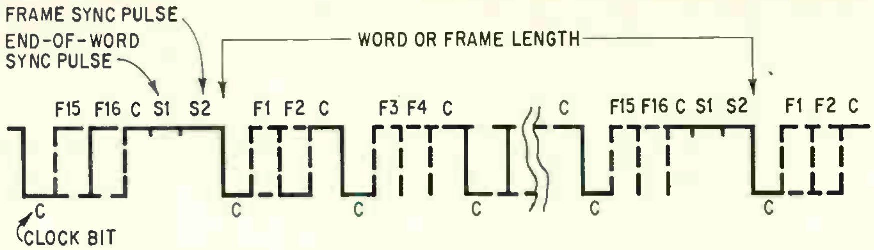

Expandable. Encoders can be connected in order to increase monitoring capacity. Function bits F1 and F2 are employed as parity bits.

oped by Larse engineers. Here each pair of consecutive function bits is preceded by a clock bit represented by a binary zero, and is followed by a binary-1 clock bit. Following the 16th function bit are three consecutive binary 1's inserted by the code generator. These represent a trailing clock bit, an end-of-word sync bit, and a frame sync bit. The latter is employed when more than one encoder is used and thus a frame may contain two or more 16-bit words.

In the Larse code, a data word is defined as the 16 function bits plus the sync bits that result from one scan of the input circuits. A data frame is defined as the complete serial group of words that results from one scan of all input functions. Where a single encoder or SEN is employed, the data frame contains only one data word.

After the coding, the data is modulated and sent out on the communications channel. Three types of pulse-code-modulated output signals are available. The first is a frequency-shift-keyed audio tone (PCM/FSK) for two-level NRZ transmission on voice-grade telephone lines. The second is an amplitude-modulated audio tone, also for two-level NRZ transmission on voice-grade telephone lines, usually in a frequency-division multiplexed arrangement of several encoders sharing a common circuit or in a voice-plus-data operation mode. Finally, there's a direct-current-keyed signal for transmission on telegraph lines or d-c single-wire loops.

The encoder PCM systems are directly compatible with radio transmission, particularly in a quiescent operation mode where the encoder only transmits for one second for a change-of-state or an alarm condition. Larse points out that "since momentary or low-duty cycle radio transmission does not require FCC licensing, this mode will be preferred for many remote locations."

At the receiving end, each data word is temporarily stored in an input register while the decoder (REDE) performs several validity tests. One is a parity check and another is a double scan comparison. Both are selectable features when the chips are ordered since they require special data formats. After the data is validated, it is shifted to the output register and out to the external display, data logger, or computer processing system.

Larse says that the system's big advantage is the flexibility that's built into the MOS/LSI chips. For example, a variety of system and communication modes may be implemented with different SEN and REDE arrangements such as simplex, half-duplex and full-duplex systems. In a simplex system one or more encoders transmit to one or more decoders in one direction only. For half-duplex operation each terminal (remote or central station) contains both an encoder and a decoder, allowing transmission in either direction but not at the same time. And full duplex allows simultaneous, two-way transmission.

Because of the many input and output options, the units can interface with anything from TTL circuits to relay logic. And their small size—each unit measures 3 by 6½ by ½ inch—allows incorporation into existing equipment racks. In fact, the complete SEN unit takes up much less space than a Bell System modem.

Prices for both SEN and REDE units range from $450 to $600 each depending on options. Delivery will be off-the-shelf by the middle of July.

Larse Corp., 1070 East Meadow Circle, Palo Alto, Calif. 94303 [338]

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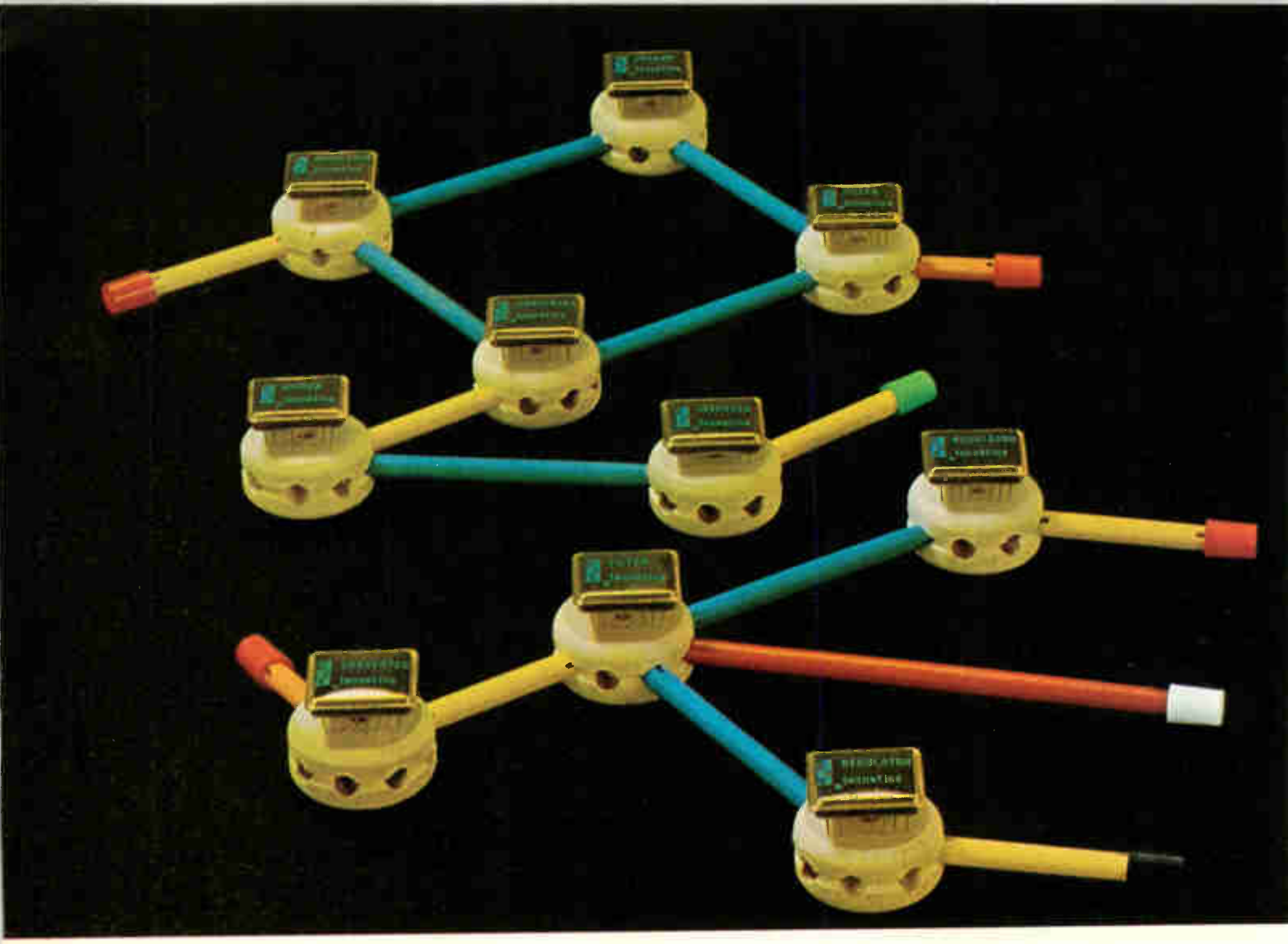

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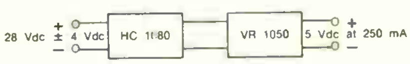
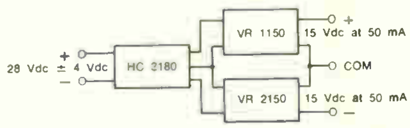
APPLICATIONS

Post-Regulated Converter



Typical specs: Line Regulation (24 to 32): 0.02% • Load Regulation (½ to full): 0.01% • Ripple (p-p): 0.1%

Post-Regulated Dual Converter



Typical specs: Line Regulation (24 to 32): 0.05% • Load Regulation (½ to full): 0.01% • Ripple (p-p): 0.6%

Pre-Regulated Converter

Typical specs:
Line Regulation (24 to 32): 0.02% • Load Regulation (½ to full): 3.0% • Ripple (p-p): 0.1%

These converters are the latest in Tecnetics' series of cold weld hybrid power conditioning components. Regulators are also available off-the-shelf—and other modules on the way include inverters, reference amplifiers, drivers, filters, and more.

For more information on these and other TEC power conditioning products, call us collect at 303-442-3837, or see EEM, pp. 2120-2125, the inside cover of EBG, or write . . . Tecnetics, Inc. (formerly Transformer-Electronics Co.), P. O. Box 910, Boulder, Colorado 80302. TWX 910-940-3246.

tecnetics inc.

The innovators in power conditioning

Laminated bus bar eliminates noise

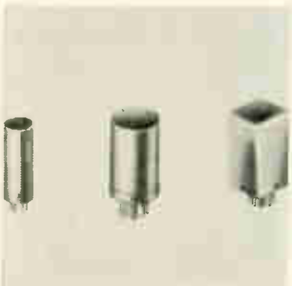
Thin-film dielectrics and epoxy encapsulation added to flat copper conductors produce a rugged connection system

High capacitance and rigidity are the most desirable properties in laminated bus bars. The high capacitance is needed, in the power section of computers, for example, because it eliminates the noise, crosstalk, and spurious pulses that are produced by heavy currents moving through dense wiring. Rigidity is important because the length of copper conductors tends to make the bars flexible and easily breakable.

In most laminated bars, however, thick dielectric films—5 to 8 mils—are used to separate the copper conductors. These have proved inadequate because the flexible copper, laminated into a sandwich eight to 10 layers thick with nine dielectrics, causes the films on the outer edges to break. Moreover, thick films provide low capacitance.

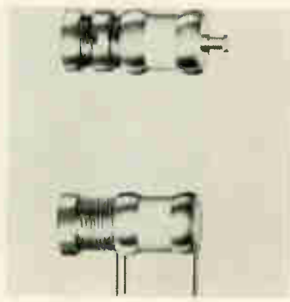
By using a thin-film dielectric and epoxy encapsulation, AMP Inc. has provided both high capacitance and rigidity in its power distribution system called Capitron. AMP says the system also solves two other problems common to thick-film methods: vibration and degradation. The rigid structural member takes care of the vibration

Crystal-controlled clock oscillator model CO-231 provides a stable output to drive TTL or DTL logic. The oscillator operates from 5 v d-c, and provides a stability of ±0.0025% over 0-70°C for any frequency between 4 khz and 25 Mhz. The oscillator is designed for p-c board mounting and measures 1.5 x 1.5 x 0.5 in. Vectron Laboratories Inc., 121 Water St., Norwalk, Conn. 08854 [341]

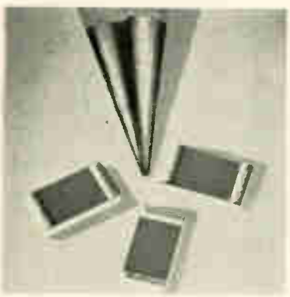


A wide variety of standardized plug-in metal housings of aluminum and steel are suitable for shielding electronic circuits. Engineered and designed to exact specifications, these economically priced housings are prefabricated, compact and easy to assemble. A catalog is offered describing services available. Keystone Electronics Corp., 49 Bleecker St., N.Y. 10012 [342]

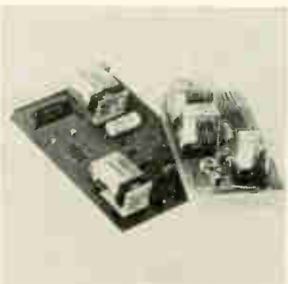
Ten-turn, turns counting dial model H-510 is designed for use with precision potentiometers. Readability is that of a 1 13/16 in. dial in 1/3 less panel space. The unit is for direct mounting on 1/4 in. and 1/8 in. shafts. No special panel holes are required, and backlash is eliminated. Price is $3.99 in 1,000-lot quantities. Bourns Inc., 1200 Columbia Ave., Riverside, Calif. [343]



Air dielectric trimmer capacitors are variable from 0.4 to 6 pf. The MVM-006, for panel mounting, measures 9/16 in. long and has a turret terminal. The MVM-006W, for p-c board use, is 31/32 in. long. Temperature coefficient of capacitance for both is 0 ±50 ppm/°C measured at 1 Mhz from −55° to +125°C. JFD Electronics Corp., 15th Ave. at 62nd St., Brooklyn, N.Y. [344]

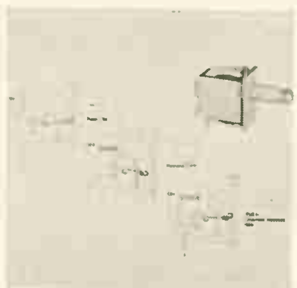


Thick film chip resistors offer wide design flexibility in hybrid circuit use. Available in four sizes from 0.050 x 0.050 in. to 0.050 x 0.150 in., they offer a standard resistance range from 100 ohms to 500 kilohms. Tolerances range from ±20% down to ±1%. Temperature coefficient is ±200 ppm over the range −55° to +150°C. Dale Electronics Inc., Box 609, Columbus, Neb. [345]



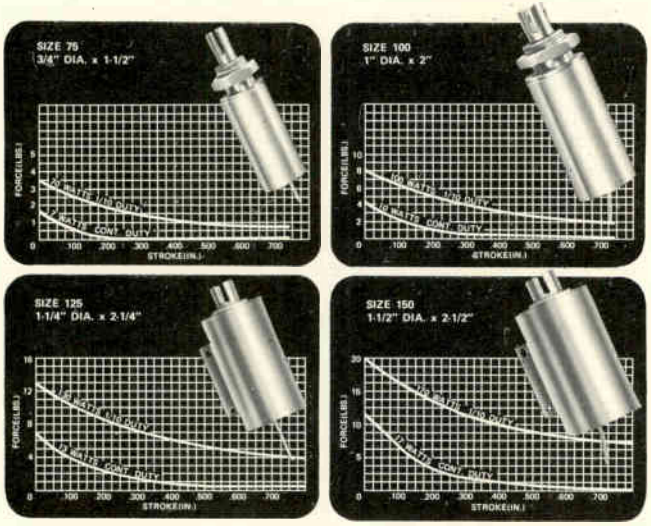
Miniature cradle relays in the Hi-Mag series require 45% less coil power than units of comparable size and ratings, yet they provide a minimum of 15 grams of contact pressure. With only 30 mw per pole, input power loads as high as 150 w are switched reliably for millions of operations. Contact configurations are up to 8 form C. Allied Control Co., Plantsville, Conn. [346]

Thermistor pellets sealed in glass diode type enclosures are for large volume applications such as temperature compensation of wirewound relays, motors and generators including servo and synchro resolvers. Units come in standard resistances (at 25°C) of 2, 5, 10, 20, 50, 100, 200 and 500 kilohms, and 1 megohm. Fenwal Electronics Inc., 63 Fountain St., Framingham, Mass. 01701 [347]



Momentary and pull-to-override interlock switch designated model E69-30A is of molded nylon for snap-in panel mounting. It has been engineered for use as a drawer, door, appliance and tv interlock switch. It is available in spdt or spst, either normally open or normally closed. Cherry Electrical Products Corp., 1650 Old Deerfield Rd., Highland Park, Ill. 60035 [348]

New from Ledex! Long stroke, straight pull solenoids

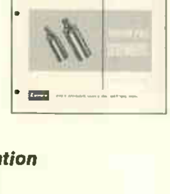


Now when you need long stroke linear motion you can look to Ledex, the same people who have for years been engineering and producing one of the broadest lines of rotary and short stroke straight pull solenoids on the market today.

This new line of straight pull solenoids comes in four basic sizes, with a force range of ½ to 20 pounds and a stroke range up to ¾ inch.

You get Ledex long term dependability, too. A resilient pad has been built in to cushion impact and eliminate repeated pounding of the pole faces. The electroless nickel plated solenoid plungers move in a brass sleeve bushing to assure low friction, positive alignment and long wear.

Eight standard models (two in each size) are available off the shelf so you can do your prototyping in a hurry. But if none of these fit your requirements exactly, we're ready to custom design a solution for your actuating problem. As a matter of fact, Ledex is probably best known for its engineering know-how and its willingness to work with you to meet unusual application requirements.



Write today for your copy of Bulletin C-1100 containing detailed specifications of the new line of Ledex straight pull solenoids.

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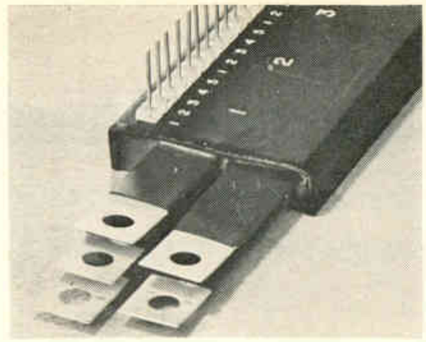


Distributor. Bus bar combines low capacitance, structural ruggedness.

—usually a problem during shipping and handling of the computer —and the epoxy minimizes the degradation of materials from environmental contamination.

The Capitron can be used as a chassis structural member and as a mounting point for connectors. Almost any common type of termination system can be used with the laminated bus bars. The devices can be designed to accommodate almost any space requirement. The largest laminar bus made by AMP is horseshoe-shaped, measures 50 inches on the side and 12 inches across the top, and has 16 layers, one of which can carry as much as 300 amps.

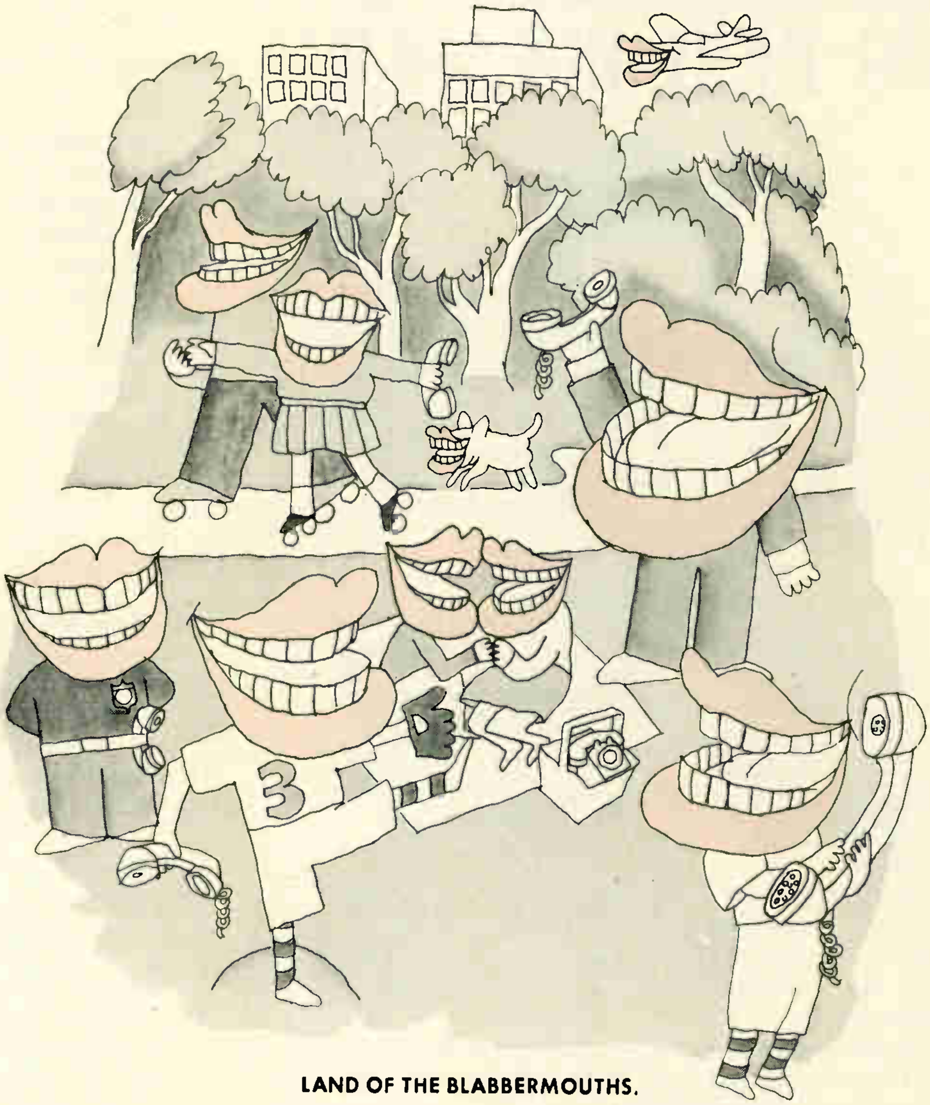
Cuts volume. When used as a structural member, the bus helps reduce volume and weight. In one airborne communications system, the company says, volume was reduced by 30% compared to a system with conventional bus bars.

The thickness varies with the number of layers. A large bus with 16 active layers, 17 dielectric layers, including the encapsulant and the structural member runs about ½ inch. Most buses have four or five active layers. With interleaving, the capacitance runs anywhere from 360 picofarads per square inch to 1000 pf/inch^2. The insulation resistance is greater than 200 megohms when measured at 500 volts after 240 hours at 65°C and 95% relative humidity.

This technology can be used to design laminated bus bars that can handle voltages as high as 50 kilovolts if required. Most applications run from 500 to 1,200 volts d-c.

Prices depend on size. A five-layer bar, 19 by 2 inches by ½-inch, sells for about $10.

AMP Inc., Harrisburg, Pa., 17105 **[349]**



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Blab blab blab. The communications flow in the U.S. is turning into a gusher. Can technology keep up? Martin Marietta communications people are studying unusual new digital techniques to expand the volume of conventional circuits. We're also conducting transmission experiments in the millimeter wave region. It could give some much-needed tongue room in the crowded electromagnetic blab spectrum.
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SUBSIDIARY OF GULTON INDUSTRIES, INC.

Relay matrix switches 1.5 Ghz

Device uses a compensated stripline structure for higher-frequency operation

Reed relays often are used where low insertion losses are required and switching speed is not essential. Until now frequency range had been limited to less than 60 megahertz. But Integral Data Devices Inc. decided to apply r-f techniques to reed relays in an effort to extend their usefulness well into the r-f spectrum.

Using a compensated stripline structure, Integral Data Devices has built a 5-by-5 matrix of reed relays that's able to switch frequencies as high as 1.5 Ghz.

"At these frequencies," says Alfred Vulcan, president, "the devices can be used in r-f communication systems, closed-circuit and cable television, digitally controlled receivers, and other equipment that now has conventional relay switches."

Vulcan says his firm is investigating the use of reed-relay switching matrices in monitoring hospital patients' physiological functions. Data such as heart rate and blood pressure can be fed into a central station. There, a doctor can push buttons on the keyboard switching matrix, transmitting information about patients to recording devices.

The company says that the switching matrix will simplify many communication systems which still use patch panels where wires must be moved around manually. The switching matrix can be either computer controlled or manually operated.

Specifications

Configuration	SP4T
Frequency	d-c to 1.5 Ghz
Insertion loss	0.5 db max
Isolation	60 db typical
Vswr	1.5:1
Power handling	10 watts cw
Switching speed	1 millisecond

Integral Data Devices Inc., 35 Orville Drive, Bohemia, N.Y. 11716 [351]

Realistically-priced *ac* motor speed control systems . . . computer-matched to a wide range of Howard fhp motors. Solid-state controls, with built-in tachometer. With a closed-loop feedback network that provides speed reference to give additional power as needed. Full starting and maximum torques are available. At any speed setting.

Sine Master ac motor speed control systems give the reliability, safety and convenience found until now only in more costly, complicated systems. The cost? About the same as DC-type controls. (But think of all the brush maintenance and expense with DC-type fhp motors!)

Get all the facts in the just-published "tell-all" Bulletin No. 6 16.01. New, from Howard.

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Crt's beam is pencil-thin

Helix collimates electron flow to enhance brightness and writing speed

Beam divergence, electron speed variations, and space-charge repulsion are among the factors that limit resolution of electron beams in most cathode-ray tubes. But a new electron-gun structural design, using a resistive helix, collimates the beam so that its diameter is limited only by the space-charge repulsion of the electrons within it. This feature, says Rank Electronic Tubes, can significantly improve displays—it can provide higher brightness levels at current writing speeds, require lower screen voltages for specified brightnesses, or produce higher speeds with current brightness levels.

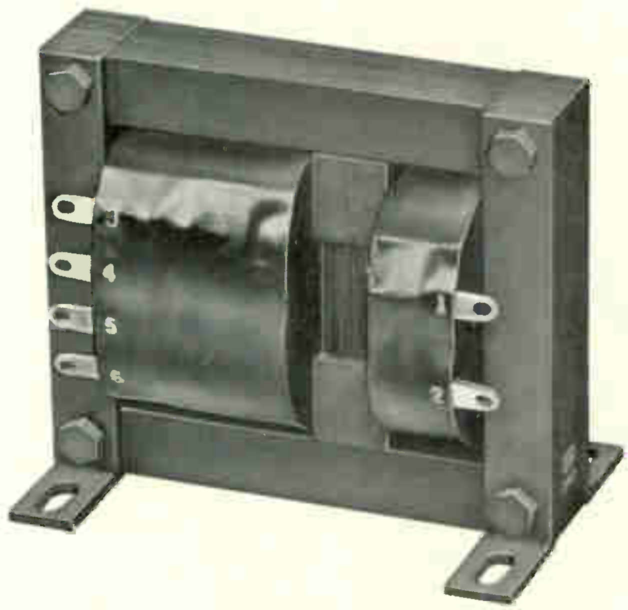
A new tube, designated the Monocon by Rank, includes the advanced design and produces almost perfectly collimated beams with uniform current densities. The company says that line widths as small as 12 microns can be achieved and beam diameters modulated over a range of 20:1.

The electron gun comprises a baffle, grid, two electrodes, and the accelerating helix. The angle of the beam emerging from the second electrode can be controlled by the potential difference between the two electrodes. The beam then is collimated by the fields generated in the accelerating helix. The result: the beam's diameter at the point of deflection is almost the same as the spot diameter on the phosphor screen.

For a range of line widths extending from 10 mils at an anode potential of 900 volts to 90 mils at a 1,200-volt anode potential, only slight variations in the line widths occur for screen currents of 0 to 1,000 microamperes.

Rank Precision Industries, Inc., 260 North Route 303, West Nyack, N. Y. 10994 [350]

Most engineers know ADC Products builds custom ferro-resonant transformers for constant-voltage power supplies.



But do you know... ADC Products also builds "Blue-Chip" transformers for P.C. applications, special filters and chokes, tape head and solenoid coils, plus complete power supply assemblies?

ADC Products has hundreds of stock, off-the-shelf components for computer applications. But we also design special transformers—custom designs for your particular problem—with the help of our computer. For example, if you need a special ferro-resonant transformer for a constant voltage power supply, we have a special computer program that can help our design team analyze your parameters and establish the optimum design. The background of 19,897 other designs helped us establish the program—and if we need to, we have any of these prior designs at our fingertips.

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Circle 145 on reader service card

Ten-volt reference zeroes in on zener jobs

One-inch-square device can be the d-c reference in digital converters; it's accurate to 0.005%—no if's, and's, or stability corrections

Mitchell Cotter thinks he has something that can help digital-voltmeter makers. In fact, anyone who needs a small, stable, and highly accurate voltage source can reap the benefits. An engineering consultant, Cotter played a part in designing Certavolt, a 10-volt reference intended as a replacement for zener-diode units. It's being made by Computer Diode Corp.

Certavolt has an over-all accuracy of 0.005%—with emphasis on "over-all." There's no separate specification for aging or changing temperatures or anything else. The Certavolt output voltage strays by no more than 500 microvolts between 15°C and 55°C, for up to a year, for input changes of up to 5% of the specified 28 volts d-c, and for any output between 0 and 10 milliamps.

Encapsulated in a 1-inch-square, ½-inch-high package, the device has only four terminals—two each for input and output. It consumes 600 milliwatts, and its maximum noise figure is 10 microvolts rms or 100 μvolts peak-to-peak.

Certavolt's first role will be as a reference in dvm's and other analog-to-digital devices. "Most a-d equipment is capable of much

Universal a-c bridge measures resistance, inductance, capacitance and winding ratio of transformers, etc. Internal frequency is 1 khz. The unit is only 5 x 7⅛ x 3 inches, and weighs 2¼ lbs. It is powered by an inexpensive 9-volt battery. The bridge is suited for production testing and laboratory use. Price is $60. C. H. Mitchell Co., 18531 Ventura Blvd., Tarzana, Calif. [361]

Tv Sweep Chanalyst WR-514A has the combined features of a tv sweep generator, marker generator, marker adder, and special "ChromAlign" system for color bandpass alignment. It provides r-f, i-f, and video output sweep signals for alignment of vhf tuners, i-f amplifiers, video amplifiers, and color bandpass amplifiers. RCA Electronic Components, Harrison, N.J. 07029 [362]

Self-contained, battery-operated X-Y recorder model 2745 uses eight D cells for 75 hours or more of continuous operation. Transistorized circuitry has low current drain and high input impedance. The 2745 has ±1% accuracy and a response time of 0.5 sec for a full scale change on the Y axis, 0.7 sec on the X axis. Simpson Electric Co., W. Kinzie St., Chicago. [363]

Test fixture TF0050 permits complete monitoring of all of the characteristics of punched tape and magnetic tape readers. Displays and controls are provided so that transient error conditions may be readily detected. The basic unit is priced at $2,000 with adapters extra cost options; delivery, 3 to 4 weeks. Chalco Engineering Corp., 15126 S. Broadway, Gardena, Calif. [364]

Digital multimeter model 1000A operates from −20° to +120°F. It features 10 readings/sec, 700-msec step response; conformal coating for reliable operation in humid environments. Unit has five d-c voltage ranges (±200 mv to ±1 kv), and six resistance ranges (200 ohms to 20 megohms). Price is $295. ElectroNumerics Corp., 2961 Corvin Dr., Santa Clara, Calif. [365]

Tracking generator/counter model 8443A works with the model 8552A/855B spectrum analyzer, making possible swept frequency measurements, and fast, accurate spot frequency measurements from 100 khz to 110 Mhz. Dynamic measurement range is greater than 120 db. Price of the 8443A is $3,500. Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. [366]

Reed relay test set RRT-101 will rapidly test single—or up to six-pole relays for excessive contact resistance under precisely controlled dry circuit conditions. Relays are actuated at rates up to 200 per second and each contact set is monitored by a sensitive detector channel for excessive contact voltage drop. Price is $3,100. Optimized Devices Inc., Pleasantville, N.Y. [367]

Digital integrating microvoltmeter DS-100 uses automatic zeroing to halt drift due to time and temperature. Sensitivity of the unit is 1 μv even at speeds of 20 readings per sec. Noise is reduced by at least 120 db through the differential input/output guarding techniques. Prices range from $920 to about $1,500. Doric Scientific Corp., 7601 Convoy Ct., San Diego, Calif. [368]

Circle 147 on reader service card →

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- Overall gain at 1000V...2 x 10^7
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- Dark current at gain of 10^6.. 1.2nA

The 9781B, a 9 stage tube with UV transmitting glass envelope, is designed for use with low level UV and visible radiation in spectrometer and similar applications. The B11A (B11-88) base means the 9781B will replace other tubes of this design to improve system performance.

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greater accuracy than the voltage reference allows," says Cotter. "The dual-slope integrator can have exceptionally great accuracy. Even the ladder networks are capable of tremendous ratio accuracy. In fact, Analog Devices and several others have brought out 16-bit converters, but the reference is usually left out of the picture [*Electronics*, March 16, p. 141]. It's 16-bit accuracy alright, but it's not available as a working voltage accuracy."

Several dvm makers have looked at Certavolt, and Cotter says that one already has decided to switch from a zener-diode reference.

Dvm's aren't the only place Certavolt can be put to work. "It's really a power supply," says Cotter, "in the sense that it will provide this accuracy for up to 10 milliamps of output current in the basic unit. Other Certavolts are available that will provide 25 ma, still with this 0.005% accuracy. So you can power fairly high-speed, high-current ladder networks or even high-speed integrators directly with the unit."

The price is $93 in small quantities, and between $50 and $60 in volume. "We think this is very competitive," says Cotter, "when you consider the prices of aged, high-precision temperature-compensated zeners like the 1N940 and 939. They run $20 to $30 for the zener alone."

Cotter feels that nothing short of a standard cell can match Certavolt for stability. "They've been making zeners here at Computer Diode for the past five years, so there's considerable experience in precision-zener manufacturing," he says. "The stability of a zener is not that good."

Cotter won't explain how Certavolt works, but he does say it has "a new type of semiconductor device" that's not an avalanche device in the usual sense.

Aside from this component, Certavolt has "a very accurate transfer amplifier and a potentiometric ratio," says Cotter. The potentiometer is a thick-film device, accurate to within 0.0001%.

All the circuitry is discrete, but Computer Diode vice president Gary Simonyan says the device can be made as a hybrid circuit, and predicts a flatpack Certavolt.

Computer Diode Corp., Pollitt Drive South, Fair Lawn, N.J. 07410 **[369]**

New instruments

Amplifier has 11 settings

BCD commands are needed to select the gain; bandwidth goes to 30 khz

Here's an amplifier that any engineer can love, but only a computer can control. Neff Instrument Corp.'s 125 has 11 separate gains, but no front-panel switch for selecting any of them. Instead, the unit's gain changes in response to four-bit binary-coded-decimal commands from a computer or other digital system at transistor-transistor logic levels.

The 125 is available with one of two sets of gains. The standard range is 0, 1, 2, 5, 10, 20, 50, 100, 200, 500, and 1,000; the other collection runs in binary steps from 1 to 1,024.

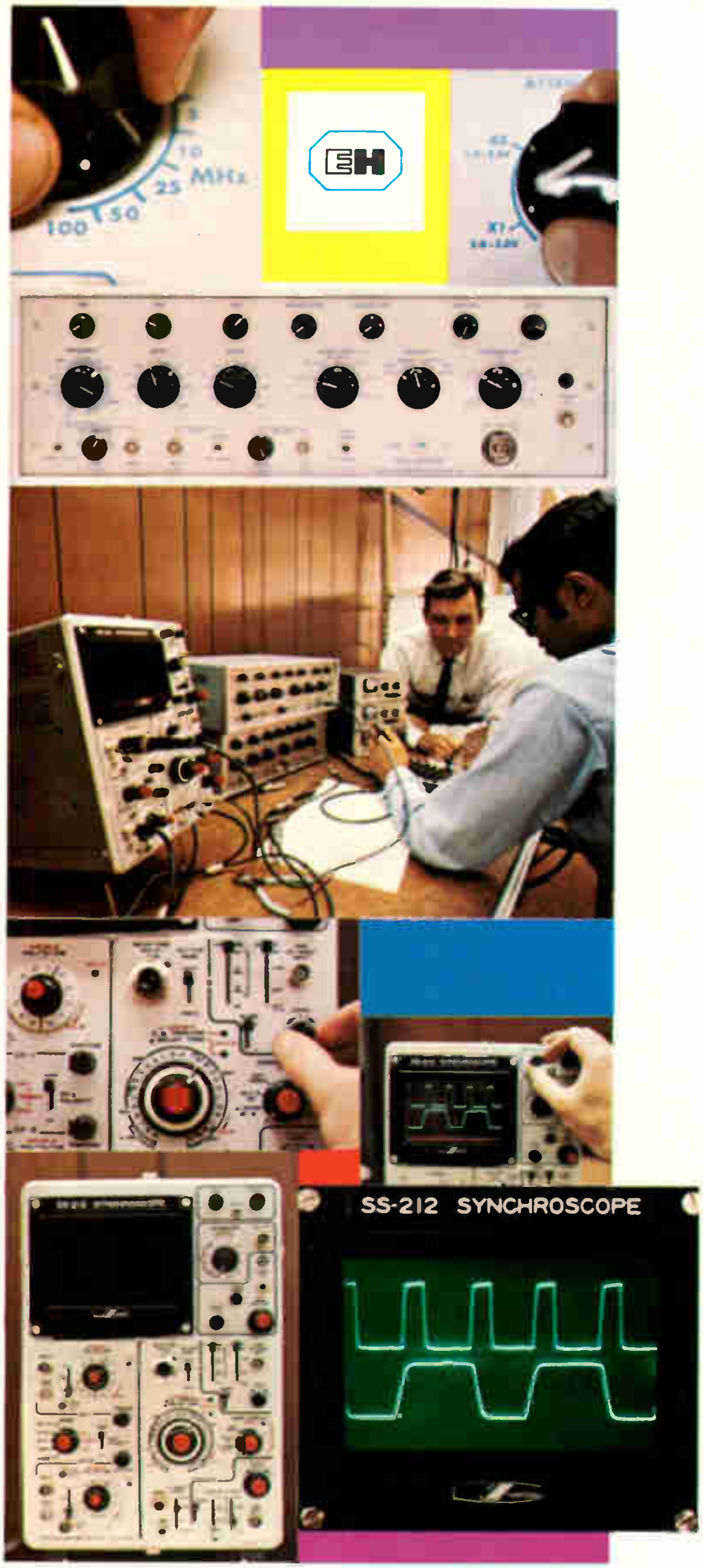
The amplifier is commanded in one of two modes. In "direct set," the amplifier has the selected gain as long as one command is applied; when the command is removed, gain drops to 0. In the other mode, a strobe signal comes in with the four-bit command, and the amplifier stays at the selected gain until it receives another strobe signal. The strobe can be a pulse as short as 2 microseconds.

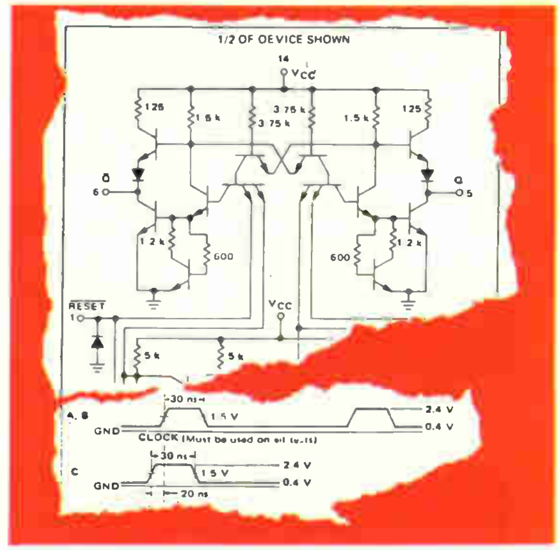
Regardless of mode, the 125's output settles to within 0.1% of its final value within 100 μsec of a gain change. The amplifier takes up to 20 volts of differential input or 50 volts of common-mode; if the input is overloaded, the amplifier recovers within 500 μsec.

The 125's bandwidth is d-c to 30 kilohertz. At d-c, common-mode rejection ratio is 140 decibels; it's never worse than 120 db.

On its front panel, which is 7 inches high, the 125 has two zero controls, one for the input and the other for the output. The 125 is two inches wide and 18 inches deep. Its price is $1,200.

Neff Instrument Corp., 1088 East Hamilton Rd., Duarte, Calif. 91010 **[370]**





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For example, the **E-H 137 pulser** is an ideal stimulus source offering a source impedance of 50 ohms, fast, ultra-clean, adjustable leading and trailing edge ramps, all the output levels you need for TTL and ECL logic and 100 MHz pulse repetition frequency.

Team this up with the **Iwatsu 212 oscilloscope** and you've got a team that'll perform to your utmost satisfaction for years to come. The Iwatsu 212 is the ideal wide-band scope featuring bandwidth in excess of 200 MHz, with sweep speeds and writing rate to match. One MΩ input impedance matches directly with the impedance level of circuitry under test. This is the only 200 MHz bandwidth oscilloscope featuring 1ns-/cm and delayed sweep in one instrument. Big, bright 6x10 cm display is another feature.

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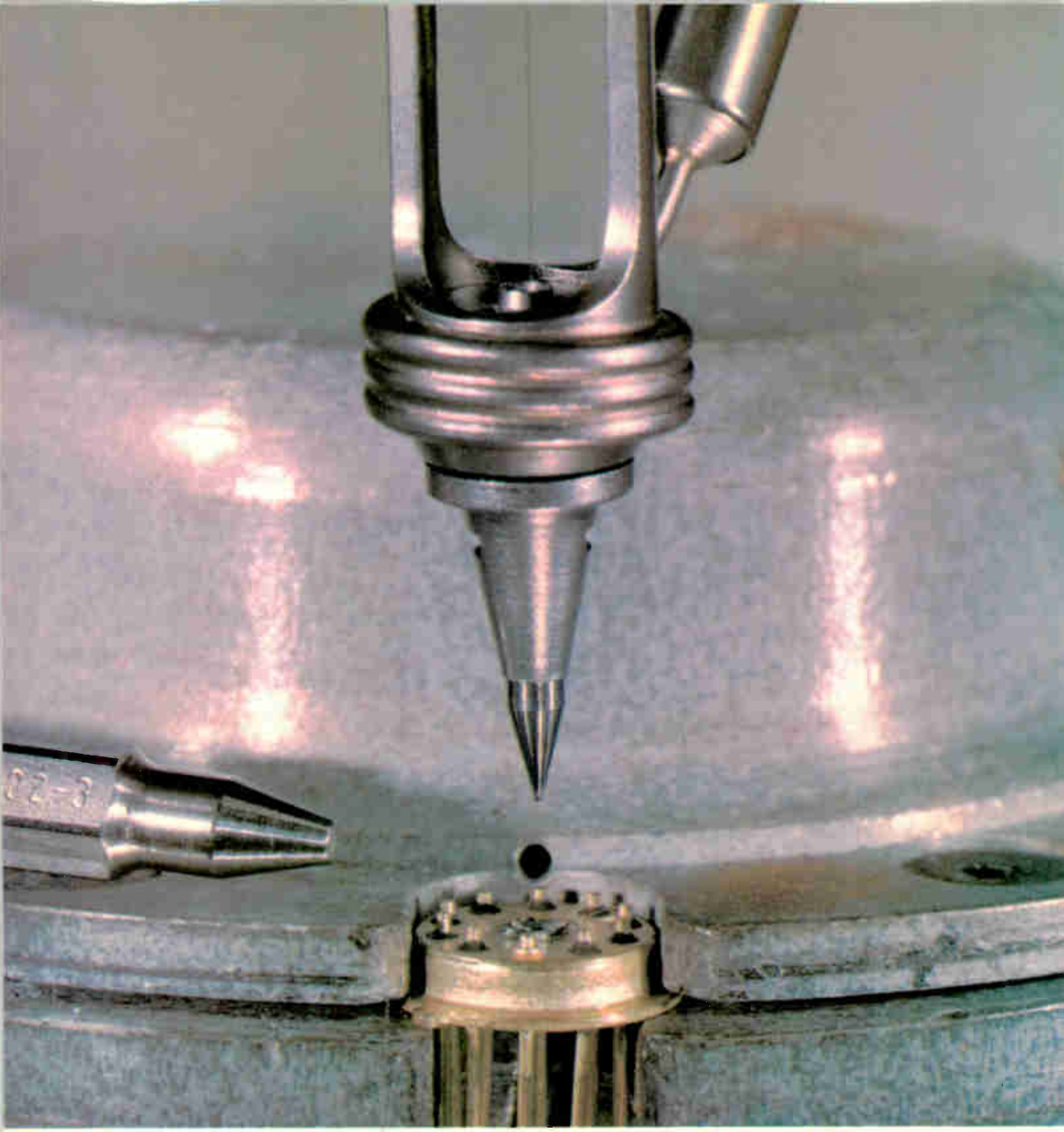

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The tungsten carbide capillary tip and its complete family of accessories for thermal compression nailhead bonding was created and introduced by Tempress in 1963. . . . Only from this pioneering source can you purchase the entire system, designed from the beginning to give maximum efficiency: tungsten carbide capillary tip, heated shank and power supply that provides constant capillary temperature from 0° to 350°C, testing pyrometer for the tungsten carbide tip, capillary unplugging fixture and punches, and flame-off torch with sapphire orifice insert. Tempress also created and supplied the tungsten carbide ultrasonic bonding tool and pioneered its technology. . . . When you purchase Tempress miniature assembly tools and production equipment, you tap the ultimate source of high precision . . . the Tempress Standard of Excellence. In fields demanding high precision, such as semiconductor manufacturing, there is no second source.

TEMPRESS

Tempress Industries, Inc., 980 University Ave., Los Gatos, Calif. 95030

Memory expandable without adding logic

MOS random-access unit designed for small computers; timing technique helps to eliminate crosstalk

When a computer maker began looking for a metal-oxide-semiconductor random-access memory to use in a small machine, the company specified low average power dissipation, no crosstalk, and the ability to select one of 16 parallel RAM's without adding external logic. The manufacturer settled on Solitron Devices' new UC 6550, a 600-nanosecond access, 64-word-by-four-bit random-access memory.

The RAM is word-organized, and has four chip-select lines that permit expansion to 1,024 by n bits without external decoding. The four chip-enable lines allow the user to employ simpler logic, for example, in addressing one of 16 RAM's in a program cycle because no external selection logic is required. The RAM is enabled only when all four enable inputs are low. When any or all of the inputs are high, all outputs are off, and no information can be written into the memory. All the inputs and outputs are bipolar-compatible.

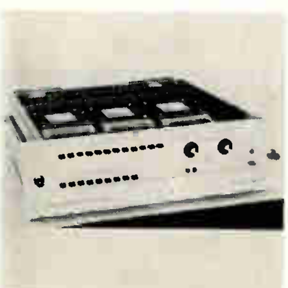
Single-phase dynamic operation simplifies timing requirements—the customer must provide only a single clock. Unlike many dynamic memories, the UC 6550 doesn't

Data communications terminal/printer PDM6633 is an automatic-send-receive data terminal with a photoelectric paper tape reader and solenoid array perforator. It has an impact printer with 132 print positions and prints 64 ASCII characters. Unit measures 22 x 23½ x 5¾ in. and weighs only 45 lbs. Peripheral Data Machines Inc., E. Chestnut St., Santa Ana, Calif. [381]

Two-piece built-in acoustic coupler TM-102 can be installed on most model 33 Teletype printers in less than 10 minutes, using just a screwdriver. The coupler electronics is housed in a remote box which mounts on the back of the 33. This eliminates interference (crosstalk) between the Teletype and coupler circuitry. Novation Inc., 18664 Topham St., Tarzana, Calif. 91356 [382]

Dual image keyboard data recorder model 2101 offers advantages over punched or magnetic tape in many applications. The data is printed on durable, easy-to-read white paper tape, each character containing both the machine code and the corresponding human readable letter, numeral or symbol. Interface Mechanisms Inc., 232nd St. S.W., Mountlake Terrace, Wash. [383]

Table-top device combines the functions of computer magnetic tape testing, cleaning and precision rewinding. The TMS-70 (for Tape Management System) is designed primarily for users of small and medium-sized tape-oriented computer systems. It cleans and tests a 2,400-ft reel of magnetic tape in less than five minutes. Kybe Corp., Calvary St., Waltham, Mass. [384]



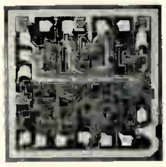
Analog data distributor MADD1-06 accepts digital information and channel address data from a computer, converts it into analog form and distributes it to selected output holding amplifiers. The unit contains a 12-bit d-a converter, a high-current driving amplifier, and up to 64 analog output sample-and-hold amplifiers. Raytheon Computer, S. Fairview St., Santa Ana, Calif. [385]

Desktop electronic calculator model 1412 is a 14-digit machine with a single memory system. The single memory provides the operator with the capability of accumulating a series of numbers or storing numbers for future calculations, as is required in many business applications. Unit weighs 9.7 lbs. Price is $875. Dictaphone Corp., 120 Old Post Road, Rye, N.Y. [386]

Electronic printing calculator P-252 can extract square roots instantly and contains a second story or memory register to facilitate computations involving complex accumulations. It can print digits and symbols at a rate of 90 characters per sec by means of mosaic dots. Philips Business Systems Inc., subsidiary of North American Philips Corp., 100 E. 42nd St., New York [387]

Electronic hard copy terminal model 911 produces page copies of computer graphics in seconds, either on or off line. It is easy to use, featuring pushbutton operation, dry copy, continuous line plots, alphanumeric printing in any size or angular orientation. Approximate price, on-line, is $22,000; off-line, $32,000. Electronic Associates Inc., West Long Branch, N.J. 07740 [388]

REDCOR



When the chips are down

REDCOR has delivered, or has on order, more computer-controlled MOS test systems than all other manufacturers combined. In fact, nearly 80% of all MOS LSI/MSI devices produced in the upcoming years will be REDCOR-tested. Surprising, perhaps, but true. Why this vote of confidence from so many industrial giants? One reason is that we design and build, using state-of-the-art techniques, all the system components, including the computers. And we provide the systems engineering, the software, and the field service . . . a "one source, one responsibility" commitment. MOS testing may not be your application, but whatever your systems requirement, let a REDCOR Systems Pro solve it for you.

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need a refresh cycle to preserve the memory's contents as long as the clock continues running at a speed as low as 50 kilohertz. Power dissipation is 500 milliwatts for a 100% duty cycle, but is less than that when several are connected, as is normally the case. According to Solitron, the 600-nsec typical access time is degraded only 100 nsec with 16 RAM's in parallel.

The problem of crosstalk encountered when going from one address to another, has been eliminated, Solitron claims. Because the clock is off for at least 300 nsec, even at the highest clock rate, the user is always sure that one address is completely cut off before another becomes effective. This eliminates the need for tight specifications on rise-and-fall times of the address, and avoids separation problems between two addresses. Most RAM's depend on dynamic factors to prevent crosstalk, and specify 10-nsec rise-and-fall time for the address.

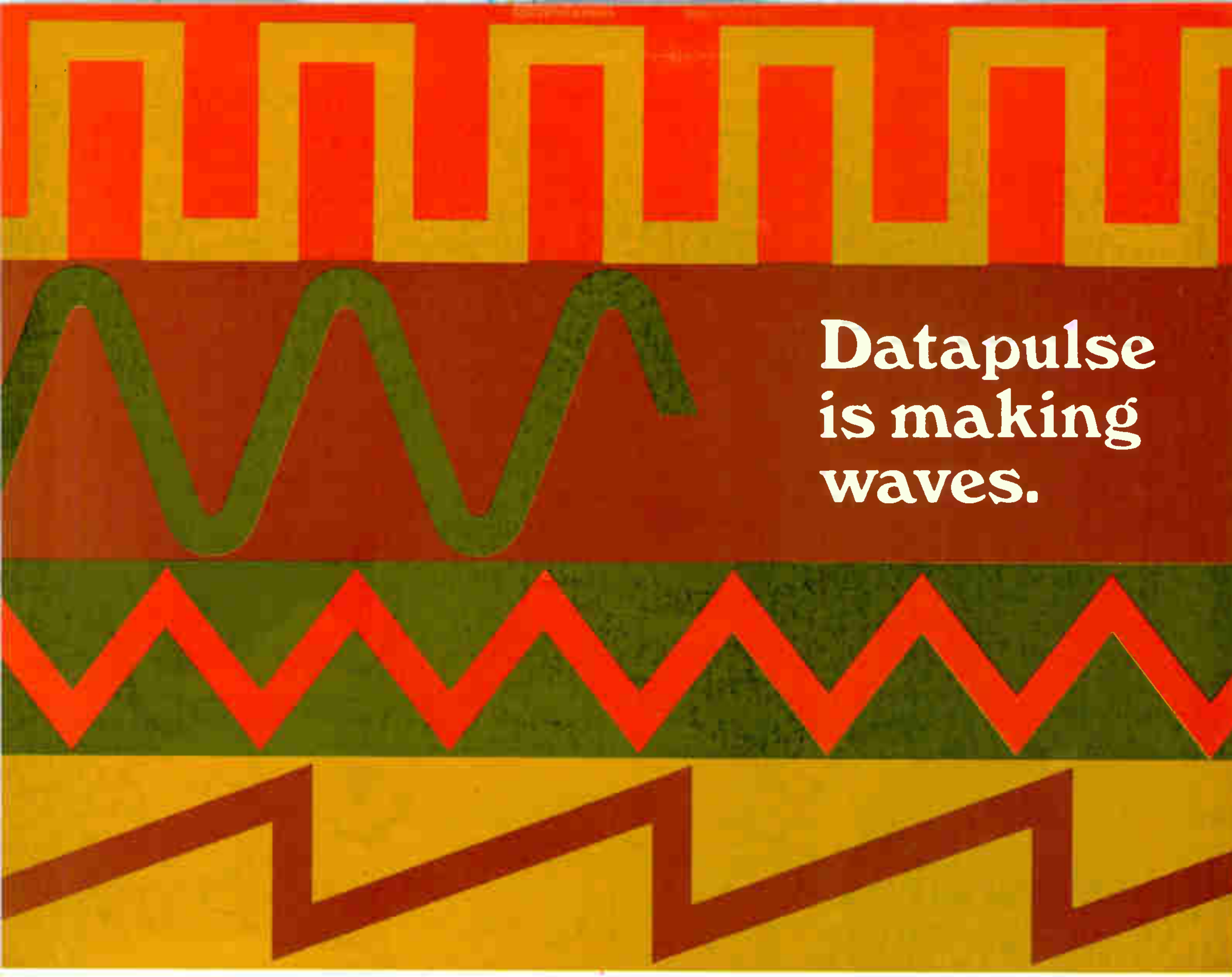
The operating temperature range is —55°C to +125°C. Maximum operating temperature for most RAM's, with the exception of small bipolar memories, is 85°C.

Solitron's RAM, can operate with +5, —5 and —15 volts available from conventional system power supplies.

When used with a bipolar-to-MOS-to bipolar system, the high-level input is —2.25 volts minimum and +0.6 volts maximum low level. For an all-MOS system, the input is —5 volts low level and —1.5 volts maximum high level. Output is +0.4 volt maximum low level and +3.5 volts minimum high level with a bipolar MOS system; —10.0 volts minimum low level, and —1.5 volts maximum high level for an all-MOS system. Capacitance is 5 picofarads for the inputs, 100 pf for the clock input, and 5 pf for the output.

The circuit is available in either 30-pin flatpack or 24-pin dual in-line packages, and sells for $70 in quantities of 1,000. A commercial-grade version, the UC 7550, with an operating temperature range from —25°C to +70°C, also will be available, but hasn't yet been priced.

Solitron Devices Inc., 8808 Balboa Ave., San Diego, Calif 92123 [389]



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

The little beauty on top, the Datapulse Model 401, sells for only $395 and gives you a dial accuracy of one percent (that's about twice as good as the competition). Frequency is 0.02 Hz to 2 MHz, and sine distortion is only 0.25 percent in the audio range. Square-wave rise time is a fast 40 nanoseconds. To handle low levels, we give you 80 db dynamic amplitude range.

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

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

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

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

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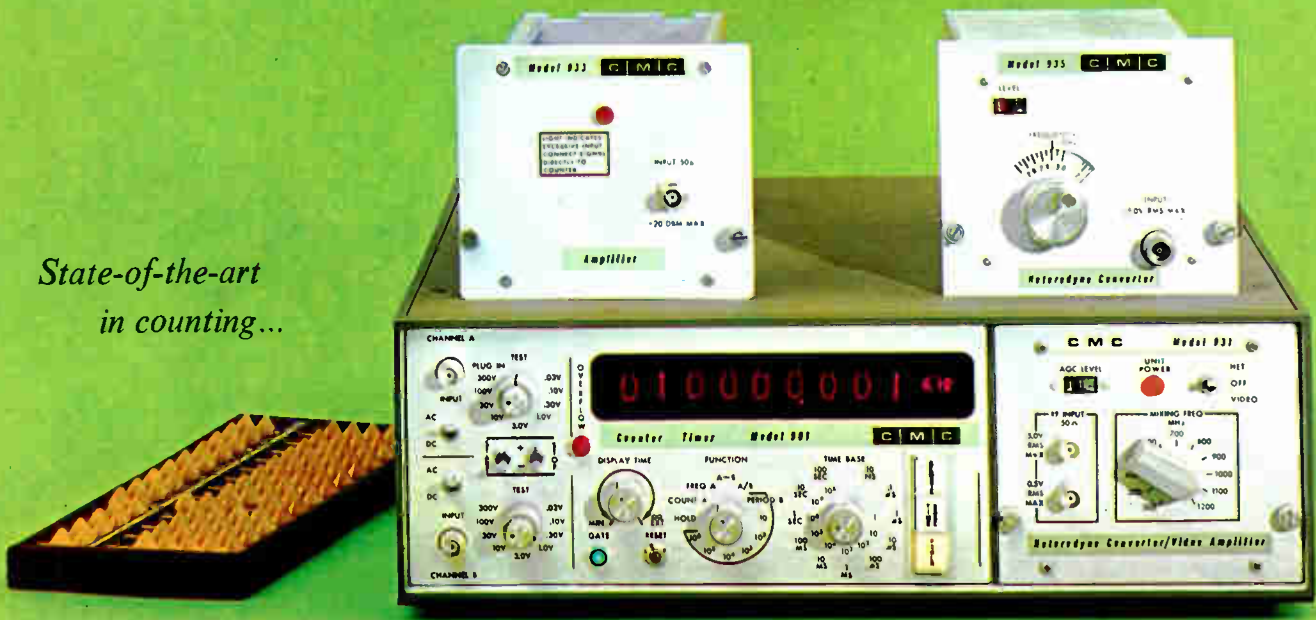
Circle 153 on reader service card

State-of-the-art
in counting...



The CMC 901 with plug-ins that do it all!

For some applications, the abacus has been state-of-the-art for 5000 years, but if you want to count directly to 200 MHz or heterodyne to 3 GHz...or if you want to resolve time intervals to 10 nanoseconds...and if you're looking for input sensitivity values to 350 microvolts—there's only one state-of-the-art universal counter-timer for you—the CMC Model 901. This counter, complete with its family of plug-ins, does it all.

It not only counts to 200 MHz directly, but it also scales signals, measures time interval, period, and multiple period average. It provides frequency and multiple frequency ratios as well as total count; and, as an optional extra, it can be operated by remote control. No wonder our 901 customers are saying, "this is the last word in counting!" But it's also where counting's going; because, with its plug-in capability, there's no limit to the future direction that the 901 can take. Here's a counter that will remain state-of-the-art for years to come.

Can you afford to pass it by in favor of a poorer performer at a higher price when the 901 is available now, right off the shelf, for only $2475? Just $3300 buys both the Model 901 and the 1.3-GHz Model 931; and for less than $3600 you can have the 901 with the 3-GHz Model 935. Or if you're looking for microvolt sensitivity, for less than $2850 you can have the 901 with the 933 Video Amplifier that gives you 30-times gain.

For the full facts, and how to arrange for a free demonstration, circle the reader service card.

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CMC

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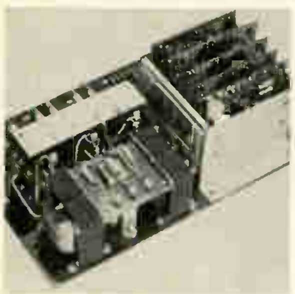
12970 Bradley / San Fernando, Calif. 91342 / (213) 367-2161 / TWX 910-496-1487

Weighing system features 0.05% accuracy

Transducer-indicator designed for large loads also can gauge other parameters; offers digital readout and bcd output signal

When you're weighing bulk materials in the hundred-thousand-pound range, an error of 0.5% could mean hundreds of pounds of give-aways or overpayments. That's why engineers at BLH Electronics Inc. expect to find a strong market in the general process industries for their weighing system incorporating the model 8000 transducer-indicator. With a maximum error of 0.05%, the weighing system reportedly is the most accurate available for measuring large loads. In an installation at the Vancouver, B.C., distillery of Hiram Walker & Sons Ltd., for example, the system will be able to measure the contents of a 200,000-pound distillate tank within 100 pounds.

The heart of the unit is the model 8000 transducer indicator, which, in addition to measuring weight, can be used to gauge dynamic force, flow, pressure, torque, stress, strain, or temperature with similar accuracy. In the Hiram Walker installation, the 8000 will be employed in conjunction with three load cells on each distillate tank. The 8000 will accept the sum of the three load-cell outputs, amplify it, and convert it to a digital



Scr servo amplifiers are for d-c motor application. The complete line includes amplifiers for motors ranging from 0.5 h-p through 5 h-p. Six-phase circuitry supplies an output approaching pure direct current to the d-c motor. Bandwidth is 30 hz. The worst case form factor on the d-c is less than 1.1. International Rectifier, 3115 W. Warner Ave., Santa Ana, Calif. 92704 [401]

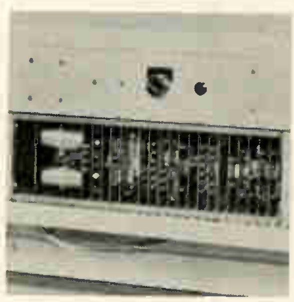
Fiber-optics illuminator provides cool intense light for difficult areas. A special heat absorbing filter cools the light from the quartz iodide lamp before it enters the bundle. The device is suited for such industrial applications as electronic circuit assembly, spot welding and soldering of precision electronic components. Bausch & Lomb, 635 St. Paul St., Rochester, N.Y. [402]

Prewired rotary solenoid assemblies are for business machine applications. Units can perform a number of functions from simple counting to complete programing of a machine. For example, in an office copier one of the units could fully control turn on and turn off of various lights, heaters, etc. Oak Mfg. Co., a division of Oak Electro/Netics Corp., Crystal Lake, Ill. [403]

Multiple-axis numerical control system model 128 is operable by manual, punch tape, magnetic tape, or computer control. The system is specially suited for extremely accurate positioning of such things as test heads or tables requiring rapid, precise movement. Maximum speed is 600 ipm when slewing a load of 150 lbs. NEMS Inc., 32 Broad Ave., Binghamton, N.Y. [404]

Parts feeding control system consists of a solid state control module, smaller than an ordinary desk phone; two proximity or photo-eye sensors that detect parts without touching; and a relay to start or stop the machine. The module is totally encapsulated against dirt, dust, grease, oil, moisture, shock and vibration. PECO Corp., 450 Landess Ave., Milpitas, Calif. 95035 [405]

Wideband wattmeter, d-c to 3,500 hz, features four quadrant, 0.25% multiplication of complex signals such as scr waveforms with or without d-c component. Voltage inputs are ±1,000 v. Current range is to ±25,000 amps. Uses include analog multiplication or measurement of power to critical loads and electrochemical processes. Halmar Electronics Inc., Columbus, Ohio [406]



Solid state control system series 700 is designed for industrial applications. It features: high immunity to electrical noise; ability to accept line-level inputs and deliver high-power outputs; use of "English" logic functions to facilitate system design, operation, and maintenance; and the use of integrated circuits for all logic functions. Tenor Co., Box 2766, Milwaukee [407]

Ampere hour meter EMAM129 offers wide-range accuracy, excellent long-term stability, and automatic output control functions. Designed for critical control of battery charging and discharging in lab and testing applications, it is also suited to automatic control of production battery conditioning. Accuracy is ±1%. Gulton Industries, 13041 Cerise Ave., Hawthorne, Calif. [408]

←Circle 154 on reader service card

. . . component shifts made self-cancelling . . .

readout and binary-coded decimal output signal via integrated circuits mounted on plug-in circuit boards.

The instrument essentially is a solid-state digital voltmeter, employing the dual-slope integrating measuring technique for stability and accuracy. In the first step of dual-slope integration, the unknown input from the preamplifier is fed through an operational amplifier to an integrating capacitor. The integrator output is an increasing voltage with a slope proportional to the input. The integrating period extends over 10,000 consecutive pulses from a clock oscillator. In the second integration step, the integrator input is switched to an internal reference current which drives the integrator output back to zero. The slope of the decreasing voltage, and hence the time to return to zero, is directly proportional to the unknown input. The time is measured by counting pulses from the clock oscillator.

The system's accuracy stems from using the same integrating components and clock oscillator in both steps; any shifts in values of components caused by temperature changes or aging therefore are self-cancelling. Accuracy of the model 8000, exclusive of the transducers, is 0.02% of reading ±1 count. Measuring speed (sample rate) is three readings per second, but can be externally adjusted down to one reading in two seconds. Display is by seven glow-discharge tubes. Another major contribution to system accuracy comes from the linearization circuitry, which compensates for variations among the several sensors. This linearization feature is optional, as are provisions for dummy zero, digital scaling, and active filtering.

The model 8000 will accept inputs from as many as eight 350-ohm strain-gage bridges or four 120-ohm bridges with cable lengths up to 1,000 feet. Dimensions of the instrument are 5¼ by 8½ by 19 5/16 inches. The price, exclusive of options, is $1,375.

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To get your sample C103 SCR, fill out the coupon below and present it (or mail it) to your authorized General Electric distributor.

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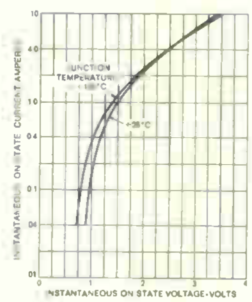
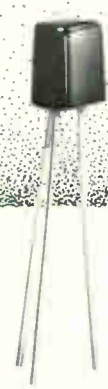


C103 RATINGS	
Peak reverse voltage	200 volts max.
RMS On-state current	0.80 amp. max.
Gate trigger current	200 μ amp. max.
Peak surge current	8.0 amps. max.
Peak reverse and off-state current	1.0 μ amp. max.



GENERAL ELECTRIC

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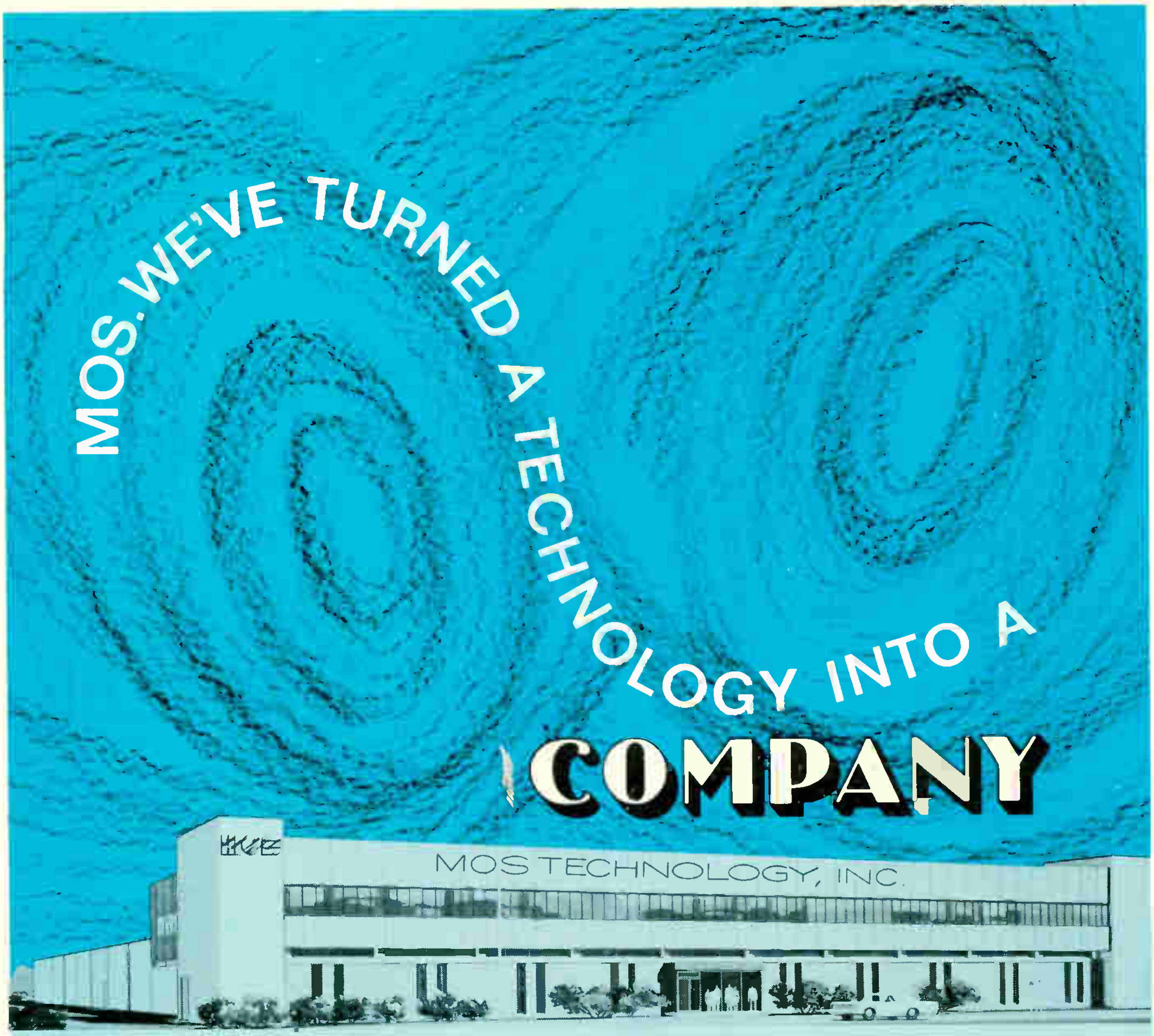

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New semiconductors

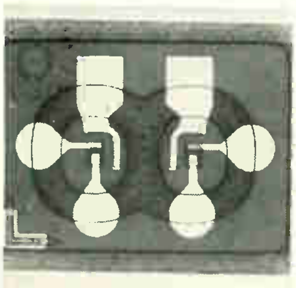
High-frequency SCR acts like two-in-one

Smaller unit is triggered first and then it turns on larger one; low gate currents on monolithic device accomplish high-speed switching

A high surge of current during turn-on can shorten the life of a silicon controlled rectifier and may even cause it to fail. Initially, only a small portion of the silicon wafer conducts. Large currents may burn a hole through the device, before the current has had a chance to spread throughout the silicon wafer.

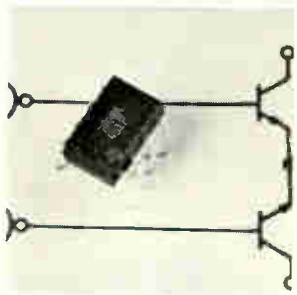
Engineers at Westinghouse devised a technique to help combat this problem. The new unit, designated the T507, is a monolithic device, but functionally it is an SCR within an SCR. The smaller SCR is turned on first, and it, in turn, switches the larger one. This enables the device to be triggered with small gate currents—typically less than 150 milliamperes—and to sustain large current surges without damage. The maximum anode-current risetime, di/dt, at 110 amperes forward rms current is 800 amperes per microsecond. High di/dt's usually demand large gate currents.

The advantage of the smaller gate current drive shows up in fast turn-on and turn-off times—typically 3.5 μsec and 30 μsec, respectively. The device handles fre-

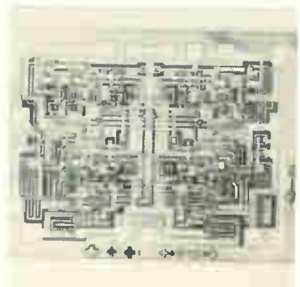


Dual monolithic transistor type IT124 employs dielectric-isolation techniques which suit it for both radiation-hardened and industrial applications. Betas of greater than 1,500 at 1 μa are guaranteed. Other features include a capacitance of 0.8 pf, base emitter matching of 2 mv, and current offset of 0.5 na. Intersil Inc., 10900 N. Tantau Ave., Cupertino, Calif. 95014 [436]

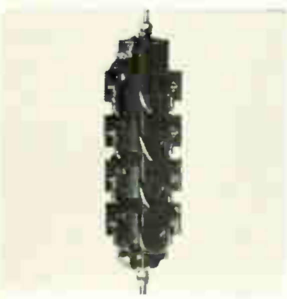
The SQ1212A-SQ1232A series of tuning diodes offer uhf/vhf designers a miniature size for compact high-frequency packaging. Capacitance values start at 1.2 pf with a Q of 1500 measured at −4 v and at 50 Mhz. These diodes are rated for 30 v breakdown. Price (100-999) is $8.60 each; delivery, 2 weeks. MSI Electronics Inc., 34-32 57th St., Woodside, N.Y. 11377 [437]



Computer system interface IC designated SN75451P provides two independent channels for use as dual lamp or relay drivers, high-speed logic buffers, power drivers, MOS drivers, and memory drivers. Collector current is 400 ma, and collector-emitter voltage is 30 v. Price (100-999) is 97 cents each. Texas Instruments Inc., P.O. Box 5012, M/S 308, Dallas 75222 [438]

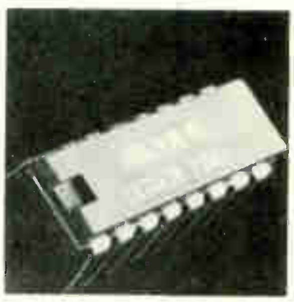


Monolitnic, digital IC's are designed to perform efficiently in extremely high noise environment. Designated as SG393, SG394, and SG395, the devices are high threshold logic circuits designed to perform NAND gating functions. Units are offered in a hermetically sealed, metal-lid, 14-lead, dual-in-line package. Sylvania Electric Products Inc., Woburn, Mass. [439]

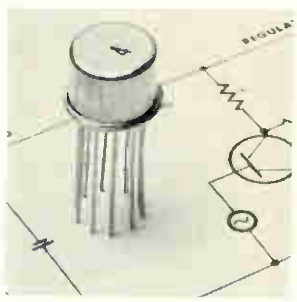


Broad range (5 to 500 kw), high-voltage, controlled avalanche silicon rectifier stacks are available in a variety of configurations. The stacks, which have a cylindrical construction, cover the range 1 amp to 10 amps, and up to 100 kv. They can be operated either by convection cooling or immersed in oil. Mullard Inc., 100 Finn Court, Farmingdale, L.I., N.Y. 11735 [440]

Five dual line driver/receivers, MC1580L-1584L, handle driving/receiving chores in both saturating (MRTL, MDTL, and MTTL) and nonsaturating (MECL) logic systems plus the interfacing between different levels in a system. Units feature high input and/or output impedances in the 5 to 12 kilohms range at 10 Mhz. Motorola Semiconductor Products Inc., Phoenix 85036 [441]



Four-bit binary full adder DM-7283 uses internal carry look-ahead circuitry that cuts ripple time to 12 nsec. Unit is the equivalent of about 30 gates. It accepts four A and four B inputs plus the carry input, and has four sum outputs plus the carry output. It can also be used as a dual single-bit full adder. National Semiconductor Corp., Santa Clara, Calif. [442]



Hybrid IC voltage regulator DVR-100 is announced. The output voltage is internally adjusted to 12 v ±5% or ±1%; load currents up to 100 ma with adjustable internal over-current protection. With a minimum of external components, output voltages of 12 to 40 v and load currents up to 3 amps can be obtained. Dickson Electronics Corp., Box 1390, Scottsdale, Ariz. [443]

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Micro Compet QT-8B is the world's smallest electronic calculator. And it operates on three power sources — AC, built-in battery, or any 12V car battery — so you can use it anywhere.

And since it uses ELSIs (Extra Large Scale Integrations), it measures a small 5-5/16" wide, 9-11/16" deep, and 2-13/16" high. Weighs a light 3.63 lbs. Yet it does ordinary and complicated calculations up to 8 digits. Take a look at the Micro Compet QT-8B soon. It can make life a lot easier for you.

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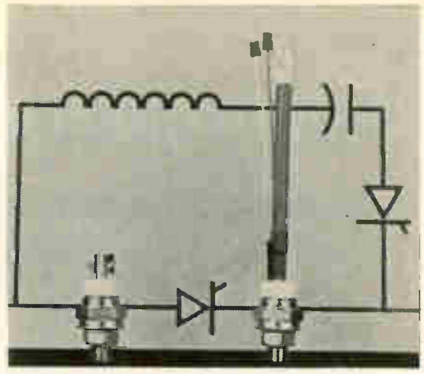

Dynamic gate. The anode-current risetime is 800 amps per μsec, but rapid spreading velocity across the wafer keeps the device cool.

quencies up to 10 kilohertz for half sine-wave operation and up to 7 khz for rectangular-wave operation. And the device's low forward voltage drop of 4.5 volts assures that it runs cool.

The 600-volt device has a dv/dt, or rate of forward-voltage rise, of 200 volts/μsec, and can attain forward- and reverse-blocking voltages of 1,200 volts.

Company spokesmen say that they have been using a center-firing approach rather than the more common method of turning the device on at its edge first. As a result, the drive current saturates the center of the gate and spreads from the center to the edge of the wafer. This type of saturation, the company feels, is faster than firing the device from the edge and having the current spread across the entire surface of the wafer.

Widest use. The device should find its greatest use in high-frequency applications requiring fast turn-on and turn-off, says Stanley Hunt, sales manager. In addition to such uses as induction heating, standby power supplies, a-c motor controls, high-frequency lighting, pulse modulators, and cycloconverters, Hunt sees important uses of the SCR in computer power supplies, where battery-operated supplies must be switched in immediately if a fault occurs.

The T507 is available in either a flex-lead or a flag-lead package. Price is $43.50 for quantities of 10 to 99. Delivery of the devices takes two weeks.

Westinghouse Electric Corp., Semiconductor Division, P.O. Box 868, Pittsburgh, Pa. 15230 [444]

40 Watt UHF

Octave bandwidth ϕ transistor

8-67

225-400 MHz...5dB gain...24V.

TRW introduces a new state-of-the-art line of broadband high power UHF transistors. The JO2001 transistor incorporates hybrid circuit techniques inside the packaged device to reduce the reactive part of the input impedance to nearly zero (hence j-zero). The devices give extremely broadband and reliable performance from simple and consistent matching circuits. Exceptionally low input Q's allow octave band widths from fixed tuned circuits without costly individual circuit trimming for simplicity and ease of manufacture.

The JO2001 provides a minimum of 40 watts with 5.0 dB gain across the 225-400 MHz band from a 24 volt source. Minimum efficiency is 50%.

Two or more of the devices can be paralleled simply for higher power levels. Delivery is immediate in production quantities. Order from factory or any TRW distributor.

For complete information and applications assistance, contact TRW Semiconductor Division, 14520 Aviation Blvd., Lawndale, California 90260. Phone (213) 679-4561. TWX 910-325-6206.

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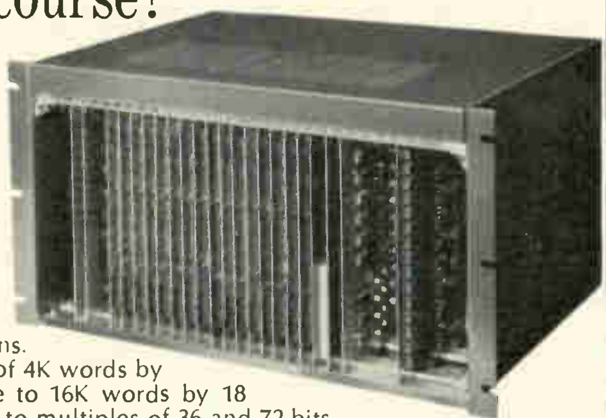

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Toko's advanced electronic technology also enables it to provide computer components, such as memory stacks. Contact Toko today for details.

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Circle 203 on reader service card

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When it comes to advanced circuit design

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- All breadboard interconnections with solid #22 guage hook up wire
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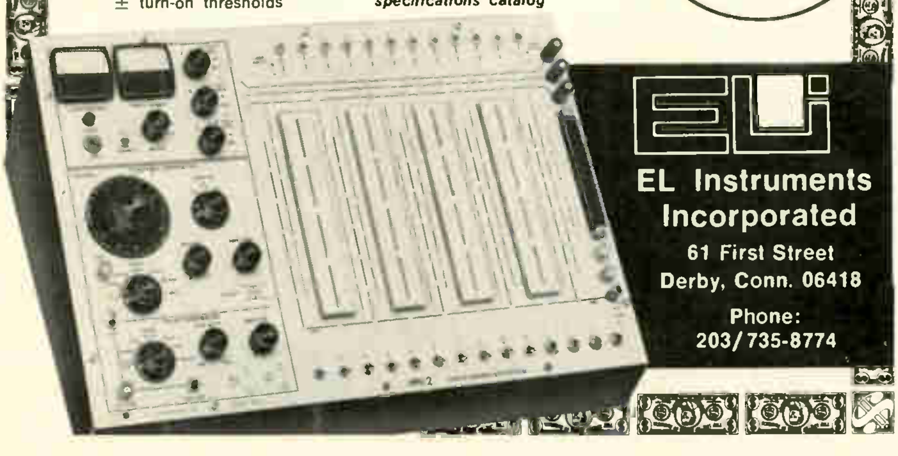

EL Instruments Incorporated
61 First Street
Derby, Conn. 06418
Phone: 203/735-8774

New semiconductors

C/MOS circuit uses 1.5-v supply

14-stage, ripple-carry binary counter has dissipation of only 4μw

Threshold voltages below one volt have been achieved in complementary metal oxide semiconductor circuits, enabling them to operate from a single 1.5-volt cell. And the lower supply voltage means even lower power dissipations compared to the C/MOS circuits using 6- to 15-volt supplies.

The lower supply and threshold voltages resulted from an ultraclean oxide developed by RCA's Solid State division. The p-channel threshold was reduced by the oxide technology and the n-channel threshold was cut by combining the technology with adjustment of the p well's sheet resistance.

Using the new technology, RCA has built a 14-stage, ripple-carry binary counter. The smaller battery size and lower power dissipations, the company says, make the medium-scale integrated counter, designated TA5938, suitable for consumer applications such as battery-powered watches and clocks.

Using a single-cell supply at a frequency of 50 kilohertz, the device typically dissipates 4 microwatts. Quiescent dissipation at the same supply voltage is rated at 25 nanowatts. Noise immunity rating is 45% of the supply voltage over the full operating temperature range.

The unit consists of a pulse-input shaping circuit, a reset line driver circuit, and 14 ripple-carry binary counter stages. Buffer outputs are externally available from stages 1, and 4 through 14. The counter is reset to its all zero states by a high level on the reset inverter input line. Each counter stage is a static master-slave flip-flop. The counter is advanced one count on the negative-going transition of each input pulse.

Each counter's output stage is

Circle 162 on reader service card
Circle 163 on reader service card →

Here's a quick plug for micro-systems.

The A-MP Chevron Shaped Connector plugs in, plugs out and interchanges to give you connection flexibility in your most mini-micro applications.

This connector has contacts on straight centers of .050". Or staggered centers of .025". Because of their special design, the contacts are very tolerant of misalignment and very redundant in their connection.

The receptacle contacts have an outside diameter of .030". Inside there are two spiral springs that redundantly grasp every pin.

The connector housings are dimensionally identical for both pin and receptacle contacts. (A foresight for versatility's sake.) They are available with contoured edges that correspond to the staggered pattern of the contacts. Which means you can fit the housings together and maintain even contact spacings.

For application versatility, the connectors can be mounted for either perpendicular or parallel card mating in addition to the standard in-line card-to-card applications. There's also a version for ribbon cable that opens many cable-to-card or cable-to-cable possibilities, or for transmission cable to match 75 ohm impedance.

That's our plug for micro-systems. But it's not all you'll need to know about it. For more information on the A-MP Chevron Connector write:
Industrial Division,
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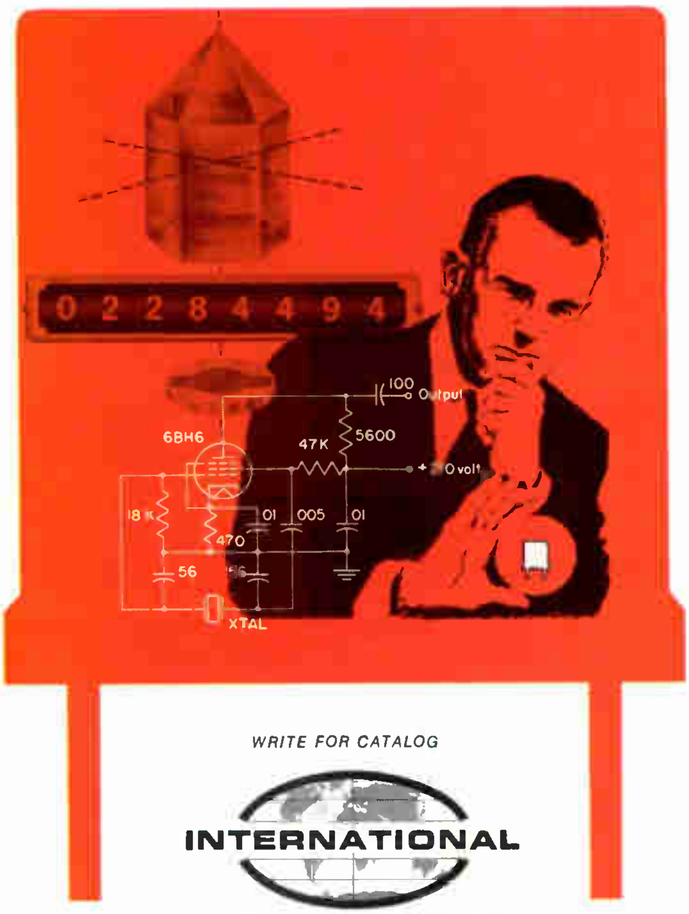

WRITE FOR CATALOG

INTERNATIONAL

CRYSTAL MFG. CO., INC.

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. . . aimed at timing jobs in consumer field . . .

available on the chip and can be brought out to provide several divider options. And circuit functions can be added or eliminated to meet specific requirements.

The unit is available in a lower-powered version, designated the TA5939. The lower power consumption is achieved by eliminating the reset function and because it utilizes only one output, from the 14th stage. In addition, the 5939 contains an extra terminal that gives it an optional drive capability from a crystal oscillator.

Both types come in ceramic dual in-line and flat packages, and in chip form.

The company sees broad applications in digital equipment where very low power dissipations are required and where operation from low-voltage battery sources is a must. These applications include battery-powered watches and clocks, fuse timers, timing and time delay, frequency division, and counting.

One much-talked-about consumer application of these low-power integrated circuits has been for timing in wrist watches. The frequency of a crystal oscillator is divided down by the multi-stage binary counter so that one pulse is generated at the counter's output for every second of time. The complex mechanism of gears in the electromechanical watches is thus eliminated. And the single-cell battery contributes to the size and weight reduction of the watch.

According to Frank Rohr, manager of market planning, the low power dissipation of the C/MOS units make them suitable also for use in cardiac pacemakers.

The devices are available in sample quantities and are priced at $35.

Specifications at 25°C and V_{DD}=1.5v

Operating power dissipation at frequency of 50 khz	4 μw
Quiescent power dissipation	25 nw
Maximum "0" output voltage	0.01 v
Noise immunity (all inputs)	0.45 V_{DD}v
Minimum "1" output voltage	V_{DD}—0.01 v
Output drive capability	—0.1 ma
Input pulse frequency (typical)	100 khz
Rise and fall times	15 μsec

RCA Solid State Division, Harrison, N.J. 07029 [475]

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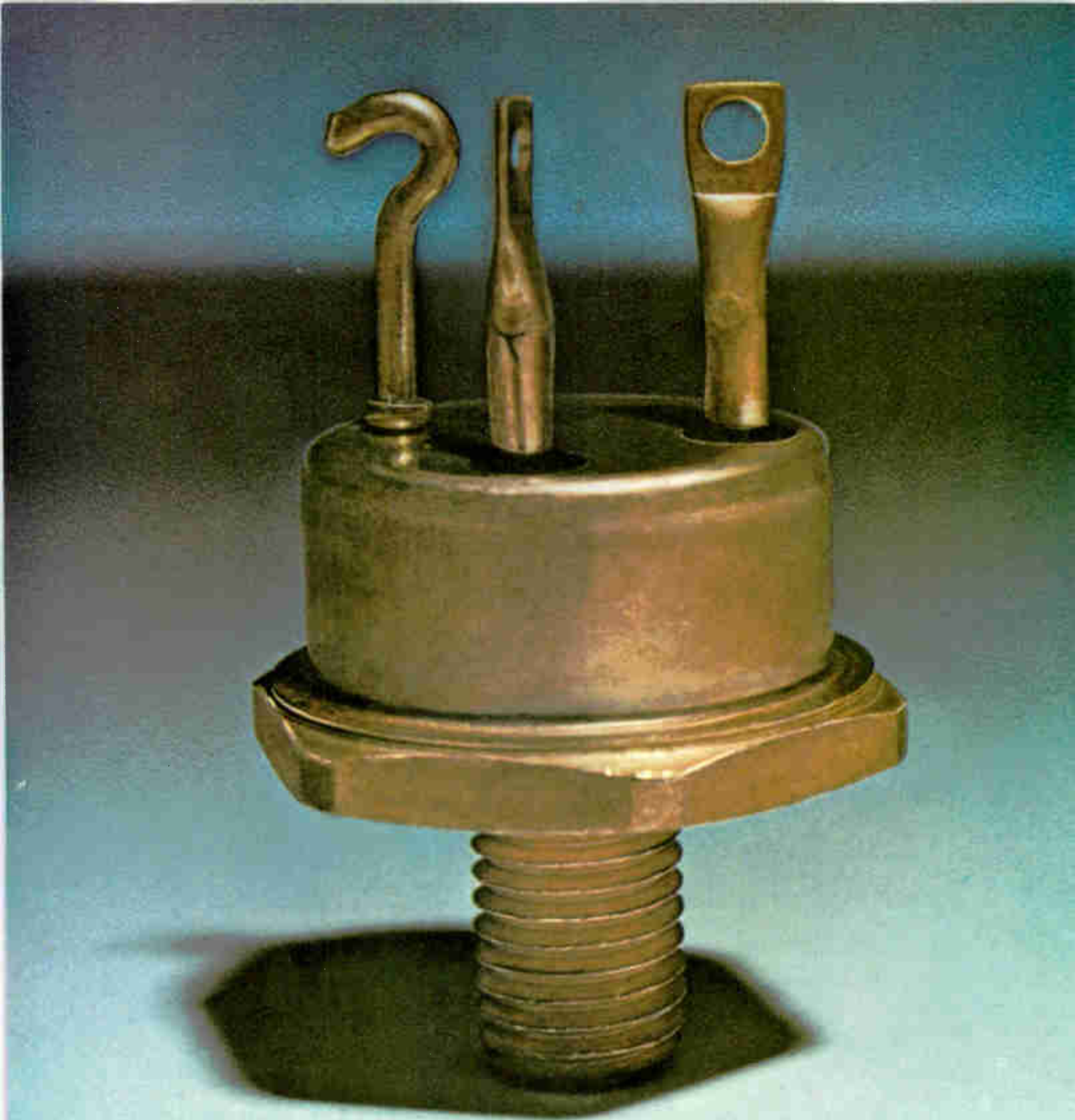

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Westinghouse epi base power transistors save you a driver stage or cut driver transistor cost.

How do we do it? Through an exceptional combination of frequency, power and gain capability. Our devices give you maximum turnoff time (t s + f) of 1.15 microseconds or less, with high gain, particularly at high currents—up to 75 amps. Hard solder construction minimizes possibility of thermal fatigue. Hermetically sealed in popular TO cases, these devices are manufactured by military processing to maximum reliability. Broad SOAs too.

Other hard facts: total switching time of .95 to 1.75 microseconds maximum, currents 2-75 amps, voltage 40-375 volts, power 35-260 watts. So drive a bargain: contact Westinghouse Semiconductor Div., Youngwood, Pa. 15697.

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Westinghouse Semiconductor Division
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Circle 167 on reader service card

Position scaler shifts data

Eight-bit TTL unit moves inputs left or right

The most common device for shifting data is a shift register, but in some applications—such as in arithmetic units—speed is critical and a shift register is too slow. For example, it takes eight clock pulses plus the propagation delay of the device to shift data eight positions in a shift register.

But with the model 8243 position scaler from Signetics, the eight-position change occurs in a time period equal to the propagation delay of the device only.

The 8243 is a medium-scale-integration device of approximately 70-gate complexity. It operates at transistor-transistor-logic levels and is controlled by a three-bit binary code. The shift or scaling range of one unit is a minimum of zero, which Signetics calls a scale select where all eight input data bits are transferred simultaneously to their respective outputs. The maximum shift is the most-significant-bit input shifted seven positions to the least-significant-bit output.

However, if two devices are used for scaling eight bits, the total configuration becomes bidirectional and data can be shifted right or left. And data being shifted out of the unit—the eighth bit in a right shift or the first bit in a left shift—can be either cropped or put back in at the other end. Open collector outputs are provided for expansion to larger scaling functions.

Applications include tracking decimal points in floating-point arithmetic and generating partial products. Previously, a designer had to employ a shift register and a buffer, which took longer.

Prices range from $12.60 for industrial units in quantities of 100, to $41.71 for the military units.

Signetics Corp., 811 East Arques Ave., Sunnyvale, Calif. 94086 [445]

New GLASKYD® 7100 FR
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a fast molding cycle
and economy.

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best connector material you can buy!

For additional information about this circuit saver, write American Cyanamid Company, Plastics Division, Wallingford, Connecticut 06492.

Circle 168 on reader service card

CYANAMID

Design aid speeds layout of IC's

Hardware-software system, adapted from Lincoln Lab project, uses IBM 1130 in preparing designs for artwork generator

Many firms use the computer to help lay out integrated circuits, but it's not unusual for them to plug in an engineer just prior to cutting the artwork so that he can clean up and tighten the computer's design, especially when some programs waste several times the silicon that a man would.

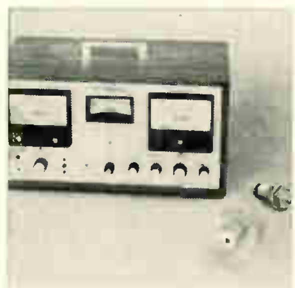
The most efficient approach is to combine the speed and memory of a computer with the judgment of an engineer. This is the route taken by the Design Assistant, a hardware-software system for layout of IC's. The unit, produced by Applicon Inc., uses an edited version of the MIT Lincoln Laboratory Mask Program.

The man behind that program is now an Applicon vice president, Fontaine K. Richardson. The program, unveiled about 18 months ago [*Electronics*, Jan. 6, 1969, p. 54], was designed to satisfy the laboratory's need for fast-turnaround IC design and involved the lab's large TX-2 computer. The designers used a data-entry tablet to make rough sketches of masks, either singly or in sets, and the computer formalized the drawings, displayed the layouts on a crt, and

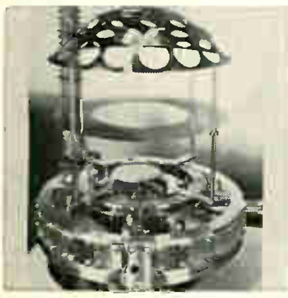
Lasertrim resistor trimming system model Y utilizes "L" cut for increased accuracy and retention of maximum power dissipation capacity of film resistors. Sequential perpendicular and parallel cutting permits trimming accuracy of tenths of a percent at production line speeds. Price is under $15,000. Apollo Lasers Inc., 6365 Arizona Circle, Los Angeles. [421]

Automatic wafer prober model 900-OL can provide indexing speeds of up to 2,000 steps per second for applications in semiconductor manufacturing. An open-loop control system governs the two stepping motors which activate the prober's indexing stage. Indexing accuracy is ±0.25 step, nonaccumulative. Electroglas Inc., 150 Constitution Dr., Menlo Park, Calif. 94025 [422]

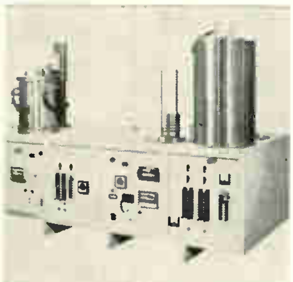
Integrated circuit cutting and forming tool model 8023 will cut, bend and stagger bend any flatpack, leaving burr-free clean ends ready for use, without injuring components, deforming or delaminating. It is easy to load and unload many different size dies. Price of the unit, complete with one set of dies, is $560. Electronic Tool Co., 3324 White Plains Road, Bronx, N.Y. [423]



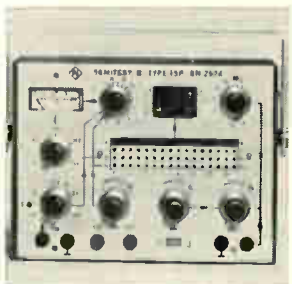
Deposition control system called Iotron automates production of vacuum deposited thin films. It employs a sensor head which monitors the rate of evaporation from one angstrom to over 1,000 angstroms/sec of aluminum and monitors thickness up to 10 million angstroms of aluminum for hours of continuous use. Sloan Instruments Corp., Box 4808, Santa Barbara, Calif. [424]



Rotary drive tooling systems series 07-023 are for uniform substrate coating for R&D and production. They can be programed for automatic operation utilizing an evaporation rate monitor, a deposition thickness controller, an evaporation programmer and an scr power supply. All systems are available from stock. Vacuum/Atmospheres Co., W. Rosecrans Ave., Hawthorne, Calif. [425]



Combination retort-vacuum furnace system is for brazing, metalizing, ceramic to metal sealing, sintering and annealing. It consists of a 2,200°F heating bell and two 7.5 in. i-d inconel retorts and a 3,300°F heating bell with one work support pedestal. Both units have independent power supplies and controls. Astro Industries Inc., N. Olive St., Santa Barbara, Calif. [426]



Rapid testing of digital IC's is achieved by the Semitest III test set, which checks the functioning of integrated logic circuits such as bipolar or MOS type TTL, DTL, DTLZ, ELC and RLT circuits. Storage-type logic circuits, such as RS and JK flip-flops, recorders, counters and frequency dividers can also be tested. Rohde & Schwarz, 111 Lexington Ave., Passaic, N.J. [427]

Compact, transistor-powered tester is for rapid electrographic detection of porosity in plated metals. The easily-operated unit incorporates all the necessary elements for this testing method—a selected chemical indicator process, a source of controlled current supply, and a system for applying pressure to the part under test. Sel-Rex Corp., 75 River Rd., Nutley, N.J. [428]

THE MAG-SHAPER

It's a magnetic pickup
for rotary or linear speed or motion sensing without direct contact

It's a pulse shaper
with a fixed width output pulse capable of driving a meter or relay

It's a speed switch
for over or under-speed detection with a 28-volt ON-OFF output

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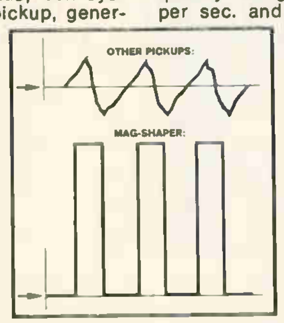
- Computer Functions
- Synchronizing
- Telemetering
- Speed Control
- Position Control
- Digital Counting

The MAG-SHAPER senses rotary or linear movement of a ferromagnetic material (gear tooth, pump vane, turbine blade, conveyer belt, etc.) past its monopole pickup, generating a voltage pulse. This pulse is fed to a *built-in* solid state shaping network which delivers a ready-to-use fixed width output pulse. While the output wave shape of other pickups will vary in form and amplitude, the MAG-SHAPER output is a pulse of known; constant width at a magnitude of approximately 2 volts less than B+. The output is capable of driving a 100 milliampere load such as a relay, meter or counter.



In a miniature package, 3.2" long, the MAG-SHAPER includes a monopole pickup *and* the electronic pulse shaping network. This eliminates problems of interface conditions and signal noise between separately located components. Standard MAG-SHAPER models are available for pulse frequency ratings from 1,000 to 10,000 pulses per sec. and pulse widths from 50 to 500 μsec. Input voltage is 18 to 32 VDC. Output is 16 to 30 VDC, 320 ohms max. load.

For applications requiring frequency/speed monitoring and control via a 28-volt "ON-OFF" signal, a SOLID STATE SPEED SWITCH is offered. A self-contained unit, it combines monopole pickup, pulse shaper and a frequency sensing network in a single MAG-SHAPER package. Standard models are available with pre-set frequency trip values from 100 to 9,999 pulses per sec.

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generated punched tape for a pattern generator which then created 10-x artwork.

The Design Assistant's operation is similar, but at $50,000 or so, the new system costs only a fraction of the TX-2 computer-Mask Program setup. Nor does it require the power or memory of the large computer; the Design Assistant is built around the capabilities of an IBM 1130 with a single 500,000 word-disk memory for bulk storage. The 1130 is not part of the system, says Richard N. Spann, marketing vice president, and so the $50,000 is for terminal equipment, software, and training only. A Computek data entry keyboard and tablet, plus a Tektronix storage tube display, complete the terminal.

The software is complete; the user does no programing. But since the semiconductor art varies from company to company, and even from process to process within a firm, the bulk of the 500,000 words of disk storage is used as a library of up to about 1,000 component definitions. For example, a transistor matched to corporate design rules would be stored as a set of rectangles on specific levels (or masks), one for each diffusion, etch step, and metalization contact. Cells—collections of components forming common functions like gates—also can be stored.

The user brings component or cell designs from disk to crt by using a shorthand symbol. A resistor can be added to an existing design, for example, just by tracing a scrawled 'rho' on the data entry tablet. And if the design in memory doesn't quite suit the needs of that moment, it can be stretched, squeezed, flipped over, and moved to fit. Any change made to one level of the design is automatically carried through to all other levels up to a total of 16.

After the layout is finished, each mask can be called up and inspected, or the composite of all masks can be viewed simultaneously. The Design Assistant then can be commanded to convert the displayed layout to digital x-y coordinate information and record it on cards, paper tape, or magnetic tape in a format compatible with the user's artwork generator.

Applicon Inc., 83 Second Ave., Burlington, Mass. 01803 [429]

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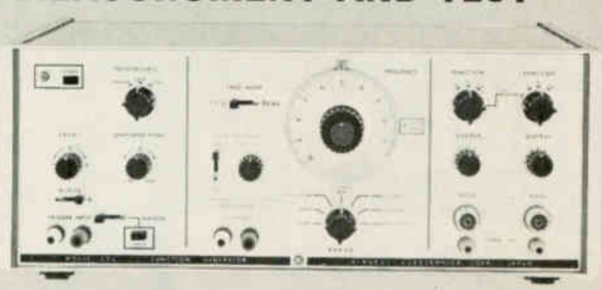

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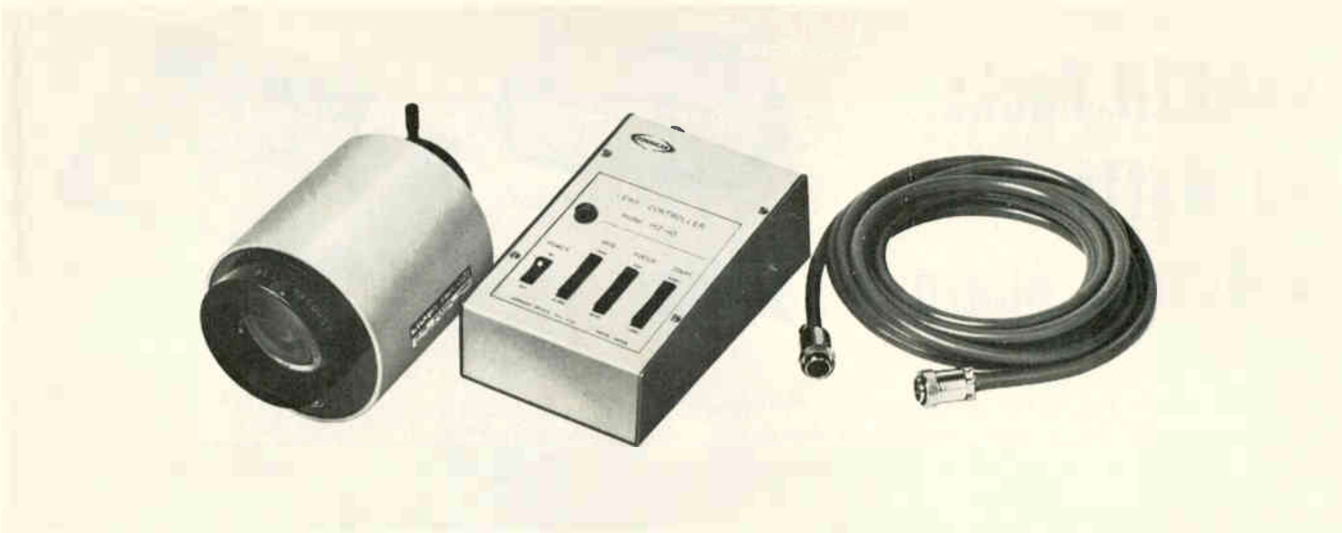

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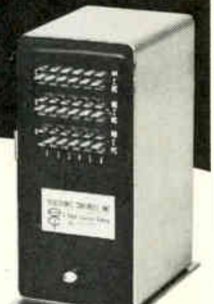

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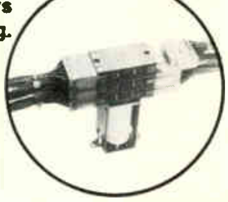

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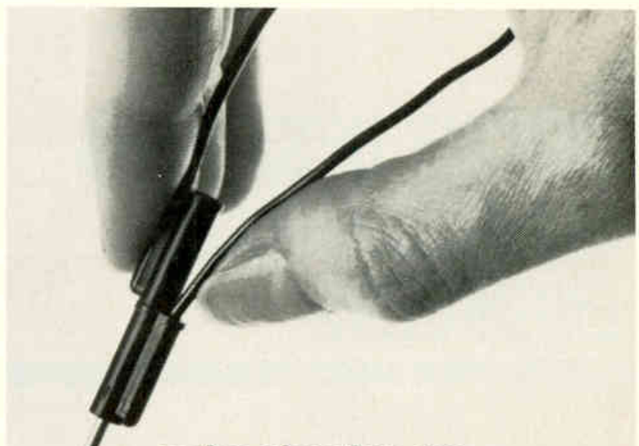

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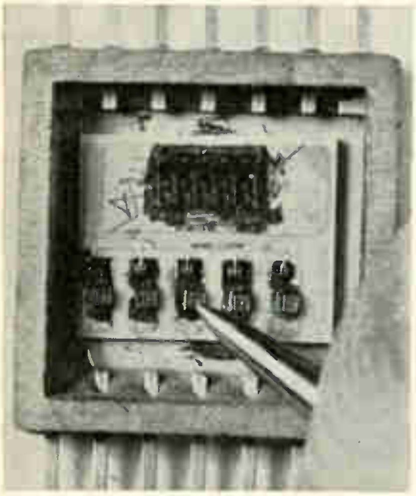

Two-component epoxy compound Epo-Tek H54 aids in hybrid-circuit fabrication by providing a bonding and coating material with high insulating resistance in thin films. It is particularly useful in bonding of active and passive components, bonding large substrates in IC packages, crossovers, or coating closely spaced conductors. It is an unfilled, 100% solids, soft, smooth, thixotropic paste with high temperature properties and excellent resistance to solvents, chemicals, and moisture. Its built-in color indicator causes the material to turn from its natural amber to a deep red as curing progresses. Epoxy Technology Inc., 65 Grove St., Watertown, Mass. 02172 [432]

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Monobond M-5 is a low viscosity, brushable paste, single component, epoxy adhesive suitable for production use. It is aluminum filled, and can be cured at the relatively low temperature of 250° F. Tensile shear of over 5,000 psi is achieved. Allaco Products Inc., 130 Wood Rd., Braintree, Mass. 01505 [434]

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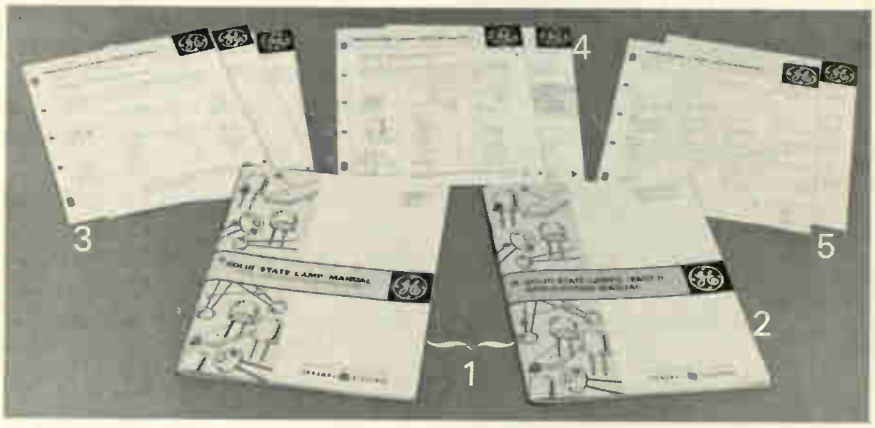

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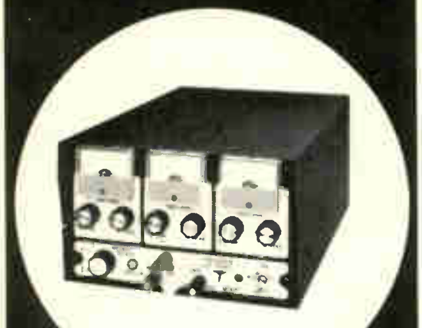

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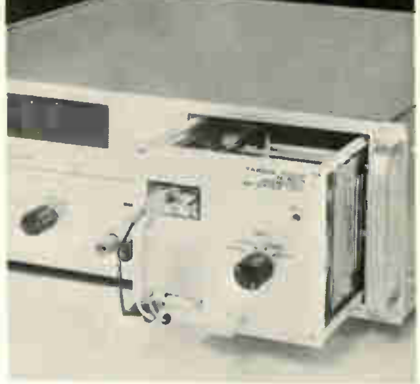
The recent emphasis on digital communications is the raison d'etre for the substantial revision of the first edition of this popular book. Now, with its store of information on digital systems and the statistical analysis of communications networks, the book should prove an extremely useful reference for communications engineers.

Only chapters 1 and 2—introduction to information transmission, and transmission through electric networks—remain unrevised. Chapter 3, on digital communication systems, chapter 6, on random signals and noise, and chapter 7, on physical sources of noise, have been completely rewritten, the others have been partially reworked.

The chapter on digital communication systems has undergone complete revision from the first edition. It provides a comprehensive introduction to baseband digital communications by applying the material presented in the first two chapters to analog-to-digital conversion, time-division-multiplex signals, pulse-amplitude-modulated systems, and pulse-code modulation. It treats the sampling procedure in a/d conversion beginning with the well-known Nyquist sampling theorem. Many examples are treated, among them, analog signals as speech, facsimile, television, and telemetered data.

The chapter on modulation techniques extends the baseband considerations of the previous chapter to high-frequency sine-wave transmission. Several types of high-frequency binary systems, including on-off keyed, phase-shift keyed, and frequency-shift keyed units, are studied and compared on spectral bandwidth basis. Synchronous and envelope detection is covered, as are analog-modulation systems, including amplitude-modulation, single-sideband a-m, and frequency-modulation. Pulse modulation is presented as a form of modulation of high-frequency sine-

10 nanoV Resolution



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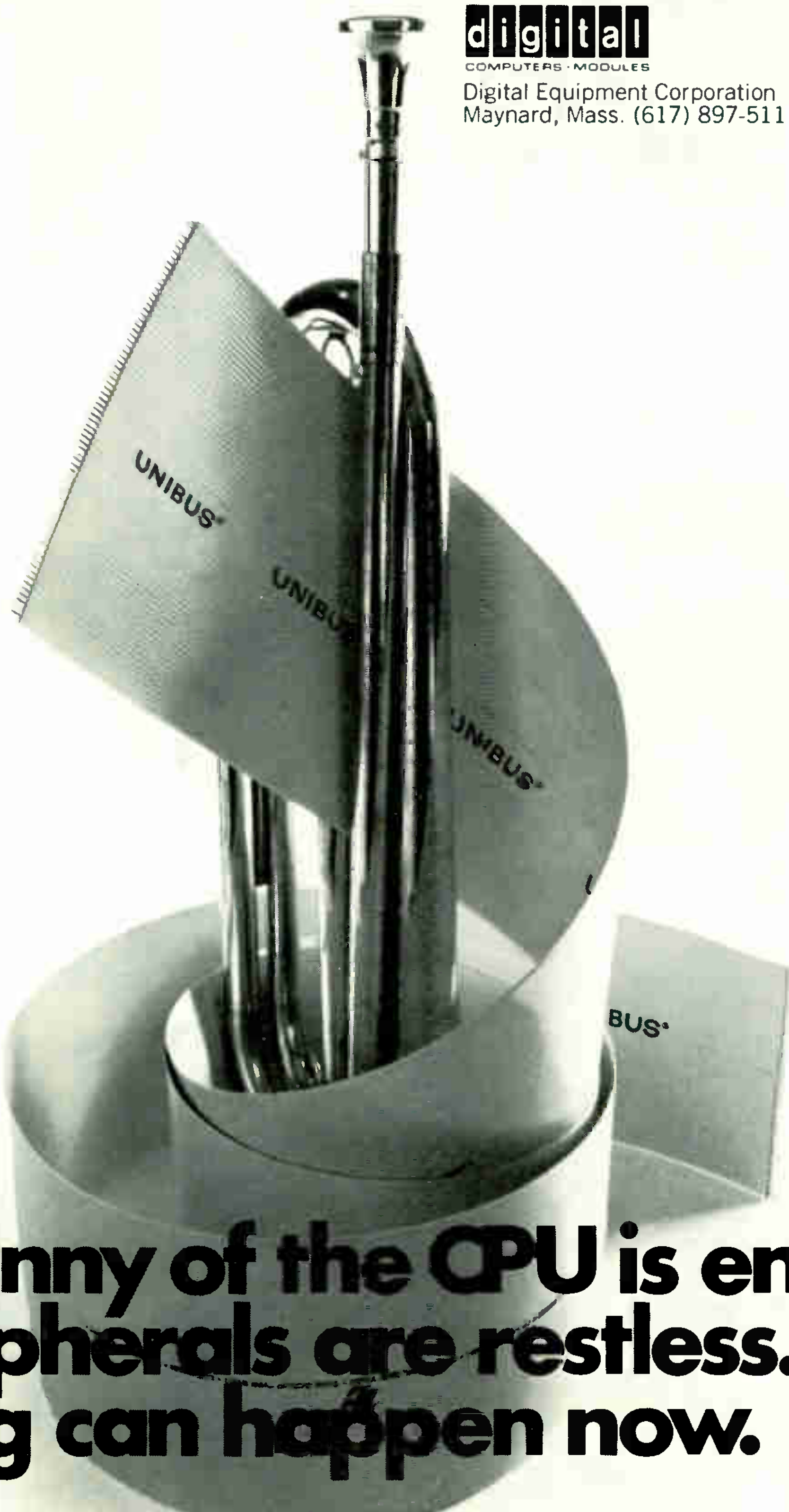

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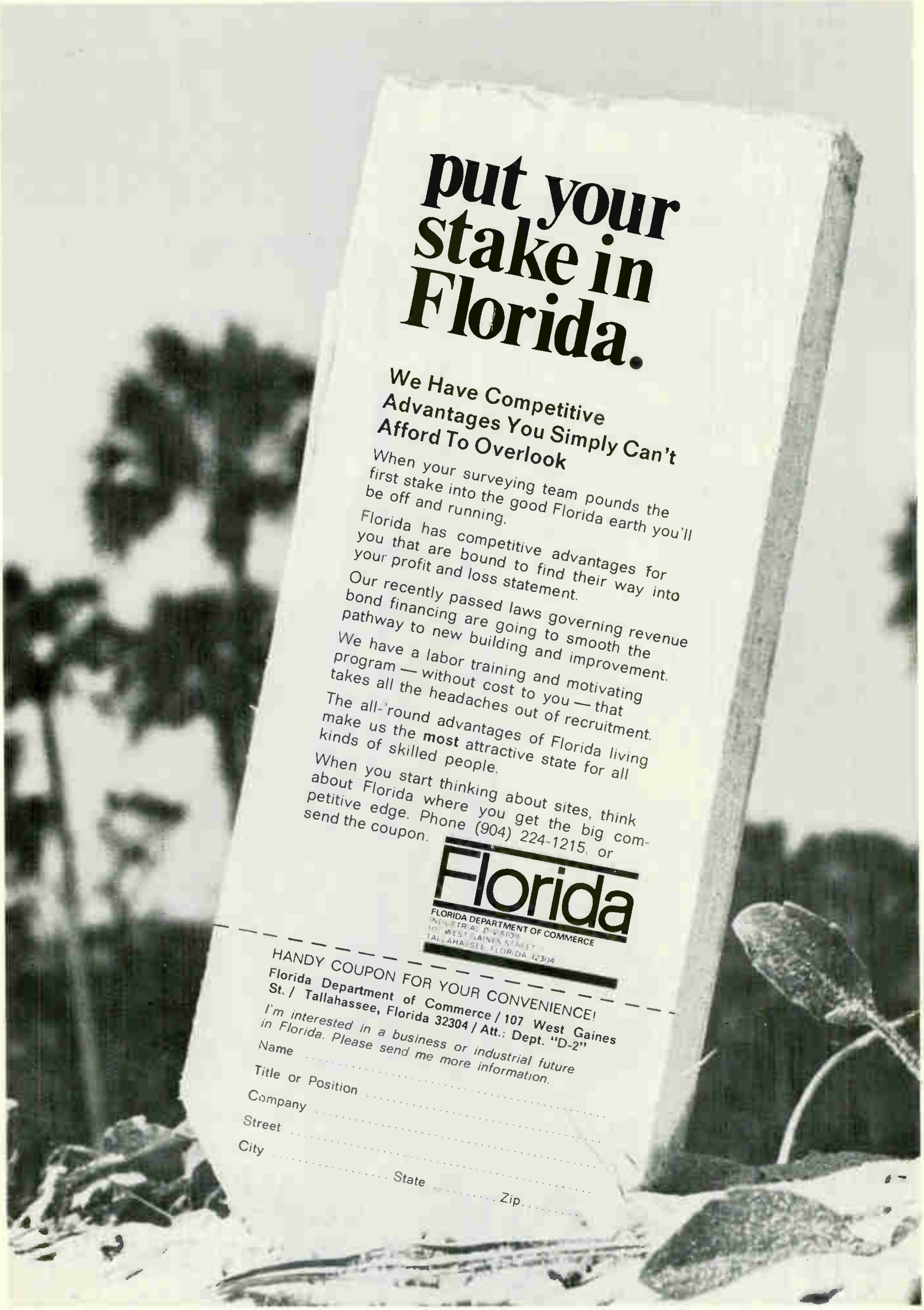

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Two chapters on statistical methods in analysis of information transmission systems, and random signals and noise introduce the elements of probability theory and then apply them to the study of noise in communication systems. Probability concepts are approached nonrigorously and then applied to information-transmission problems such as binary transmission in noise, pcm repeater analysis, and transmission over fading channels. Narrowband noise is discussed, and high-frequency binary systems are quantitatively compared. Then a-m and f-m receivers are analyzed, with spectrum analysis playing a dominant role. Finally, the existance of noise sources in communications systems is postulated.

Another rewritten chapter—physical sources of noise—emphasizes noise sources appropriate to lasers and semiconductors and is limited to noise due to spontaneous fluctuations—continuous noise. A twofold treatment is given to thermal and shot noise—first in a physical, qualitatively motivated manner, and second in the use of thermal noise a modern physics.

The final chapter deals with statistical communication theory, relying on the statistical decion theory to develop the optimum binary communication system. The approach maximizes the binary-transmission rate by placing constraints on error probability, signal power, noise, and bandwidth. The chapter also investigates methods of decreasing the probability of error beyond that available with optimum matched filtering. This is accomplished via the Shannon channel-capacity theorem, introduced in chapter one and referred to throughout the book, that makes possible transmission of digital information at the lowest error rate. An information-feedback system is developed with this theorem, allowing operation at Shannon capacity. In the conclusion, there is a discussion of error detection and correction by adding redundant data symbols to the data stream, increasing system complexity, and reducing data rate.

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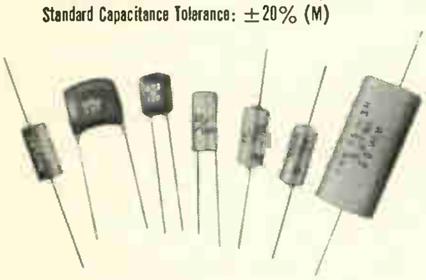

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Technical Abstracts

Picture the defects

Semiconductor wafer-surface inspection by intensity spatial filtering
R.O. De Nicola
Western Electric Co.
Princeton, N.J.

The quality of epitaxial layers grown on a silicon substrate depends greatly on the quality of the substrate. A fast and reliable technique for inspecting silicon surfaces employs laser light and spatial filtering.

To assure high-quality epitaxial growth, substrate surfaces must be chemically clean and without pits, projections, haze or scratches. In addition, the surface must be optically smooth and flat, and have no crystallographic defects.

In one current method of inspecting wafer surfaces, an operator looks at every wafer under a high-intensity lamp and checks for gross defects visually.

Instead of the high-intensity lamp, a helium-neon laser is used. The laser light passes through a beam expander and falls upon the surface of the silicon wafer. The reflected light is then focused by an imaging lens onto a spatial filter, and then passes onto the faceplate of a television camera and monitor.

The light is very highly collimated as it falls upon the silicon surface. If the silicon had no surface defects the reflected beam would remain collimated. Defects, however, scatter some of the light, which is not focused on the optical axis by the imaging lens. This is where the spatial filter comes in.

The filter actually consists of an opaque dot along the optical axis at the focal point of the imaging lens. The dot blocks the collimated light reflected from the surface of the silicon. Thus, the only light that's transmitted through the filter is the light scattered by the surface defects. This light forms white images on a black background on the tv monitor. An electronic counting system can be set up to scan the tv image automatically and count the number of times the video signal goes from black to white. This count is proportional to the defects in the wafer.

Presented at IEEE, New York, March 23-26.

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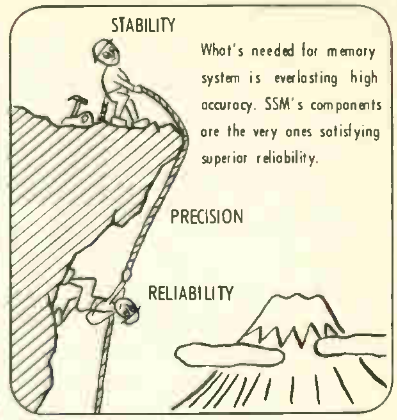

Pla-module: thin film modulated C-R circuit.

Plate-ohm: evaporated metal film resistor.

Pla-con: organic thin film capacitor by plasma reaction.

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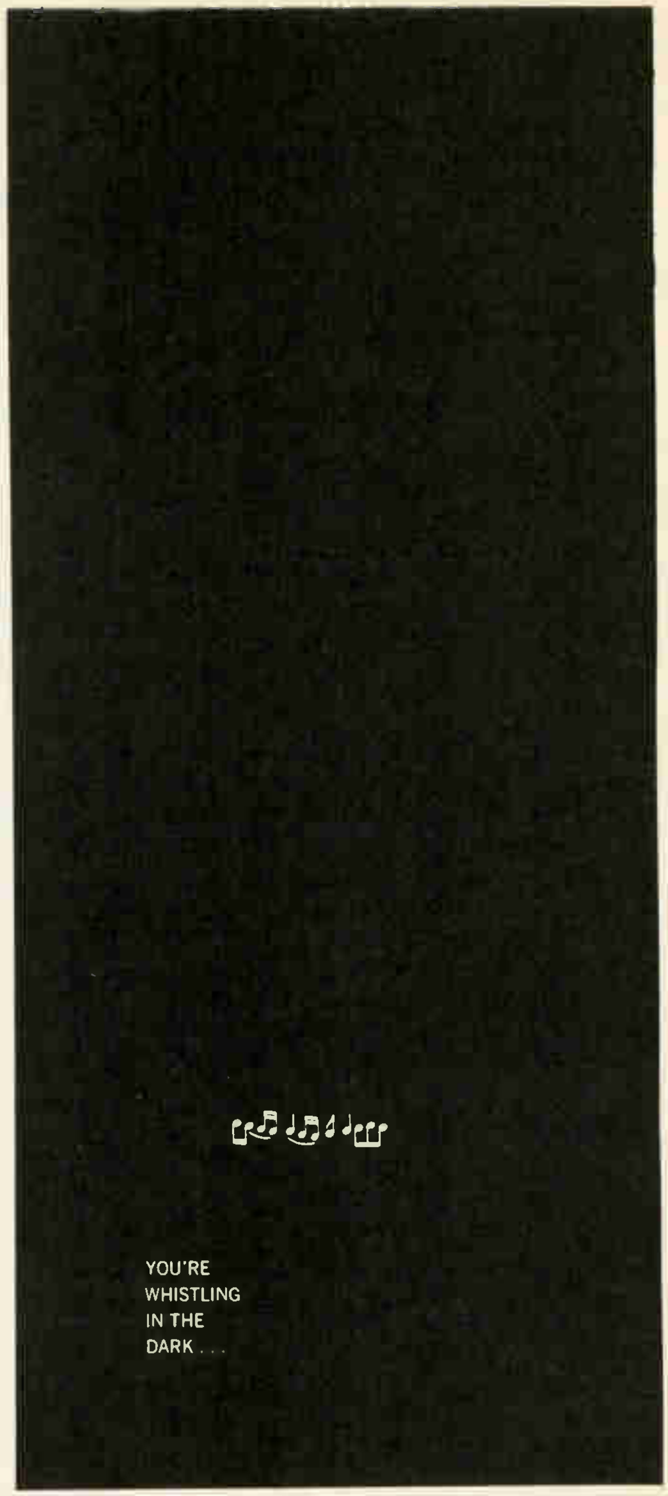

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New Literature

Logic control system. Tenor Co., P.O. Box 2766, Milwaukee 53151, offers a four-page bulletin describing the series 700 logic control system for industrial applications.
Circle 446 on reader service card.

FET-input op amp. Analog Devices Inc., 221 Fifth St., Cambridge, Mass. 02142. A two-page technical data sheet describes the $12, general purpose model 40 FET-input operational amplifier. **[447]**

Dynamic pressure sensing. Kistler Instrument Corp., 8989 Sheridan Dr., Clarence, N.Y. 14031, has available a data file containing a comprehensive compilation of literature on the latest instrumentation devices for measurement of all types of dynamic pressures. **[448]**

Silicon controlled rectifiers. International Rectifier, 233 Kansas St., El Segundo, Calif. 90245. Silicon controlled rectifiers for inverter applications are presented in the illustrated engineering brochure A-130. **[449]**

R-f and video systems. Integral Data Devices Inc., 35 Orville Dr., Bohemia, N.Y. 11716, has released a brochure describing products and capabilities in r-f and video systems design. **[450]**

Rectifier assemblies. Edal Industries Inc., 4 Short Beach Rd., East Haven, Conn. 06512. Bulletin 127 describes the F series diode silicon rectifier assemblies. **[451]**

Tantalum foil capacitor. Tansitor Electronics Inc., West Road, Bennington, Vt. 05201, has released a technical bulletin on its ultrahigh capacitance CL70 series tantalum foil capacitor. **[452]**

Sensing devices. Mullard Inc., 100 Finn Court, Farmingdale, N.Y. 11735. Three solid state, industrial control sensing devices are discussed in a brochure available by request on company letterhead stationery.

IC capability. Microcircuits, Trimpot Products Division, Bourns Inc., 1200 Columbia Ave., Riverside, Calif. 92507, has issued a capability brochure that gives performance parameters for custom thick film resistor and resistor-capacitor networks available. **[453]**

Coaxial relays. Dow-Key Co., P.O. Box 348, Broomfield, Colo. 80020, has available a 20-page 1970 general catalog on its line of vacuum coaxial and other coaxial relays. **[454]**

Power supplies. ACDC Electronics Inc., Oceanside Industrial Center, Oceanside, Calif. 92054. A six-page, short-form catalog describes a complete line of stock delivery d-c power supply modules

JFD

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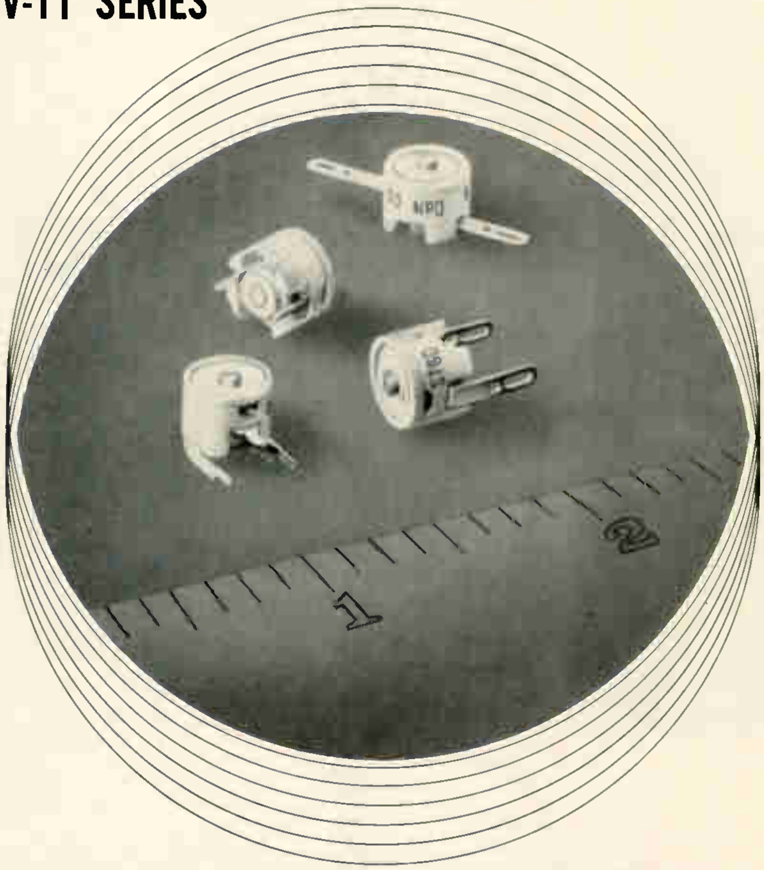

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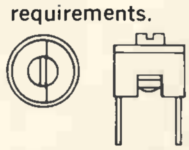

Illustrations actual size.

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New Literature

including the latest miniaturized power supplies and rack assemblies. [455]

Transistor test system. Teradyne Inc., 183 Essex St., Boston, Mass. 02111, has published a brochure on its versatile T241 computer-operated transistor test system. [456]

Time codes. Datametrics Division, CGS Scientific Corp., 127 Coolidge Hill Rd., Watertown, Mass. 02172, has released a technical brochure entitled "Modulated Time Codes Find Data in Analog Recording Systems." [457]

Strip line chart. Custom Materials Inc., Alpha Industrial Park, Chelmsford, Mass. 01824. A chart of strip-line laminates lists 11 standard material types which are available with copper foil cladding, aluminum foil cladding, or aluminum ground plants. [458]

Electrolytic capacitors. Siemens Corp., 685 Liberty Ave., Union, N.J. 07083. A line of long-life, miniature electrolytic capacitors is described and illustrated in a four-page bulletin. [459]

Wideband amplifier. Arvee Engineering Co., P.O. Box 3759, Torrance, Calif. 90510, has published a bulletin on the model 610 wideband amplifier that operates from standard +15 v d-c power. [460]

Product reference guide. Bell & Howell Co., 706 Bostwick Ave., Bridgeport, Conn. 06605, has released a four-page product reference guide that briefly describes function modules, analog systems and instrumentation as related to process control. [461]

Direct-writing recorder. Beckman Instruments Inc., 3900 N. River Rd., Schiller Park, Ill. 60176. Type RM Dynograph multichannel direct-writing recorder is featured in two-page bulletin 665A. [462]

Power semiconductors. Sensitron Semiconductor, 221 W. Industry Court, Deer Park, N.Y. 11729. Specifications for a complete line of power transistors, power rectifiers, rectifier assemblies, zener and reference diodes, triacs and SCR's are offered in an 80-page catalog. [463]

Digital printer. Clary Corp., 320 W. Clary Ave., San Gabriel, Calif. 91776, has released full-color bulletin S-188 on a 180-line-per-minute digital printer for instrumentation, data acquisition, and logging systems. [464]

Selenium devices. International Rectifier, 233 Kansas St., El Segundo, Calif. 90245. Selenium rectifiers, Klip-Sel transient voltage suppressors, and contact protectors are outlined in 40-page, illustrated engineering brochure B-108. [465]

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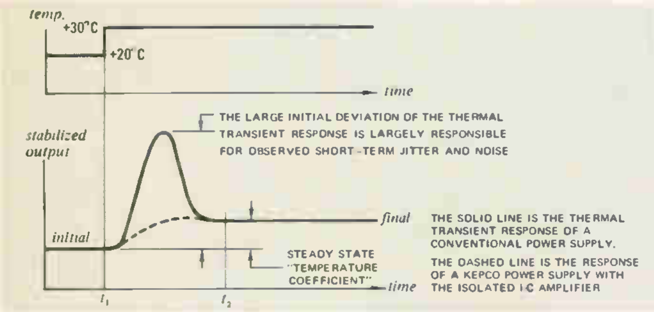

Every element in a power supply has a temperature coefficient, the reference, the sampling resistors, the amplifier. . . . Their net steady-state value is reported as the *"temperature coefficient"* on the spec sheet. Some elements in the supply, however, also exhibit a *transient response* to temperature changes, a large initial deviation which recovers slowly to the steady-state temperature coefficient. In these elements, coefficients of change are balanced against others so that only the differential change appears in the steady-state coefficient. Unequal or localized heating or cooling - even a very small amount - will cause major perturbations which decay only as the elements regain thermal equilibrium.

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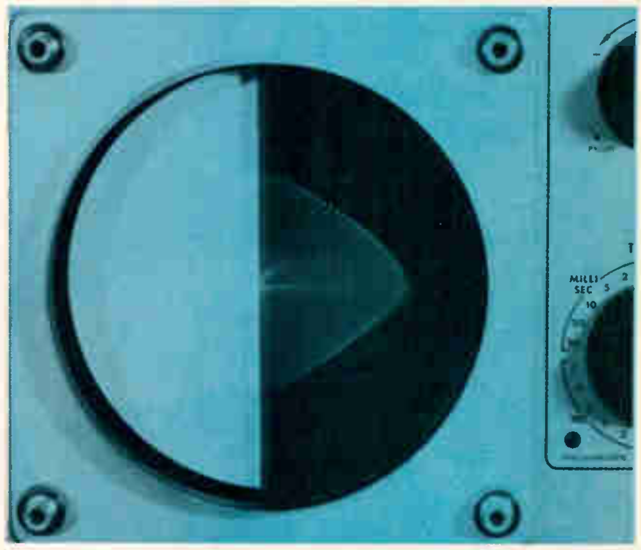

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International Newsletter

June 22, 1970

France may try to regain control of Bull-GE

France's plan to win back control of Bull-GE may throw a monkey wrench into General Electric's plan to sell its French computer business to Honeywell. Bull was France's only major computer maker when GE bought it in 1964—over heavy government opposition—and it is now the backbone of GE's overseas computer operations.

Officials of France's Plan Calcul, which the government set up in 1966 to rebuild a native computer industry following the Bull takeover, are urging the regime to refuse authorization for Bull-GE's transfer to Honeywell. They hope the state-backed computer maker, Compagnie Internationale pour l'Informatique, then could somehow wrest control. CII covets Bull-GE's well-developed European and Third-World sales and service network.

Insiders say CII and Britain's International Computers, Ltd., which in late 1968 shelved a plan to set up a joint European sales network, now have restarted talks based on the possibility of "sharing" Bull-GE. French sources say CII has launched similar cooperative marketing talks with Honeywell, to join the US firm in case CII can't beat it. Company officials deny these reports, however.

Well-placed sources indicate that if the French government does block Bull-GE's sale to Honeywell, GE would not sell out to CII but would simply hold on to its French subsidiary, which then might operate as agent for the proposed Honeywell-GE computer holding company.

British firms set for semiconductor memory production

Several British companies are about to break the monopoly of semiconductor memory production held by U.S. firms. Mullard Ltd., the British Philips subsidiary, is about to offer samples of a 64-bit MOS random-access memory with 200-nanosecond access time. The thick-oxide, high-threshold chip includes decoding and is in a 16-lead dual-in-line pack. In August Marconi-Elliott Microelectronics Ltd. expects to offer a word-oriented 16-word eight-bit MOS read/write memory in a TO-5 package, capable of operating from d-c to 4 megahertz. M-E uses low-threshold, silicon gate MOS technology; the chip is said to be directly TTL compatible. Intended applications are data transmission, computer scratch pads and fast registers. By the end of this year both M-E and the Plessey Co. expect to offer 256-bit low-threshold MOS RAM's with access times of 0.5 to 1 microsecond.

U.S.-made MOS memories offered in Britain cost less than ferrite cores below 1,000 bits, but are more expensive at 4,000 bits and twice the price at 8,000 bits. The expectation is that the small MOS stores will be widely used within a year, particularly in data processing peripherals, and the 8,000-bit units will appear in small computers within two years. Large mainframe MOS memories are three to five years off.

Japan color tv makers are hit by U.S. recession

Japanese exports of color tv to the U.S. took a sudden nosedive in April. Only 42,914 sets were shipped here, compared with 64,788 in March and 73,007 in April 1969. Industry sources pin the blame for the drop on the recession in the U.S., where overall sales of color tv are off at least 25%. Exports held up during the first three months of the year, however, because these sets had been ordered last year.

April's decline also reflected the introduction of new 1971 models in

International Newsletter

July. When sales are running briskly it is still possible to sell previous-year models through August, but when business is bad inventories are pared back to a minimum before introduction of new models.

Japanese industry sources say U.S. offshore activities are not a factor in the April results. Although Philco, Admiral, and RCA have factories on Taiwan, they are not yet making color sets there—and the level of U.S. imports of color tv's from other companies on Taiwan is still small, only amounting to about 9,800 sets in the first quarter of 1970.

France screening proposal for commercial tv

France soon could get a commercial television network, similar to Britain's ITV, **under a plan submitted by a group of industrialists, including aviation magnate Marcel Dassault. Monte Carlo Television, owned by the group, would build relay transmitters at present transmitting stations of France's two state-owned networks to spread its coverage throughout France.** Technical maintenance and program quality would be supervised by the state stations in return for a share of revenues.

Though official French reaction is not known, tv executives are said to be open to the idea, since plans to launch a third government tv chain have been repeatedly sidetracked by budget austerity measures. **And tv set builders are naturally elated at the improved sales prospects that expanded—and possibly more popular—programing would offer.**

Germany sells computer to Swedish bank . . .

Up against strong international competition, West Germany's Nixdorf Computer AG has just won a big Swedish contract for data processing equipment. The contract, worth more than $6.3 million, calls for the installation of a nationwide network of computer terminals that will tie together some 350 branch offices of Skandinaviska Banken. Nixdorf, West Germany's top-ranking producer of small edp equipment, says that eventually the Swedish network will comprise about 500 such terminals.

. . . while Sweden sells atc system to the Netherlands

Sweden's Standard Radio and Telefon AB, an ITT subsidiary, walked off with an electronics coals-to-Newcastle deal. Standard Radio won an order from the Dutch Air Force for an electronic air traffic control system costing $2 million. **Selling electronic equipment to Philips-dominated Holland is considered a major feat in Europe.** The system, similar to one that Standard Radio is supplying the Swedish Air Force, receives meteorological, direction-finding, and flight data from various airfields. Data is processed by computer and displayed on a large screen to give flight controllers a close-up view of a large area.

Swedish plane enters Swiss replacement race

A Swedish SAAB subsonic jet is being considered by Switzerland as an alternative to two top contenders for an attack aircraft to replace aged British-built fighters [*Electronics*, May 11, p. 64]. SAAB has offered a new version of its 105—the 105 XH, to compete against the top contenders: A-7 Corsair II and Fiat G-91. **What attracts the Swiss is low price: They can get 160 SAAB aircraft at the price of 40 Corsairs and an in-between number of Fiats.**

The new 105 version offers extended armaments and more fuel capacity, as well as improved avionics, including a SAAB-designed high-precision bombing system that features a laser ranging device.

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Zeeman effect gives West Germans highly stabilized helium-neon laser

Developed by Siemens AG, the LG 65 device offers fully automatic operation and eliminates the need for time-consuming frequency-control adjustments

A helium-neon laser that is claimed to stay on frequency better than any commercial laser has been built by West Germany's Siemens AG. Company engineers coupled the laser to a neon absorption cell that uses the Zeeman effect and achieved a frequency stability better by at least one order of magnitude than other commercial laser systems. Frequency accuracy is claimed to be better than 10^{-10}.

The new laser's long-term stability is rated at better than 100 kilohertz per day of operation. This means that the laser's stability remains virtually constant for thousands of hours of operation. Lasers with similar stability ratings have so far been built only for laboratory purposes, Siemens says.

Low cost. The new laser, designated LG 65, was built at the company's Munich development labs and sells for slightly more than $7,000 on the German market.

In addition to high-frequency stability and low price, the LG 65 offers fully automatic operation with, therefore, no need for time-consuming frequency-control adjustments. Just 30 seconds after it's switched on, the unit reaches its rated stability level. Furthermore, using the Zeeman cell produces a frequency reference signal that is external to the laser itself, eliminating frequency modulation effects.

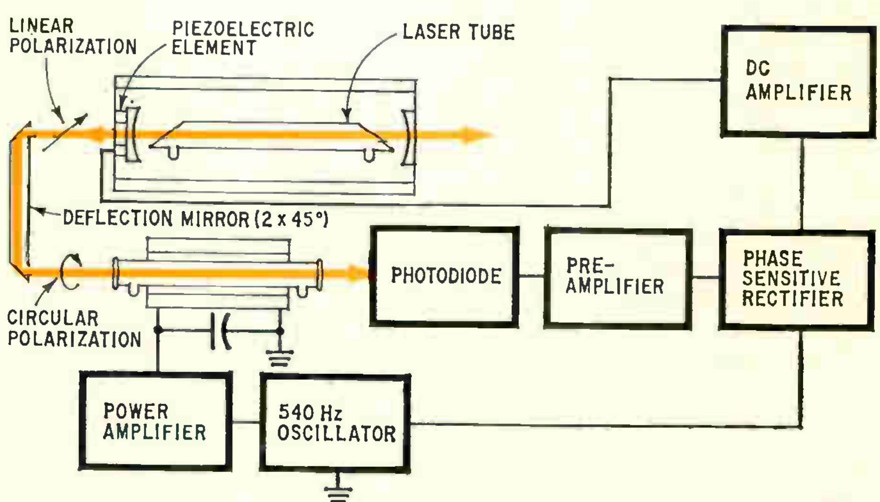
The most important requirement for obtaining frequency stability in a helium-neon laser is that it be operated at only one of its resonator's natural frequencies. In the LG 65, as in other types of lasers, such single-mode operation is obtained by a suitable choice of design factors, balancing such variables as the curvature of the resonator's two mirrors, the distance between them, and the laser tube's capillary diameter.

Feedback. With the single-mode requirement met, Siemens engineers concentrated on frequency stabilization. Their answer is based on the principle of automatically adjusting the effective length of the laser's resonator—the distance between the two mirrors—until its natural frequency is the same as that of a known and well-defined reference frequency. In the LG 65, the Zeeman cell supplies this reference frequency.

In the new Siemens device the laser tube, with a capillary diameter of about 0.8 millimeter, is installed in a resonator built ruggedly enough for industrial applications. One of the resonator's two mirrors is mounted on a piece of piezoelectric ceramic material, which can be slightly deformed by applying an electric field to it. Thus, the resonator's effective length, which is basically about 128 mm can be varied.

The laser beam passing through the adjustable mirror is deflected twice through 90° in a prism which, because of its phase-shifting characteristics, changes the initially linearly polarized light into circularly polarized light. This light is then passed through the Zeeman cell to a photodiode, which measures the light intensity.

By applying a longitudinal alternating magnetic field to the Zeeman cell, the total absorption curve of the cell is split up into two symmetrical but smaller curves—a result of the Zeeman effect. One curve represents light which is polarized clockwise while the other curve covers only that light which



Effects. Alternating field around Zeeman cell splits its absorption curve, generating frequency-dependent feedback to piezoelectric mirror adjuster.

is polarized counter-clockwise. This polarization can be changed by reversing the direction of the magnetic field.

Tuneup. When the a-c field is applied to the cell the light absorption varies in proportion to the deviation of the laser frequency from the cell's center line or reference frequency. If the frequency of the laser light does not coincide with the center line, the light beam is amplitude modulated, with the modulation frequency corresponding to the frequency of the applied magnetic field. In this case the photodiode produces an output signal which is used for tuning. When the laser is properly tuned to the cell's center line the modulation disappears.

A d-c voltage derived from the photodiode and fed to the piezoelectric material tunes the resonator's adjustable mirror. A phase-sensitive detector compares the phase of the a-c field with the phase of the photodiode error signal, and determines whether the laser frequency is located to the left or to the right of the Zeeman cell's center line and thus indicates correction-voltage polarity.

The laser's power supply and control unit, weighing about 65 pounds, is designed for installation in 19-inch standard-sized racks or cabinets. The laser head is roughly 7 by 4.5 by 14 inches in size and weighs approximately 25 pounds. The laser's stabilized beam wavelength is 6329.9148 angstrom and its output power is 0.1 milliwatt.

International

Patent Medicine

The treaty to standardize worldwide patent procedures—though it is in its fourth and final draft and has the approval of 54 countries—still faces some major problems. Some of these originate in Washington, where Birpi, the French acronym for the International Bureau for the Protection of Intellectual Property, is trying to nail down some final loose ends.

Some problems are political. For example, the chief U.S. negotiator, Patents Commissioner William E. Schuyler Jr. cannot enforce the treaty until it gets Senate approval and the signature of the President. In a busy election year, a Senate Foreign Relations Committee source says, "It could take as much as a year before the treaty is even submitted for consideration."

What's first. More complex than the time-consuming politics involved, however, is the issue of national patent policy. Contrary to American practice, where a patent is granted to applicants who can prove first invention, Europeans generally award patents on a first-to-file basis. Though the draft treaty adopts the European practice, the adoption carries so many legal qualifiers that the compromise is expected to have little significance. Under Article 60, subsection 4 (E), for example, the U.S. can nullify the first-to-file ruling by merely notifying individual treaty partners of its intention to keep doing business as usual. As Schuyler puts it, the U.S. will not go along with a policy that could permit a foreign inventor to preempt a bona fide American inventor even if the foreign national could prove he filed first. American support of the agreement, Schuyler explains, "is conditioned upon the premise that the treaty will not have an adverse effect on the majority" of U.S. engineers and scientists.

U.S. officials will accept such a treaty even if it is so qualified, because they expect significant benefits from those sections which consolidate and coordinate international patent searches with only five worldwide offices. Under Birpi's plan, the U.S., West Germany, the Netherlands, Japan and the Soviet Union will be responsible for multi-national patent searches in the Western Hemisphere, Western Europe, the Benelux nations, Asia, and Eastern Europe, respectively.

What's more, an inventor whose idea is found to be patentable in another country will be able to obtain for a nominal fee an advisory opinion to guide him in determining the countries in which he wants to file for patent protection. The inventor will send his applications in the language of the countries concerned to Birpi at Geneva for distribution.

Even more important than the reduction in paperwork and red tape, however, is a clause that extends the international application time from the 12 to 20 months from the date of domestic filing. American companies see this as a distinct advantage considering that the first-to-invent rule often leaves an inventor hanging for more than a year before he learns whether his application will be granted.

In duplicate. The treaty proposal also calls for the adoption of a standard international application format, which will substitute one set of information and proof-of-invention requirements for the 54 different ones that now apply in the member countries. That will greatly speed patent-granting procedures. However, a good part of the present time lag in getting foreign patents—up to eight years in some countries—is due to the complexity of international search. To get a foreign patent it cannot be described in literature any place in the world—"if it were found in the Dead Sea scrolls, you wouldn't get a patent," says one Patent Office official. He believes that once countries build up confidence in the five proposed search facilities, international search will have to be done only once.

Japan

Speaking likeness

Phantom left and right speakers, which do not really exist, are the design innovation in two small stereo radios that the Sony Corp. has just started selling in Japan. The radios are each complete in a single box; a matrix speaker system provides the same realistic stereo sound as a conventional radio with two outboard speakers. Not only do the radios take up less room, but they are far more portable than the usual multi-unit stereo. The smaller of the two new radios is only 10 inches wide; the larger one is 14 inches wide.

Sony engineers say that interest in single-box stereo began way back when stereo records were introduced. Single-unit stereo microphones were developed with two elements. One element had unidirectional characteristics and faced forward. The second, mounted perpendicularly just in front of the first, had bidirectional characteristics to pick up sounds coming from the left and right.

Since then many groups have tried to work out a similar arrangement with speakers, but without much success because of difficulties created by the large size of speakers. Even at medium frequencies this large speaker size introduces a separation that disturbs phase relationships between front and side-facing speakers. Thus, the sound from this type of system does not seem to have depth—even though it seems to have width. Another disadvantage of this type of system is that side-facing speakers make it difficult to provide efficient baffles.

All ears. In its new approach Sony turned its speakers around. It uses three speakers facing approximately forward. The speaker in the center is fed with a right-plus-left sum signal. The right-hand speaker is fed with a right-minus-left difference signal, while the left-hand speaker is fed with a left-minus-right difference signal. These two difference signals are the same with opposite polarities.

For proper operation the three speakers must actually be located as close to one another as possible. Then, it is necessary to advance the phase of the signals fed to the two outside speakers. Phase is very important in this system, because its stereo effect is mainly dependent on phase relationships. The stereo effect of conventional stereo systems is mainly dependent on amplitude relationships.

As with conventional stereo systems, the stereo effect of Sony's radios is best when the listener is directly on the center line of the radio, at a distance determined mainly by radio power output. Phase circuits are designed to advance the difference signals so that sounds originating at the same time and radiated from both center and outside speakers arrive simultaneously at this point regardless of frequency. Wavefronts from the three speakers then combine to produce a stereo sound pattern about this point. The sound pressure patterns from the center speaker and one side speaker are superimposed so that the listener hears each channel separately.

The stereo effect is enhanced by angling the two outside speakers slightly away from the center line. At higher frequencies, speakers become strongly directional, and pointing the speakers slightly outward tends to maintain separation even at higher frequencies. The stereo effect is further enhanced

Emergency beacon. A two-year experiment on the use of unguided modulated laser beams as medium-capacity short-distance transmission routes through the congested centers of cities is underway in Japan. The Electrical Communications Laboratory of the Nippon Telegraph and Telephone Public Corp. is particularly interested in testing the approach for emergency communications during and after a disaster. The key feature for emergency use is that laser beams cause no interference with existing microwave radio facilities, nor is there interference between individual laser systems, so that emergency laser systems could be installed where needed.

Laboratory work indicates that for a 1.25-mile span the service would be curtailed due to atmospheric conditions—including smoke and fog—only about 0.5% to 1% of the year. The new tests will determine if these predictions are true and will also determine reliability of equipment. The NTT system uses a double-wall helium-neon laser built by the Nippon Electric Co. that has about a 4,000-hour lifetime—which is four to eight times that of former types. Other new components include a lithium tantalate modulator, which requires only 30-volt input pulses to modulate the laser beam, and an avalanche photodiode with a gain of about 30 decibels.

In the installation shown, two lasers are used for transmission of color tv. Both are modulated at 120 megabits. One laser signal has vertical polarization, the other horizontal. These orthagonally polarized beams are combined to produce a single beam with a transmission rate of 240 Mbits.

by increasing the amplitude of the signal fed to the two outside speakers. A spread control, which increases the amplitude of the signal fed to the two outside speakers while decreasing amplitude of the center-speaker signal, increases the apparent spacing between the two phantom speakers while maintaining constant loudness. A volume control changes all signals in constant proportion, thus varying loudness without affecting spread.

Fits in. The new speaker system is compatible with the stereo signal normally broadcast on f-m, because very little signal processing is required. The right-plus-left sum signal is received on the main channel and fed into to center speaker. The right-minus-left difference signal is detected by a simple envelope detector and goes through the phase circuit. The signal is then fed into the left-hand and right-hand speakers, which are simply connected with opposite polarities. The more complex product detector normally used in stereo is not needed because the difference signal is used directly.

Sony is now studying a two-speaker variation of this speaker system for tape or record applications in which the straight left and right signals, rather than sum and difference signals, are available. Each speaker is fed its appropriate signal together with a smaller amplitude signal of the opposite channel. The circuits are designed to provide appropriate polarities and phase shift. Thus, the two speakers operate together to provide the sound field produced by the center speaker of the three-speaker system, while each speaker operates individually to provide the sound field produced by one of the outside speakers of the three-speaker system.

Great Britain

Lateral pass

Radiation monitoring instruments operate by detecting and measuring the very small currents—typically from 10^{-10} amps to 10^{-13} amps—developed as the radiation ionizes air molecules. Conventionally, measuring techniques use high value resistors in the feedback loop of an operational amplifier. Work now being done at Britain's Atomic Energy Establishment with lateral transistors makes possible the use of lower value resistors. The result: faster, more accurate readings and less expensive instruments.

Settling. A general-purpose radiation monitoring instrument with a useful measurement spread has four or more ranges and the same number of high value resistors, typically with values between 10^{10} ohms and 10^{13} ohms. A high-impedance range switch is necessary, and switching introduces transients which sometimes take so long to settle that the reading is useless. At very low current densities—10^{-14} amps—there is often fluctuation in the density of the ionized particles crossing the ionization chamber, which makes the reading erratic. This can be overcome by putting a capacitor across the resistor, but at the cost of a further penalty in settling time.

According to Pat Fowler and Richard Greaves of the government-run AEE at Winfrith, Dorset, putting a lateral transistor into the circuit before the op amp makes it possible to use resistors three orders of magnitude lower for the same current values. Hence, a current of 10^{-13} amps needs a resistor of 10^{10} ohms instead of 10^{13} ohms. This gives two advantages: the range switch can have lower impedance, which effectively eliminates transients and consequently settling times, and the lower value resistors need not be glass encased and are, thus, much cheaper. Fowler and Greaves have built an experimental instrument, and are negotiating licenses with interested manufacturers.

Significantly, Fowler and Greaves have found an application for a lateral transistor in which its characteristics are a positive advantage instead of being grudgingly accepted because there is nothing better. Lateral transistors have low beta gain—up to about two—and are normally used only when a pnp transistor is absolutely necessary on the same chip with npn transistors.

The AEE men make use of the alpha gain and in particular the differential current gain between a single emitter and two collectors. The transistor uses an n-type substrate, and two p-on-p^+ collectors in the form of rings. The rings have an inside diameter of 50 microns, an outside diameter of 70 microns, and a center-to-center distance of 100 microns. The emitter, a 23-micron dot inside one ring, is also of p-on-p^+ material. Hence one collector is much further from the emitter than the other. This physical difference results in a big difference in alpha gain.

The collector nearest the emitter has a current gain of around 0.7, while the remote one has a gain of around 0.001. This differential current gain—roughly on the order of one to 1,000—is maintained over a current range of more than 1 million to one.

Connection. The current from the ionization chamber is fed into the remote, low-gain collector. The lead from the ionization chamber also connects to the emitter through an amplifier, to ensure the current goes to the collector. The input current generates a logarithmic current in the second collector which is fed to the input of the meter-drive amplifier. Because the meter-drive current is now three orders of magnitude greater than the ionization current, it is much easier to measure.

The lateral transistor is easily made by diffusion on a p-channel enhancement MOS transistor production line. Though several manufacturers are interested in licenses, Fowler thinks that even more interest will be shown when the transistor has been developed to accommodate differential gains of 10,000 or 100,000 to one—one or two more orders of magnitude better than the present devices. Fowler is now working to overcome one limitation of the approach. With present transistors, the relation between the two collectors is not absolutely linear and some errors creep in when the ionization current is very low and the output gain more than 1,000 to one.

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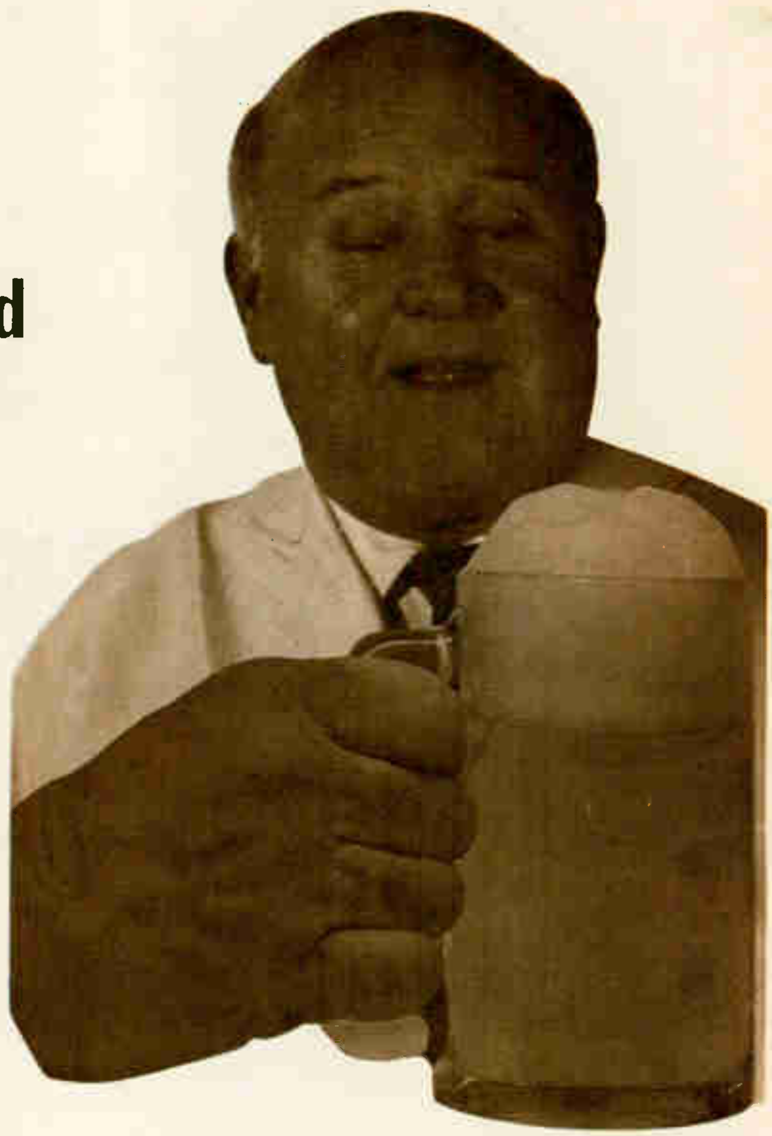

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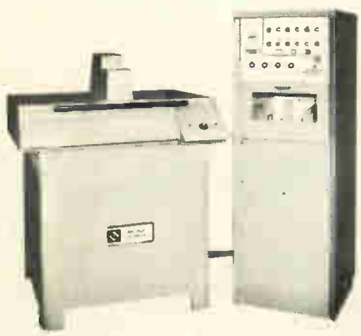

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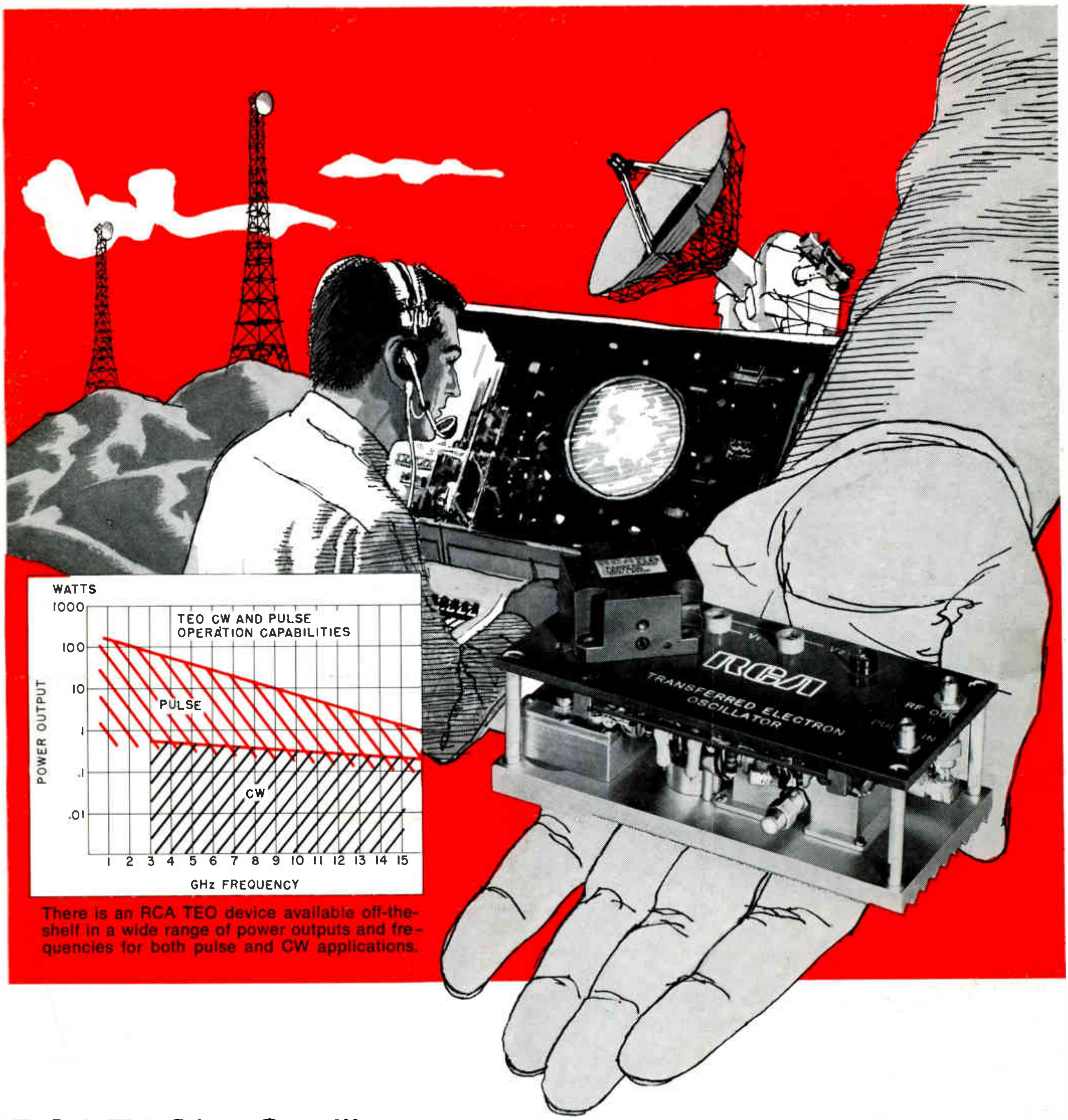

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