Software patents pro and con 96
Space needs revive color-wheel tv 114
Navy gets new airfaring watchdog 133

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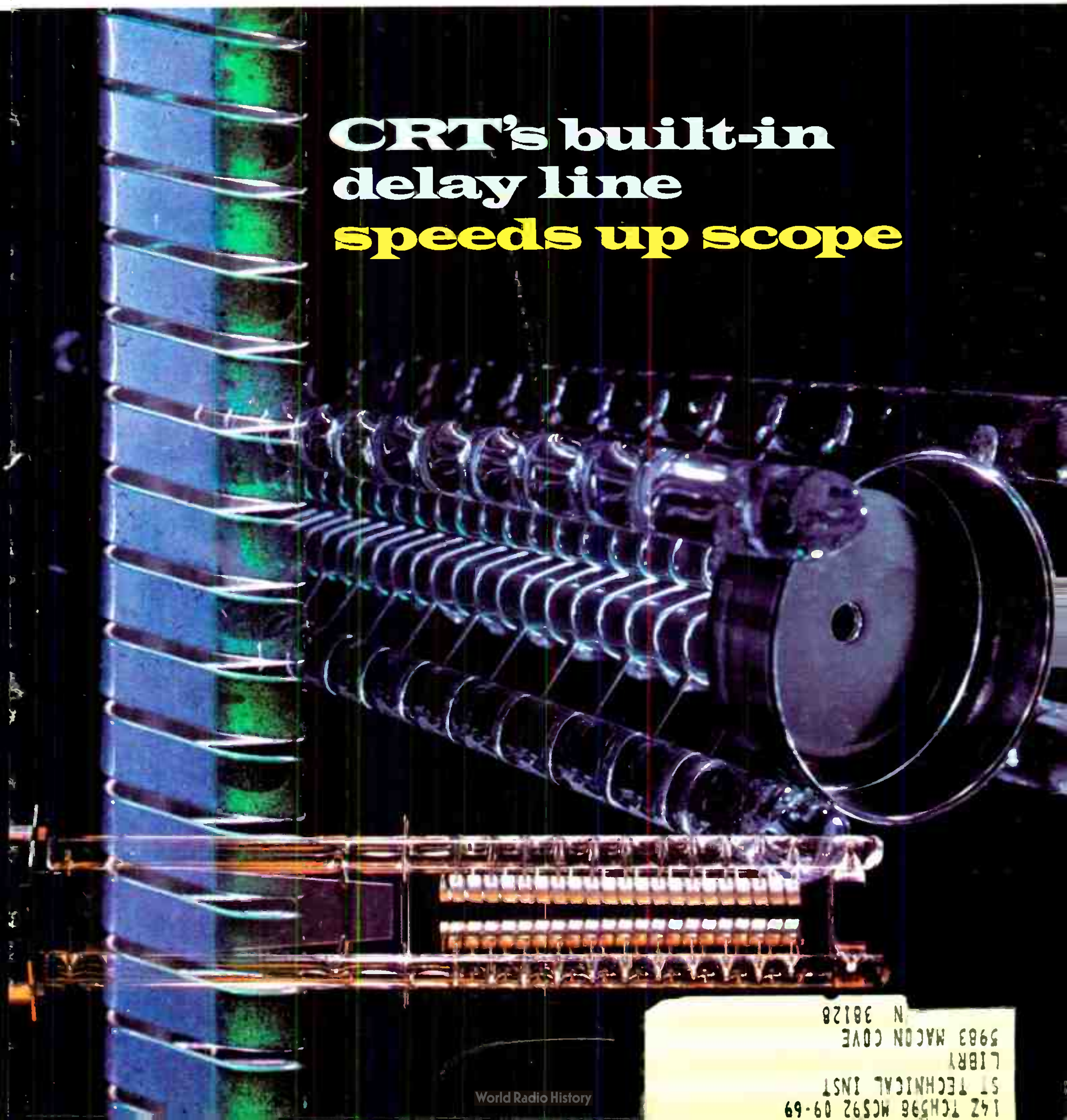
July 7, 1969

Electronics®



CRT's built-in delay line speeds up scope

Our singularly accurate transistor noise analyzer tells you the whole story

The singular advantage of Hewlett-Packard's new 4470A is its inherent ability to read out transistor noise voltage (e_n), noise current (i_n) and noise figure (NF), accurate to better than ±1 dB. And when you tie these factors into one neat package, you end up with the most complete noise performance story ever told. Unless you want accuracy an order of magnitude greater by calculating your measurements with e_n and i_n.

The 4470A was designed for accuracy and convenience in laboratory, for incoming device inspection and for QC testing applications on FET and bipolar transistors. Yet the analyzer is simple enough to be used by production personnel.

Measurements are made at 4 Hz bandwidths, for precise checks at 11 spot frequencies between 10 Hz and 1 MHz. Noise figure is read directly in dB, using conveniently applied external or internal source resistances.

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Find out more about the simplicity of measuring transistor noise from your HP field engineer or write to Hewlett-Packard, Palo Alto, Calif. 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

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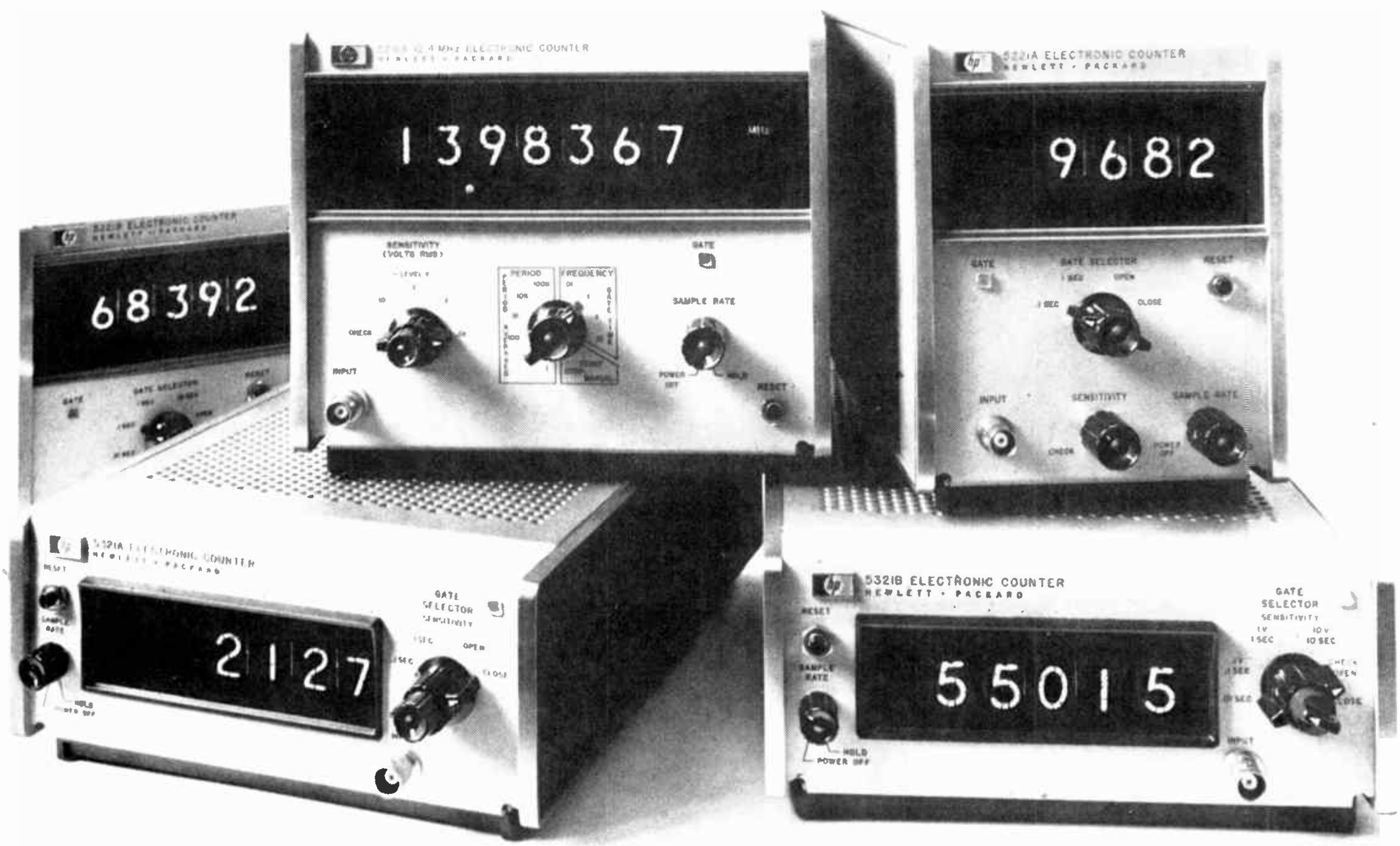

Electronics

Volume No. 42 Number 14 July 7, 1969

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U.S. Reports

Electronics International

New Products

Technical Articles

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Readers Comment

Quite a big byte

To the Editor:

The article on rotating disks and drums [May 26, p. 96] makes a rather misleading statement about Vermont Research's 4.2-megabit drum memory. It has a bit transfer rate of 1.8 megahertz or 225 kilobytes per second—rather than the 225 bytes per second quoted in the article.

Also let me point out that our 8-megabyte drum is available in either bit serial or byte serial configurations with eight read-write amplifiers. The eight-bit parallel format at 2.0-megahertz clock rate gives us a 2 megabytes per second or 16 megabits per second data transfer rate, deskewed and self-clocked.

Please also note that the illustration of the flying head action on page 98 shows the single-reed mounting that is unique to Vermont Research products.

George Marchyshyn
R&D department
Vermont Research Corp.
North Springfield, Ver.

Not the only system

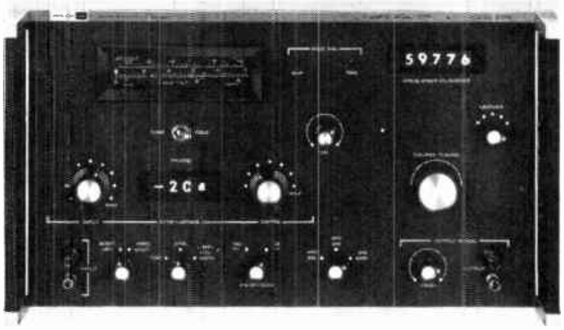
To the Editor:

I noted with great interest the article on pay tv [May 26, p. 123]. While I believe that the report is quite informative, it may give the reader the impression that the Zenith system is the only system under consideration by the FCC. It is my understanding that five organizations submitted to the commission technical details on systems which fall within the FCC definition of subscription television. They are the International Telemeter Corp., Kahn Research Laboratories Inc., the Skiatron Electronics & Television Corp., TeleGlobe Pay-TV System Inc., and Zenith.

No one questions the fact that Zenith has done important pioneering work in this field. However, all of the competitive systems have advantages and disadvantages. Therefore, the statement, "Nor have two or more approaches been vying for acceptance, as was the case with

This Sierra L-F wave analyzer costs $2,295.

(For about the same money, others can give you a fraction of its accuracy: ±3 Hz).



(...and about half its range of 20 Hz to 110 kHz)

Short of spending another $2,000, you cannot buy the accuracy of a Model 301B L-F Wave Analyzer. Nor its broad tunable coverage of the low-frequency spectrum. Nor its convenience and all-around usefulness.

Consider, for example, the benefits of up-to-date readout techniques. Model 301B displays tuned frequency on a five-digit counter, driven by solid-state circuitry. A second digital display presents the algebraic sum of the two attenuator settings, doing away with calculations. A lighted pointer on direct-projected meter scales gives you parallax-free readings of voltage and dBm.

As a wide-range wave analyzer, Model 301B delivers precise data on individual components of complex signals. You can accurately measure fundamental frequencies, harmonic voltages, intermodulation products, and other noise and signal voltages too small to be indicated by other means.

Built-in signal generator

By looping pulse outputs back to the 301B input, you can produce a harmonic signal every 100 Hz or 1 kHz (READ or TUNE position). A built-in 1-MHz clock frequency assures the accuracy of all generated pulse harmonic frequencies in this mode. By tuning the set to any harmonic frequency and locking on AFC, you can operate it as a frequency synthesizer throughout the entire range. In this function, it provides a restored signal of high frequency accuracy at the restored output terminals.

Among other Model 301B features: dual-selectable bandwidths of 10 and 100 Hz; a meter recording output; an optional bridging line transformer (Model 129-600) that makes measurements of true dBm on 600-ohm lines possible with only 0.1 dB bridging loss.

Product File 369 discloses everything about this remarkable economic development. Write Philco-Ford, 3885 Bohannon Drive, Menlo Park, California 94025. Or call (415) 322-7222, ext 329.

SUMMARY SPECIFICATIONS

Frequency	
Range	20 Hz to 110 kHz
Accuracy	(20 Hz to 110 kHz) 1 Hz ambiguity, ±2 Hz error
Input Level Range	
Voltage (Full scale)	30μv to 300 v in 1, 3, 10, 30 sequences
dBm (ref 600-ohm line and 0 dB on meter scale)	+50 to −90
Input Level Accuracy	±0.5 dB
Selectivity	
Narrowband	10 Hz (6-dB points) 60 Hz (60-dB points)
Wideband	100 Hz (6-dB points) 500 Hz (60-dB points)

PHILCO Ford

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Readers Comment

color television," may be misunderstood by your readers.

It is our belief that our patented system is a practical and inexpensive means for providing the public with subscription television. Since decoding equipment cost is a major factor in this field we believe that serious consideration of our proposal will be given by the commission. This system is also free of the problem of aircraft flutter which creates objectionable time delays in picture synchronization in at least one of the proposed systems.

Leonard R. Kahn
President
Kahn Research Laboratories Inc.
Freeport, N.Y.

■ No slight was intended by the omission of other companies vying for the pay-tv market. Zenith, however, is perhaps furthest down the road thanks to the Hartford experiment and is generally acknowledged as the leader. As things now stand, Zenith's Phonevision system will probably be the first to go on the air.

Standards and style

To the Editor:

I am sure you want your magazine to be as error-free as possible, and I am also sure that you will agree that it is important and desirable to adhere as closely as possible to any recognized national standards that may be applicable.

For these reasons I am writing to draw to your attention a number of "errors" that crept into the May 26 issue. This not a complete list, but a few examples only.

Reference designations: (USAS Y32.16) on page 91, D should be CR; the numbers are not subscripts, i.e. R3 not R_3.

Unit symbols: (USAS Y10.19) on page 91, μf should be μF; on page 107, hz should be HZ, and w should be W.

Graphic symbols: (USAS Y32.2) on page 107, voltage regulator diode—see item 8.5.6.1.

I might also point out, with reference to the schematic diagram on page 107 that the diode type number should be 1N4003 not IN4003.

Sidney V. Soanes
Ferranti-Packard Ltd.
Toronto, Canada

■ Mr. Soanes is a member of the IEEE standards coordinating committee for letter and graphic symbols (SCC11), and his points are well taken. However, Electronics uses a style guide set by typographical and aesthetic considerations as well as by recognized committee-set standards. Standards are ignored if we feel that we are communicating better without them. In general, we prefer lower case letters to the upper case letters shown in Mr. Soanes' letter. We feel that a single letter designation is better than a double letter configuration. He is correct on the 1N4003, and on symbols for devices; both were lapses on our part.

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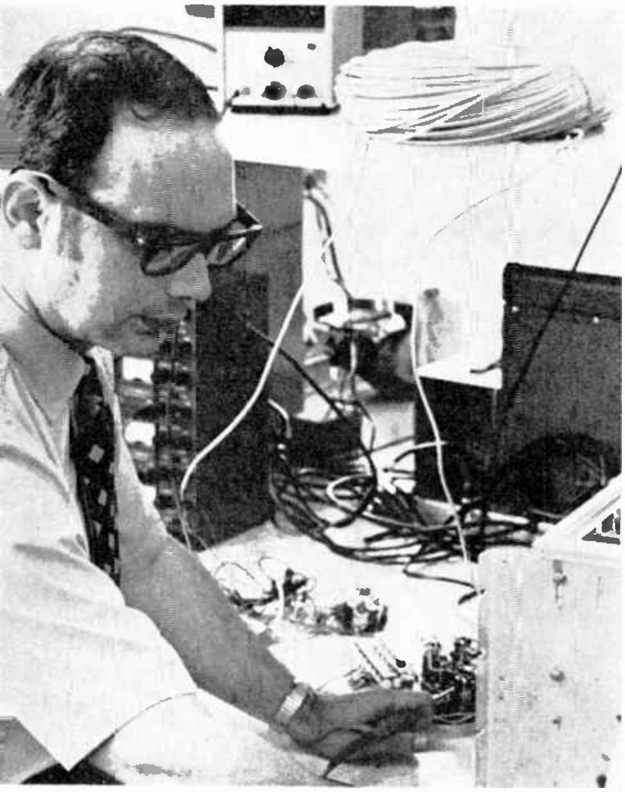
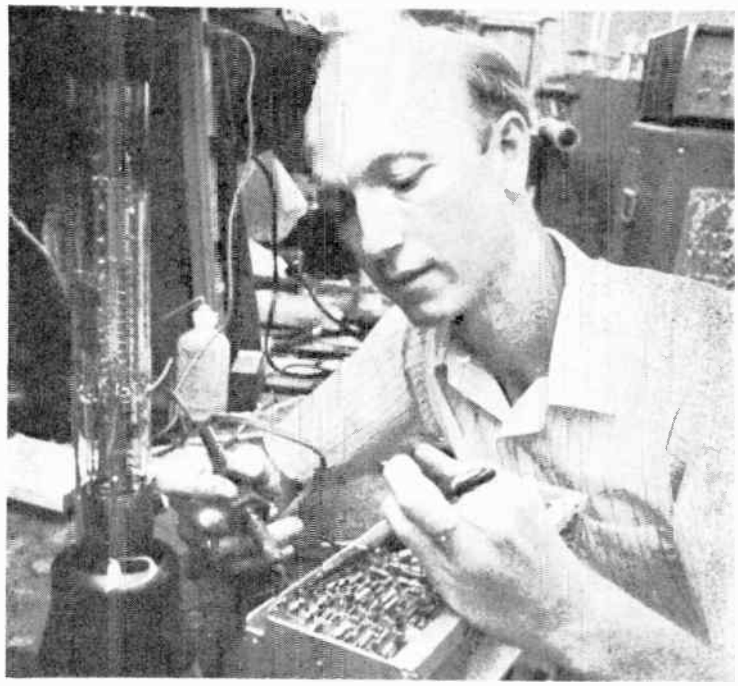
Who's Who in this issue



Aaronson

While working on communications equipment at RCA, Gerald Aaronson, who wrote the article on gyrators (page 118), turned to active filters. Now with General Telephone & Electronics Laboratories, he's doing R&D in switch-network remote access computer terminals and telephone systems. Aaronson holds a master's degree from Brooklyn Polytechnic Institute.



DeVilbiss

"A man for all frequencies" is how one co-worker classifies Alan J. DeVilbiss, author of the cover story on the 250-Mhz scope that begins on page 90. Before joining Hewlett-Packard in 1965, where he helped design the IC's, vertical amplifier, and crt for the company's model 183, DeVilbiss was with NASA's Jet Propulsion Lab. He holds a bachelor's degree from Louisiana Polytechnic Institute and an M.S. from Cal Tech.

Rackman

Now in private patent practice in New York City, attorney Michael I. Rackman has been interested in the question of providing computer programs with protection since the early 1960's when he was at Bell Labs. Co-author of the article on patenting software (page 96), he holds an LL.B. from New York University and an M.S.E.E. from Columbia.

Popper

Versatile Howard R. Popper, co-author of the article on patenting software (page 96), has been a working engineer as well as a practicing lawyer. He won a B.S. from Rensselaer Polytechnic Institute in 1952, later earning an LL.B. from Brooklyn Law School. A Navy veteran, he served as an assistant ship superintendent of navigational electronics.

Circle 11 on reader service card →

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2N5067-69	2N5319	
2N5732	2N5731	
2N5734		

TO-66	TO-63	TO-59
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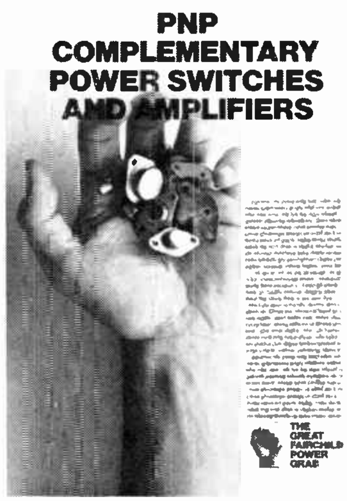
AUGUST



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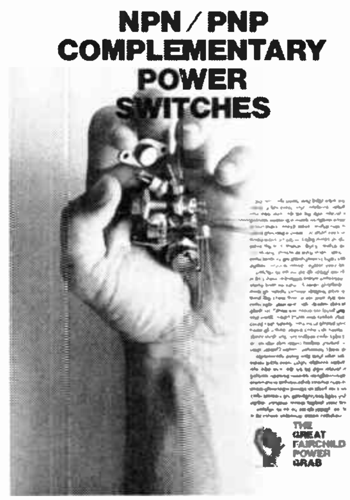
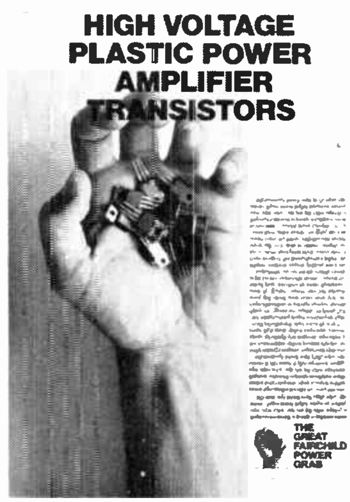


OCTOBER

NOVEMBER



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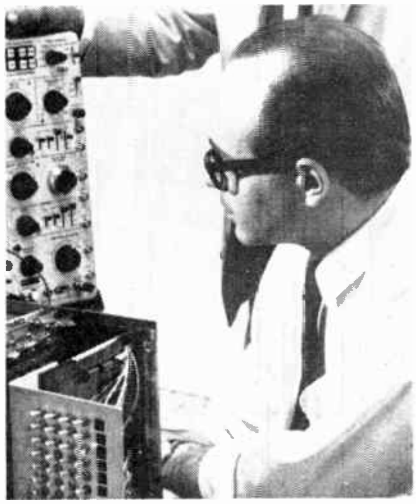
THE GREAT FAIRCHILD POWER GRAB

Who's who in electronics



Dinman

"You might call it a product of frustration," says Saul Dinman about the GRI-909 industrial and process control computer. Dinman is the vice president and chief engineer of GR Industries of Newton, Mass., and the computer is the company's first major product.

But it's been coming for a long time. Dinman first worked on computers at RCA in the late 1950's. "After a short stint on missile guidance systems, I worked on the 110, one of the earliest industrial computers," he recalls. "Those were cutthroat days; everyone was in the act and every order was for a custom installation." To ease the competitive stress which was to drive many companies out of the market by the 1960's, RCA formed a joint venture with the Foxboro Co.; "Foxboro did systems marketing while RCA handled software and interfacing with the 110. Once the work on the 110 was finished I found myself spending almost full time on interfacing," says Dinman. When the venture was dissolved Dinman left for Foxboro along with most of RCA's industrial computer systems personnel. With them went a license to make the 110 and its associated electronics.

The way it crumbles. But Dinman tried other computers too; his first systems task was the automation of a cookie dough line with a Digital Equipment Corp. PDP-4. Dinman was program manager for the contract which eventually covered a system for closed loop control of 13 separate batch processes.

He soon began taking stock of his lessons with the 110 and PDP-4. "Every control system demanded new interfacing," he says, "But the computer always remained the same. It was hard to make a buck in fixed-price custom systems, so we tried to save money by building more flexibility into the interfacing electronics. We tried to reduce all control functions to a denominator which the computer could handle in a common way. Thus, we could save on software, and on some hardware too in the long run." The solution was a generalized input-output technique and a so-called bus buffer box to make data structures similar throughout a system.

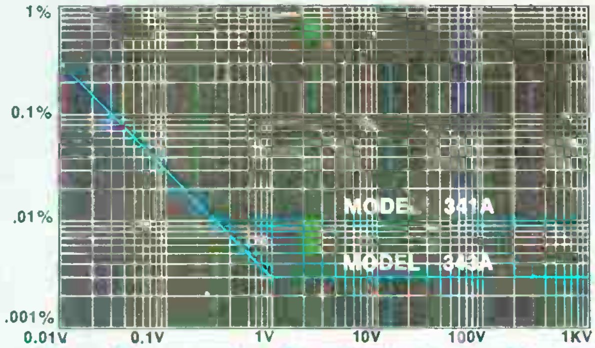
Dinman left Foxboro for DEC in early 1969, where he was put in charge of logic modules. At DEC, Dinman came up with the PDP-8S after DEC president Ken Olsen said, "It would be nice to have an under-$10,000 computer."

Familiar road. Though the 8S succeeded beyond expectations, Dinman was forced to concentrate on his module line. Nor was he able to include in the 8S or any other computer his ideas on software and 110 flexibility. Taking a route followed by many frustrated engineers, Dinman left DEC to form his own company with Samuel Ochlus as partner and president.

Now, after only about 18 months in business, the company is advertising a computer "like none you have ever seen before"—the $3,600 GRI-909 where course and destination buses extend right into the machine's internal architecture. This makes all external and internal parts of a system directly addressable in a language tailored to the user rather than the programer.

"Things were going so well that I actually began to think of trying something different," says Burton J. McMurtry, the man who put Sylvania Electric Products into the

What price performance? Not much. These two new solid state DC Calibrators have been designed to satisfy both performance-minded engineers and their budget-battered bosses. Both of these fine instruments offer the kind of specs that will cost you up to fifty percent more elsewhere—and still not give you the performance you always get when the Fluke name goes on the front panel. Check them out.



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Model 343A. Here's a calibrator equal in resolution (0.1 ppm) to the most expensive instrument on the market in only 3½" of panel space. Price is $1695 for an absolute accuracy of 0.003% over a 0 to 1100 volt range. Stability is 0.0005%/hour. Quick amplifier response provides an output within 25 ppm five seconds after any range or setting change. Four-terminal floating output is featured. Current is automatically limited at any preset level between 1 ma and 30 ma. Line and load regulation are 0.0005% of setting. Shock, vibration, and altitude specs of MIL-T-21200 are met. The Model 343A is housed in an attractive package for bench use and rack mounting weighing 23 pounds.

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MODEL 343A DC Calibrator

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

Who's who in electronics

electro-optics business. He left Sylvania on June 30 after 12 years—though he will serve as a consultant—to enter the venture capital business.

"I felt a great sense of accomplishment," McMurtry adds, "but my interests have always been very strong in new areas. And I'm going into something which is completely new for me and has a greater breadth than just optics."

McMurtry will take none of his Mountain View, Calif., staff with him. In fact, he says, he had a major influence in picking Kenneth L. Brinkman as his successor.

Four hunters. McMurtry will be joining three others in the capital venture business: Jack Melchor, one of the founders of Hewlett-Packard Associates and former general manager of H-P's data acquisitions division; Donald Smith, former division general manager of H-P associates; and Lowell Morse, a bay area businessman.

They will be evaluating opportunities to finance the application of new technology across the entire electronics field. In some cases, the group will finance a new company; in other instances, it will back expansion of established firms.

"We won't be avoiding lasers," notes McMurtry, "but they won't be our prime thrust, either."

McMurtry, 34, started with Sylvania in 1957 in the microwave tube division while a graduate student at Stanford University. Studying under A. E. Siegman at Stanford, he worked with high-speed photo-detectors and ruby lasers.

System approach. After receiving his doctorate, he formed Sylvania's first R&D group in electro-optics in 1961. Under his direction the group grew, and in 1964 it was transferred into the company's system division.

McMurtry became general manager of the electro-optics operation when it was split away as a separate entity with its own management and marketing team. Since its separation, its management staff has grown from 35 to 85, sales have climbed substantially, and the projections appear rosy.

This new "4th generation"
I-C plug-in counter/timer
Outperforms all others...

And will for years to come!

Why compromise for less? The Model 1500A has a main frame counting range from dc to 125 MHz (to 3 GHz with a single plug-in). This instrument is fully programmable, has provision for external time base up to 10 MHz, and many other significant features, including the well recognized advantages of Monsanto's "4th generation" 90% integrated circuit design.

Shown above is the Model 1104B 3 GHz frequency converter plug-in. Also available: Model 1100A uncommitted plug-in; Model 1101A 500 MHz prescale plug-in; Model 1102A 6-digit preset plug-in; Model 1103A 500 MHz frequency converter plug-in; Model 1107A time interval plug-in; Model 1201A DVM plug-in.

Unparalleled performance plus award-winning design make the Model 1500A the ultimate counter for the no-compromise engineer. The price for the main frame is $2850.00, FOB West Caldwell, N. J. Other models of the 1500 Series offering a wide selection of features and capabilities begin at $1800.00.

Most engineers take Monsanto's reliability for granted because of our 2-year warranty. But, just in case, we maintain 37 Service Centers located strategically throughout the United states and overseas.

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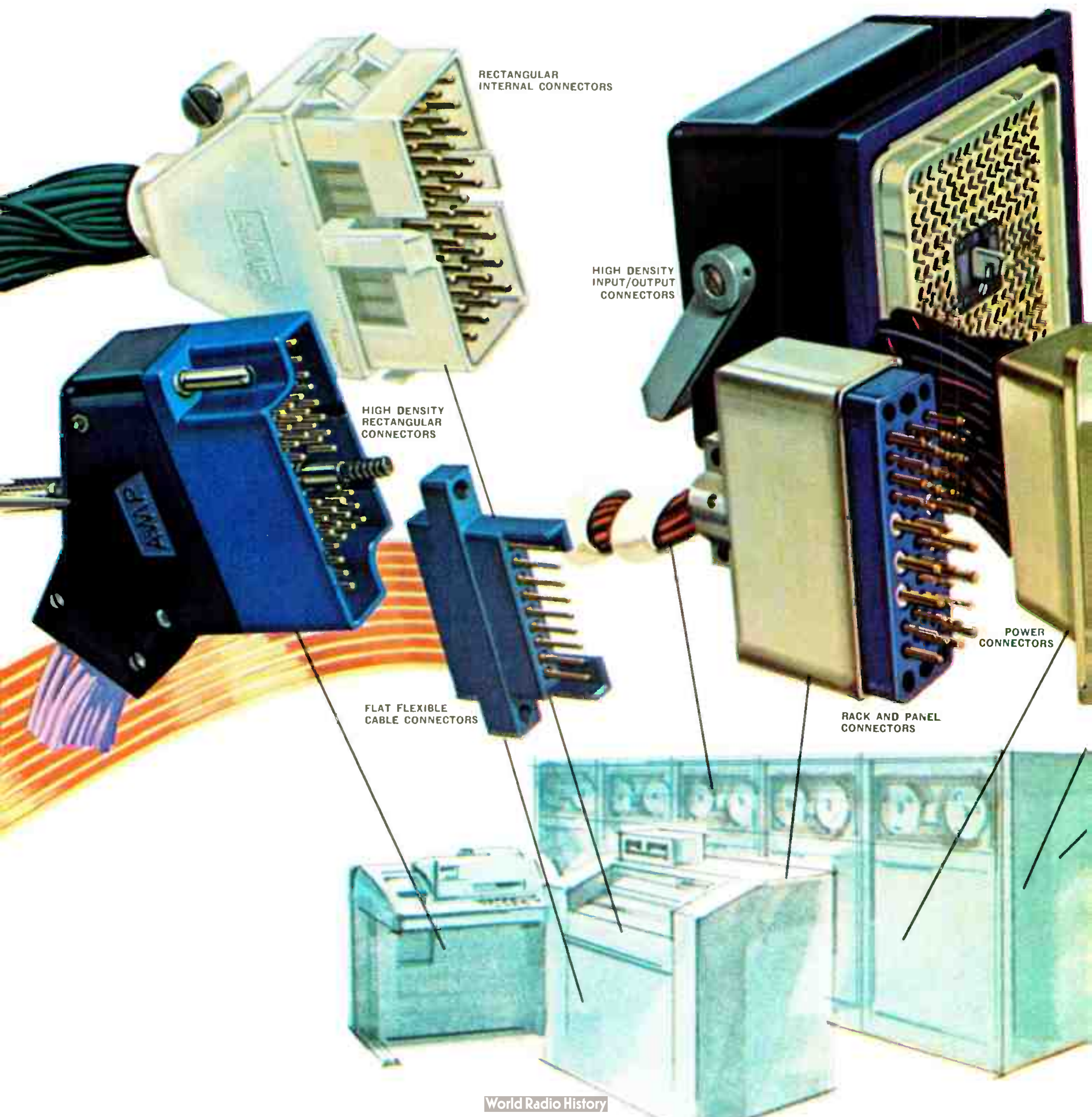

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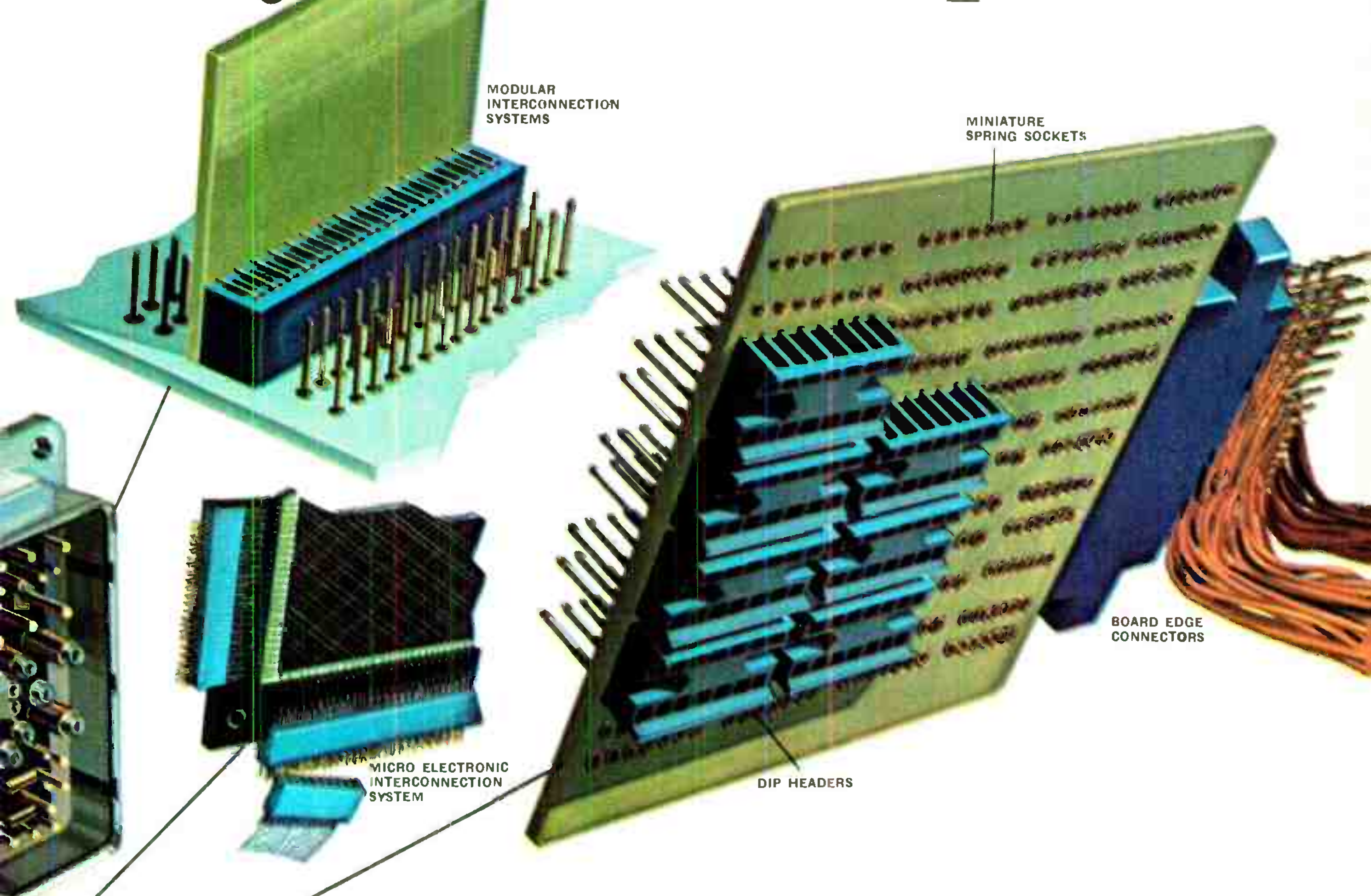

A line so complete it's never complete. We have the broadest line of connector and interconnection techniques for computers and peripheral equipment in the world. And we can design new ones to fit your ever changing needs.

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Anacondability—our name for the total corporate capabilities of Anaconda—does a lot to generate new application ideas for high conductivity coppermetals.

To assist in the selection of the right copper in the proper form and size for a specific job, Anaconda electrical conductivity specialists stand ready to spell out solutions to problems with the most complete line of rigid conductors in the industry.

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Got a special sort of a problem in electrical conductivity? You'll find the answer in Anacondability—the unique combination of copper technology, production know-how and customer service that distinguishes Anaconda coppermetals from all others.

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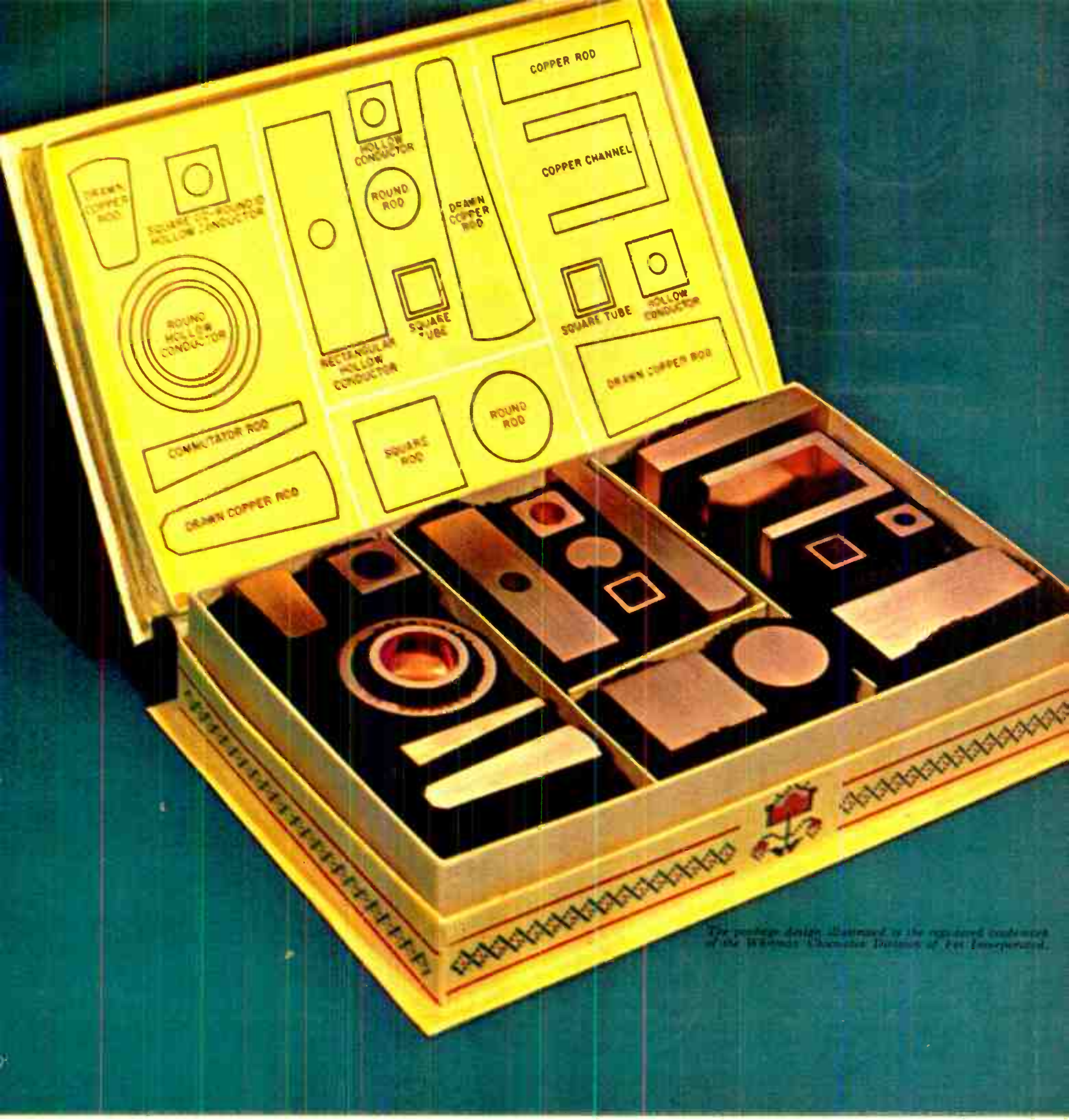

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For technical information send for Publications C-25, D-8, TP-56 covering these products. Write to: Anaconda American Brass Company, 414 Meadow Street, Waterbury, Connecticut 06720. In Canada: Anaconda American Brass Limited, Ontario.

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Meetings

Medicine men face hard times

At many engineering conferences, more can be learned in the hotel lobby, bar, and dining room than at the technical sessions because what's said from behind a rostrum is generally sugar coated. This should be especially true in Chicago from July 19 through 25 at the concurrent International Conference on Medical and Biological Engineering, and the Conference on Engineering in Medicine and Biology.

For one thing, many of the attendees don't know where their next dollar is coming from, though they know it's not likely to come from the National Institutes of Health. Washington's economy drive is hitting NIH hard, and a lot of new and expanded projects will go begging. The most optimistic outlook is that NIH will have a "holding" budget until the war is over.

Danger. Another problem facing engineers in medicine, one that's the subject of increased questioning, is the safety of medical instrumentation. And the questions will be asked at the conference, most likely at the two instrumentation sessions chaired by the Illinois Institute of Technology's William Reynolds and NIH's Dr. Robert Bowman, and at the patient-monitoring session to be conducted by Northwestern University's Dr. F. J. Lewis.

The IEEE hasn't been able to standardize medical instrumentation, let alone set safety standards. In fact, the Association for the Advancement of Medical Instrumentation (AAMI, pronounced Amy), formed a few years ago to try to bring some standardization to the field, this year for the first time will be one of the sponsors of the conference.

The best-attended sessions will probably be the two dealing with artificial organs. They have the stars: Dr. Michael DeBakey will lead one, Dr. Adrian Kantrowitz the other.

An unusual feature will be the plenary session on Wednesday. The afternoon meeting will have sections on engineering in surgery, oceanography, and the delivery of health services.

For information contact IEEE, 345 East 47 St., New York, N. Y.

Calendar

Conference on Measurement Education, IEE; University of Warwick, Warwickshire, England; **July 8-10.**

Conference on Nuclear and Space Radiation Effects, IEEE; Pennsylvania State University, University Park, Pa.; **July 8-11.**

International Conference on Medical and Biological Engineering, International Federation for Medical and Biological Engineering, Joint Committee on Engineering in Medicine and Biology, IEEE, Instrument Society of America, American Society of Mechanical Engineers, American Institute of Chemical Engineers; Palmer House, Chicago; **July 19-25.**

Annual Conference on Engineering in Medicine and Biology, International Federation for Medical and Biological Engineering, Joint Committee on Engineering in Medicine and Biology, IEEE, Instrument Society of America, American Society of Mechanical Engineers, American Institute of Chemical Engineers; Palmer House, Chicago; **July 19-25.**

Conference on Instrumentation Science, Instrument Society of America; Hobart and William Smith College, Geneva, N.Y.; **July 28-Aug. 1.**

Seminar on Case Studies in System Control, IEEE; University of Colorado, Boulder; **Aug. 4.**

Joint Automatic Control Conference, IEEE; University of Colorado, Boulder, Colo.; **Aug. 5-7.**

Third Annual Contemporary Filter Design Seminar, University of Missouri, Columbia, Mo.; **Aug. 5-8.**

(Continued on p. 24)

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proximately 1½ times actual size

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olerances: ±1.0% to ±0.01%
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emp. Coef.: to ±5 ppm/°C
oad Life (Full load for 1000 hr 125°C): 0.2% maximum change

Ladder Networks

Full Scale Accuracy: 10 bits or less, better than ±¼ least significant bit. More than 10 bits, better than ±½ least significant bit.
Frequency Response: Less than 100 nanosecond rise time or settling time
Temp. Coef.: Less than 10 ppm/°C
Temperature Range: −65°C to +175°C

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Meetings

(Continued from p. 22)

International Photoconductivity Conference; Stanford University, Palo Alto, Calif.; **Aug. 12-15.**

Western Electronic Show & Convention (Wescon), IEEE; Cow Palace & San Francisco Hilton Hotel, San Francisco; **Aug. 19-21.**

Symposium on Programing Languages Definition, Association for Computing Machinery; San Francisco; **Aug. 24-25.**

Defects in Electronic Materials for Devices, Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers; Statler-Hilton Hotel, Boston; **Aug. 24-27.**

ACM National Conference and Exposition, Association for Computing Machinery; San Francisco Civic Center; **Aug. 26-28.**

Cornell Biennial Conference on Engineering Applications of Electronic Phenomena, IEEE; Cornell University, Ithaca, N. Y.; **Aug. 26-28.**

Education and Training Technology International Convention, IEE; London, England; **Sept. 2-6.**

Electrical Insulation Conference, IEEE; Sheraton-Boston Hotel & War Memorial Auditorium, Boston; **Sept. 7-11.**

European Microwave Conference, IEE; **International Symposium on Man-Machine Systems,** IEE; St. John's College, Cambridge, England; **Sept. 8-12.**

Convention of the Society of Logistics Engineers; Cape Kennedy Hilton Hotel, Cape Canaveral, Fla.; **Sept. 9-10.**

Petroleum & Chemical Industry Tech. Conference, IEEE; Statler Hilton Hotel, Los Angeles; **Sept. 14-17.**

International Telemetry Conference, International Foundation for Telemetering, Sheraton Park Hotel, Washington, D.C.; **Sept. 15-17.**

Conference on Trunk Telecommunications by Guided Waves, IEE; London, England; **Sept. 15-17.**

Solid State Devices Conference, IEE; University of Exeter, Exeter, Devon, England; **Sept. 16-19.**

Symposium on the Biological Effects and Health Implications of Microwave Radiation, Biophysics Department of the Virginia Commonwealth University, Bureau of Radiological Health, Environmental Control Administration, and U.S. Public Health Service; Richmond Va., **Sept. 17-19.**

(Continued on p. 26)

New complementary NPN/PNP power transistors from GE

Color-molded to end assembly mix-up

Now available in volume from General Electric . . . two new 1-amp and 3-amp pairs of low-cost complementary power transistors. These NPN/PNP pairs feature low saturation voltage, excellent gain linearity and fast switching . . . all in a sensible package, at a sensible price.

GE's flat silicone-encapsulated power tab package is rugged enough to withstand hard use, and *with the new narrow leads (25 mils), can easily be formed to either TO-66 or TO-5 configurations.* To help eliminate NPN/PNP confusion during your assembly, each type is molded in distinctive color. No need for separate storage and production facilities for each type.

GE's new complementary power transistors are ideal for any class B audio application—everything from auto radios, tape players to televisions and stereo phonographs—from 3 to 20 watts output. These new NPN/PNP pairs are also well suited for use as drivers for higher power transistors, regulators, inverters, motor controls, lamp controls, solid-state relays, core drivers and many other applications.

The 2.1W P_T free air rating allows simple printed circuit board assembly with no additional heat sinking. With added heat sinking, as much as 12W power dissipation can be achieved. Performance at these levels is everything you'd expect from General Electric, leader in power semiconductors.

TYPE NUMBER new	D40D (NPN)	D41D (PNP)	D42C (NPN)	D43C (PNP)
previous	D28D	D31B	D27C	D27D
I_C (continuous)	1A		3A	
(peak)	1.5A		5A	
V_{CE} (sat.) Max.	0.5V @ 0.5A		0.5V @ 1A	
V_{CEO} (sus.)	30V, 45V and 60V		30V, 45V and 60V	
Total Power Dissipation				
Free air @ 25 C	1.25W		2.1W	
Tab @ 25 C	6.0W		12.0W	
h_{FE} (min.)	50 @ 0.1A/2V 10 @ 1A/2V		40 @ 0.2A/1V 20 @ 1A/1V*	
F_T (typ.)	60MHz		45MHz	

*Types available with h_{FE}=20 min. @ 2A/1V

For more information on these and other General Electric semiconductor products, call or write your GE sales engineer or distributor, or write General Electric Company, Section 220-72, 1 River Road, Schenectady, N.Y. 12305. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: Electronic Component Sales, IGE Export Division, 159 Madison Avenue, New York, N.Y. 10016.

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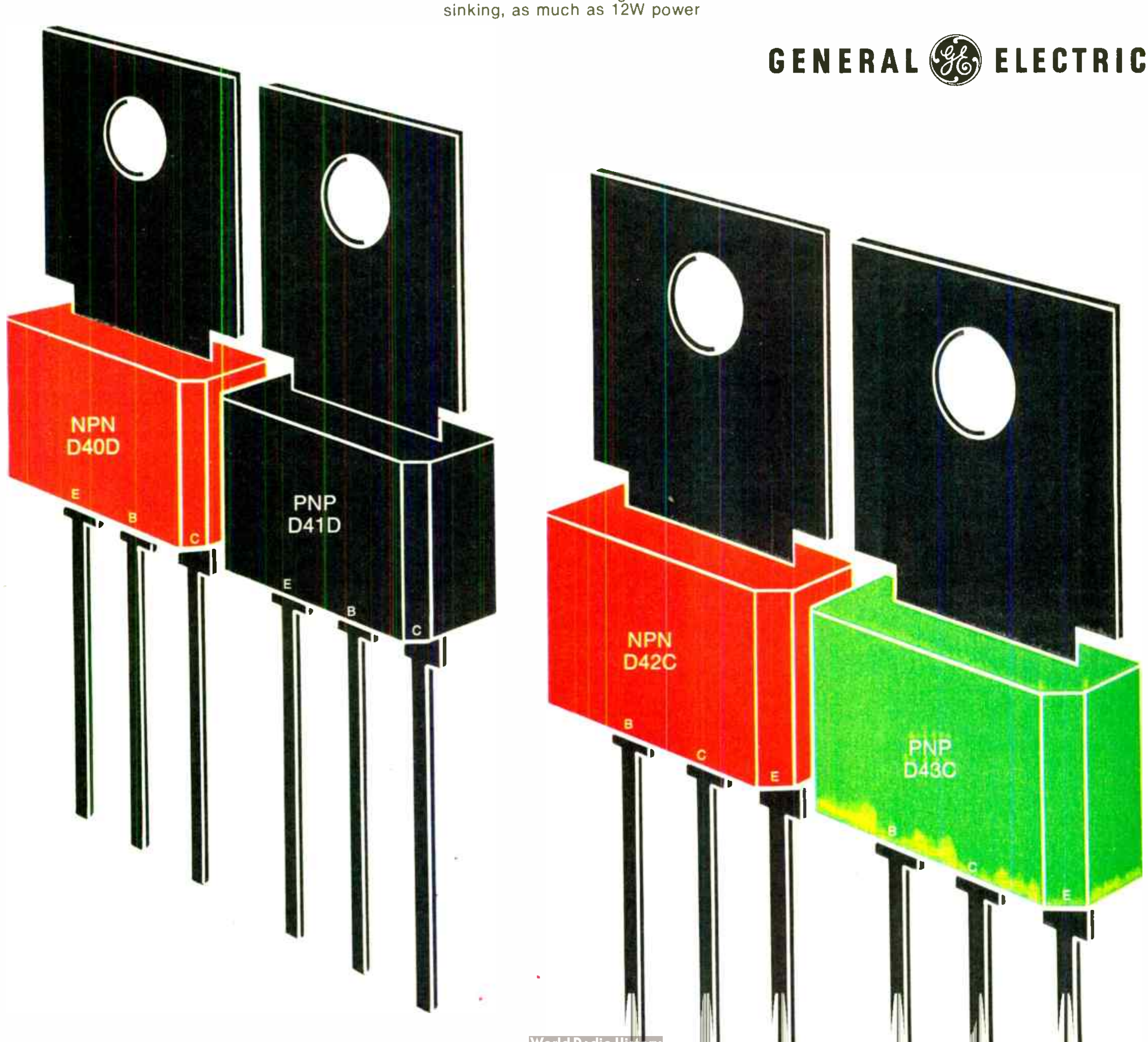

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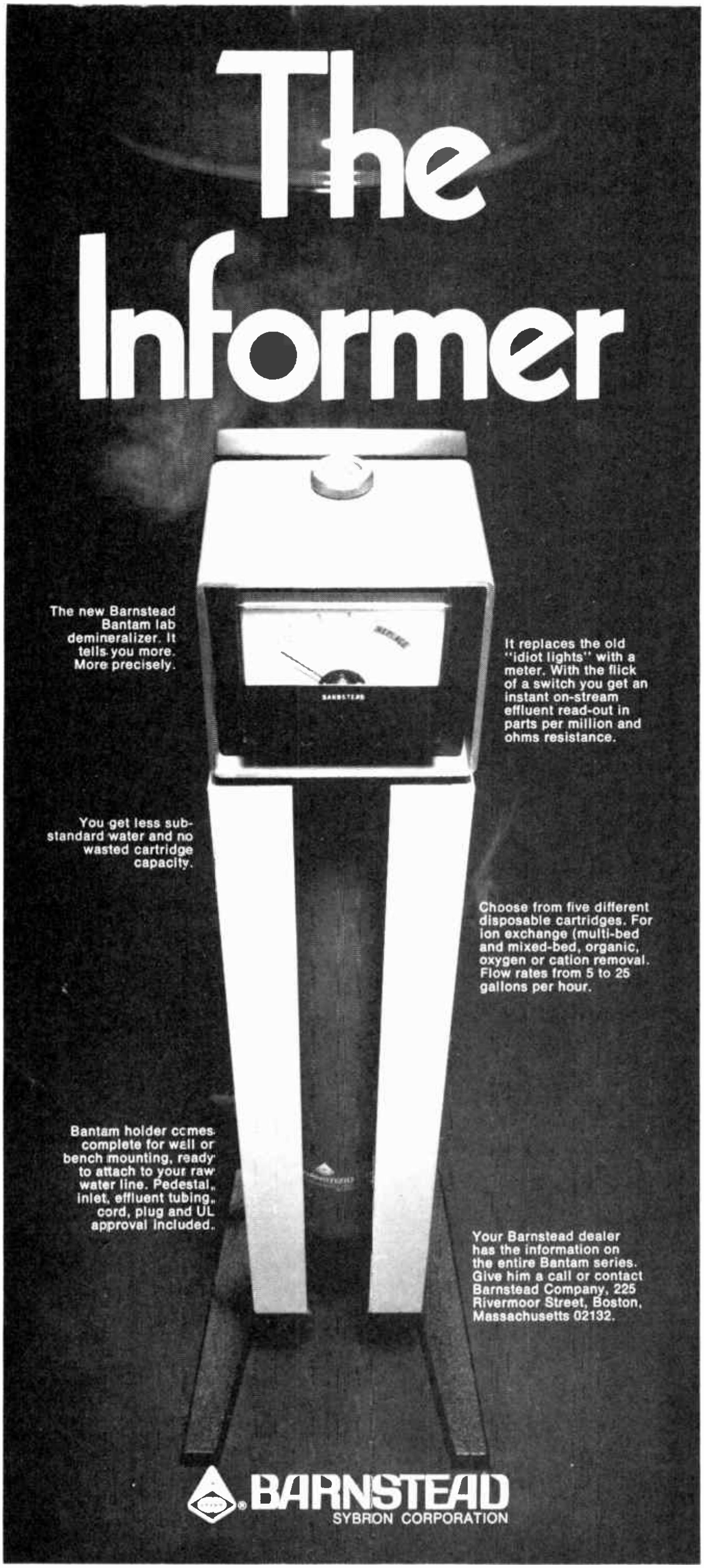

Meetings

(Continued from p. 24)

Annual Broadcasting Symposium, IEEE; Mayflower Hotel, Washington **Sept. 18-20.**

Joint Power Generation Conference, IEEE, American Society for Mechanical Engineers; Charlotte, N.C., **Sept. 21-25.**

Annual Intersociety Energy Conversion Engineering Conference, IEEE, American Society for Mechanical Engineers; Statler Hilton Hotel, Washington, **Sept. 21-26.**

Ultrasonics Symposium, IEEE; Chase Park Plaza Hotel, St. Louis, Mo., **Sept. 24-26.**

Annual Convention of the American Society for Information Science; San Francisco Hilton, San Francisco, **Oct. 1-5.**

Short courses

Introduction to Digital Logic, University of Wisconsin, Department of Engineering; **July 21-25.** $200 fee.

Modern Circuit Theory: Analysis, Synthesis and Computer Methods, University of California at Los Angeles; **July 21-Aug. 1.** $375 fee.

Radiation Effects on Semiconductors, University of California at Los Angeles; **July 21-Aug. 1.** $375 fee.

Photoelectronic Imaging Devices, University of Rhode Island, Department of Electrical Engineering; **July 28-Aug. 8.** $330 fee.

Call for papers

Symposium on Application of Magnetism in Bioengineering, IEEE, Magnetics Group, Israel Society for Biomedical Engineering; Dec. 9-11. **Aug. 15** is deadline for submission of abstracts to E.H. Frei, Weizmann Institute of Science, Rehovot, Israel.

Management and Economics in the Electronics Industry Symposium, IEE; Edinburgh, Scotland, March 17-20, 1970. **Abstracts should be submitted** to Conference Secretariat, Institution of Electrical Engineers, Savoy Place, London W.C. 2, England.

IEEE Transducer Conference; National Bureau of Standards, Washington, May 4-5, 1970. **Nov. 1** is deadline for submission of papers to Robert B. Spooner, IMPAC Instrument Service, 201 E. Carson St., Pittsburgh, Pa. 15219.

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JT connectors with rear-release crimp contacts have a lot of fans. Because they have lots of advantages. But there haven't been many ways to take advantage of these advantages. Until now.

Now, there are all kinds of ways to benefit from rear-release crimp contacts. Because Bendix is now putting them in all kinds of connectors: rectangular, cylindrical, printed-circuit, rack-and-panel. With fixed solder or filter contact options. With all kinds of shell types and sizes. With all kinds of insert patterns with 12-, 16-, 20-, 22- and 22D contacts. With high-density models with up to 128 contacts.

All to give you the opportunity to standardize. To ease operation, installation and maintenance problems in the field. To cut back on spares and application tools. And to reap all the benefits that have become traditional with Bendix JT connectors: compactness, light weight, reliability and long life.

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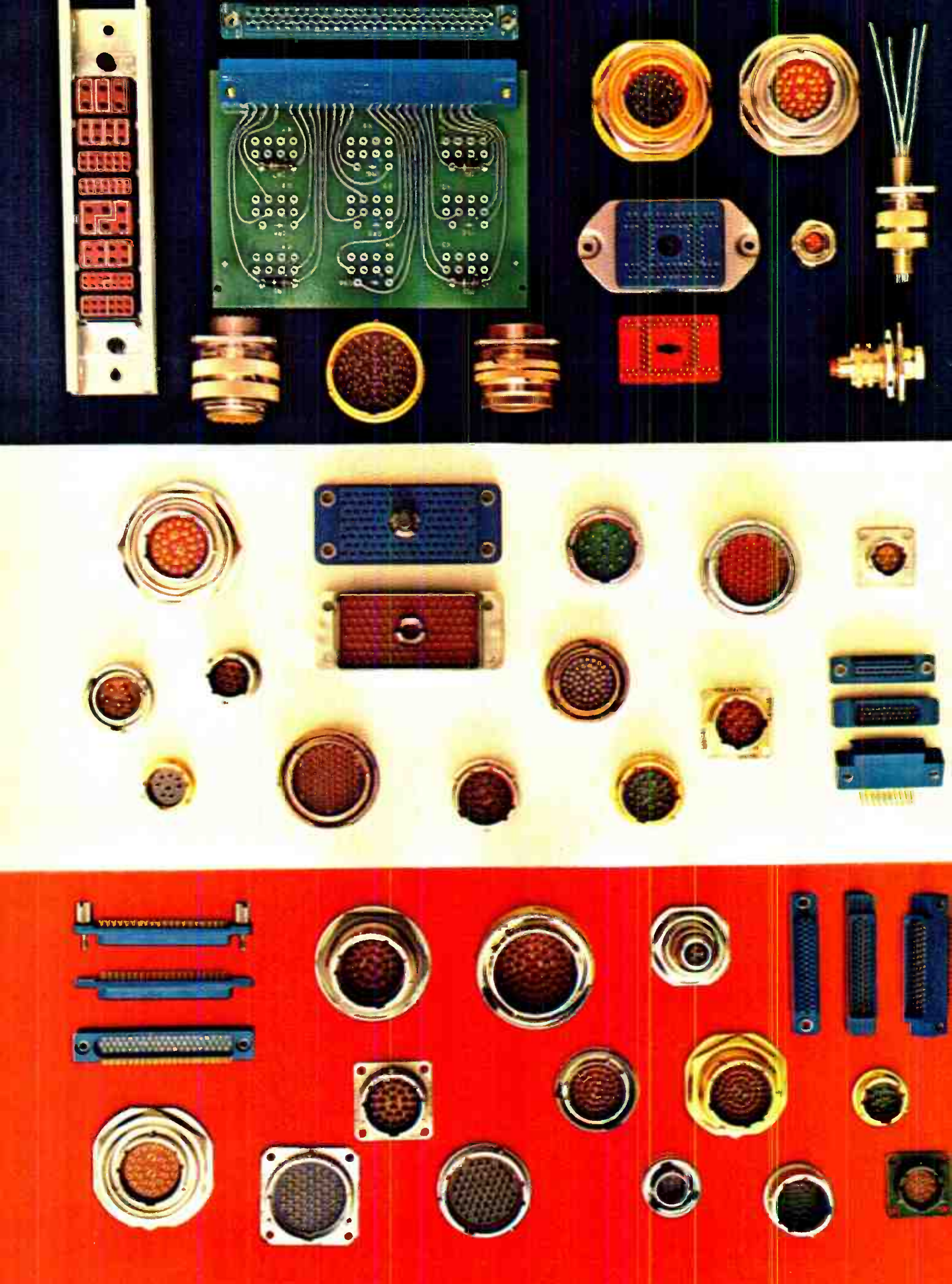

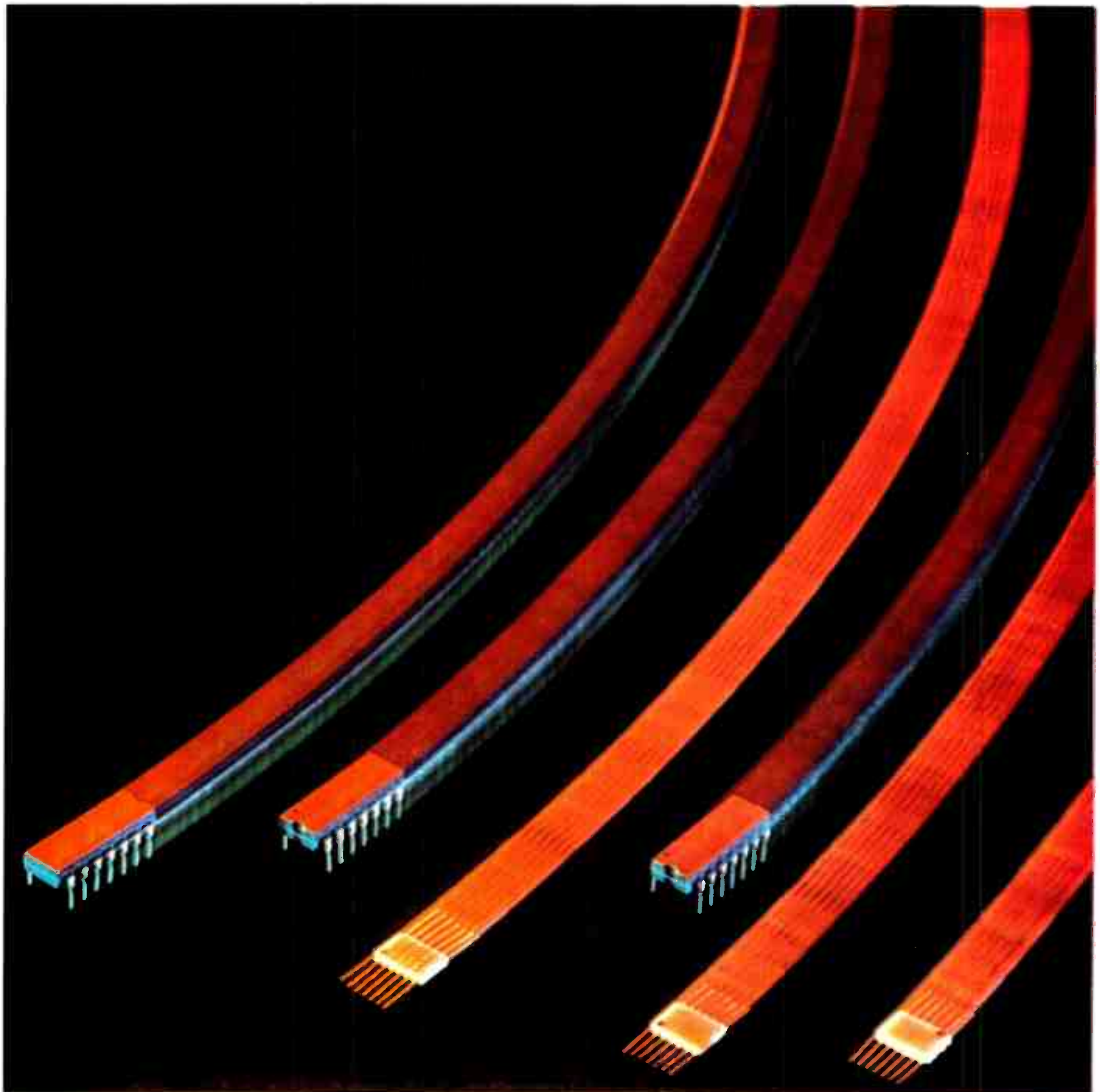

Sprague Digital ICs. Illustration: Series 54H/74H in flatpack and DIP

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Just about the fastest saturated logic circuits around. Series 54H/74H from Sprague. The whole family. Flip-flops and all.

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Series 54H	−55 to +125° C	
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Editorial comment

Great expectations . . .

It is beginning to dawn on some sections of the American public that technology per se cannot be blamed for critical social problems. Moreover, they're beginning to realize that most solutions call for manipulation of political, social, and economic factors, as well as technology. Nonetheless technology stands challenged, and the technologist does not always respond in a rational manner. He feels obligated to defend technology itself, oftentimes when what's really involved is unwise application—as, for example, to the wrong problem at the wrong time. There's also the possibility the engineer or the scientist may over-react, proposing advanced or unproven technology where it is not even required. In illustrating this point, William Harris, president of the Engineers Joint Council and director of technology at Battelle Memorial Institute, suggests that the vast majority of today's urban-crisis problems do not require the development of significant new technology; solutions, says Harris, are not research and science limited.

Just what is the role of research and development in today's complex society? One good answer is offered by Donald MacArthur, deputy director for research and technology, DDR&E. Research and development, says MacArthur, is in the "option-creating business." From among the options presented, society represented by government or industry must select a most favorable alternative. The technologist is rarely able to present the best singlehandedly. He needs help from the economist and from the social scientist. Not surprisingly, then, the skillful management of technology is a talent in great demand. As Ralph Siu, former deputy director of the National Institute of Law Enforcement, puts it, managers of technology and innovation are just as important as technical experts. Such executives must have the added dimension of "practical wisdom," Siu says. They must be excellent "impedance matchers," linking solutions to problems. Despite the recognition of these objectives, guidelines for the wise management of technology are hazy or nonexistent. A panel of scientists representing Federal agencies was recently asked this theoretical question: Where does responsibility rest in limiting the development and sale of a new device that might have deleterious effects on the human environment? The panel could not provide a simple clear answer.

The system for managing research and technology in the U.S. clearly requires an overhaul. What is needed is a revision at the national level, with particular attention paid to the role of the Federal Government in supporting the development of new technology and influencing its application to national goals.

. . . and a fourth dimension

Among the most interesting (and undoubtedly the most controversial) proposals made for revamping the way in which the U.S. sets its goals and then applies technology to their achievement is one calling for the establishment of a fourth branch of the Federal Government. The proposal was most recently and clearly set forth in a paper prepared by Nicholas Golovin, for years a member of the National Bureau of Standards staff. The paper was read to a recent meeting of the National Security Industrial Association.

The new body, to be called the evaluation branch, would probably require an amendment to the Constitution. A primary justification for the separate branch lies in its capacity to provide a heavy dose of objectivity in helping the country determine its goals and adjust priorities. Choices made by the body would be weighted in favor of the general welfare instead of special interests. Since its studies would not be controlled by the executive branch, lawmakers might be more favorably inclined to act on its recommendations. In effect, the new branch would serve as a "national information generator." It would operate as a "subsystem" within the system (the country) to evaluate its progress and generate "error signals." The new branch would include the country's leading analytical minds and would enjoy a status and neutrality on a par with that of the judicial branch.

The fourth branch is not the only alternative to providing an analysis and evaluation mechanism within the Federal Government. Others include an advisory citizens committee on goals and priorities and a cabinet-level department of science and technology. A Congressional subcommittee under the direction of Rep. Emilio Q. Daddario (D., Conn.) is presently examining these alternatives. Whether or not the idea of the new evaluation branch receives sufficient support during current hearings to be seriously considered for further study may be less important than the perspective that the bold idea gives to the problem. ■

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Our 710/800 gives you absolute amplitude measurements over a 140 dB dynamic range, any 60 dB of which appears on a large 7 x 10 cm high-contrast display. Wave analysis, distortion studies, and spectral display are enhanced by a full 50 kHz scan and a narrow 10 Hz resolution. For measuring EMI and other low-level signals, you get very high sensitivity (calibrated to 30 nanovolts/cm) plus selectable input impedances of 50 ohms, 600 ohms, 10k ohms, and 1 megohm. And you get X-Y outputs, pen lift, sync and sweep inputs, plug-in versatility and many other standard features—all for $2495.

This spectrum analyzer is truly portable. It weighs only 25 lbs.—or 30 lbs. with an optional internal battery that operates up to 8 hours before recharging.

Write for complete specifications. Ask for a demonstration. Contact Microwave Division, Systron-Donner Corporation, 14844 Oxnard St., Van Nuys, Calif. 91409. Phone: 213-786-1760.

New spectrum analyzer covers 10 to 50,000 Hz with universal measuring capability*

Electronics Newsletter

July 7, 1969

L-1011 navigator to combine simple, complex modules

Lockheed-California has decided to meet the L-1011's navigation needs with a modular system combining a simple design for area navigation with a sophisticated version for long-range requirements.

The simple configuration will probably require two general-purpose digital computers into which up to 500 waypoints can be inserted by magnetic tape to map the shortest, great circle, route between destinations; the alternative would be to have the trijet airliner fly from one VOR (very-high-frequency omnirange) station to another. However, the system will use VOR and DME (distance measuring equipment) inputs.

For fully inertial navigation, it will use two computers and three new inertial platforms designed to give both long-range inertial and area navigation. Today's Arinc Characteristic 561 inertial navigation system, such as Litton's LTN-51 and AC Electronics' Carousel 4, don't provide the area navigation feature. The inertial platforms, following the guidelines of the HAS-2 sensor expected to get Arinc approval, provide pitch, roll, attitude, and heading data, plus latitude and longitude outputs.

Lockheed is considering proposals from a number of avionics companies, one of which will be chosen to work with Lockheed on development and certification of the differing versions of the system. Once an Arinc specification exists for the HAS-2 platform and the area navigation computer, the competition could be reopened for production units. Lockheed expects the area navigation feature to greatly ease pilot workload in terminal navigation, because even terminal waypoints can be programed into the computers. The system will mean big business for avionics manufacturers (181 of the L-1011's have been ordered) although Lockheed officials won't say what the various combinations may cost.

Motorola to unveil 30 more LIC's . . .

The surge in linear IC development and product introduction continues, with Motorola apparently the leader in quantity. Fairchild will introduce 10 new linears next month [*Electronics*, June 23, p. 33], with three more probably coming before year's end. But Jim Burns, Motorola's manager of linear product marketing and planning, says the Semiconductor Products division will introduce 30 devices the remainder of the year—and now has 90 circuits in development.

Coming soon is the MC1556, touted by Motorola as a "super" general-purpose op amp having a typical input offset of 1 nanoampere and a slew rate of 3 volts per microsecond. Motorola's 1969 line also includes a series of dual line drivers with 15-nanosecond propagation delays, a 7-to-35-volt voltage regulator costing between $1 and $2, plus circuits that offer dielectric isolation or beam leads. There also will be both a dielectrically isolated and a beam-leaded version of the 709 op amp.

. . . as it predicts a $230 million market by 1974

All the linear IC activity is taking place against a background of uncertain market conditions and predictions of much better days ahead. While the total LIC market last year amounted to just $60 million, Motorola expects it to reach $70 million this year—despite a first quarter of $12.7 million—and $230 million by 1974.

A Texas Instruments spokesman sees the market shifting. Op amps make up 40% to 45% of the total, he says; IC fuses account for another

10%. But TI is emphasizing the computer interface portion of the op amp area, $10 million sales picture that the company feels will grow to close to $50 million within five years. **The TI spokesman claims the new Fairchild and Motorola circuits are "fan-outs" from the basic 709 building block.**

NASA doubts value of quick life tests

NASA, disenchanted with accelerated life tests, is searching for another method of gauging the reliability of semiconductors. Engineers at the space agency's Electronics Research Center in Cambridge, Mass., say present methods—simulating long-term reliability by testing semiconductor response to increased current, voltage, or temperature—fall far short of yielding meaningful data. **Acceleration itself, they contend, may cause failures that wouldn't normally occur under actual operating conditions.**

The center is about to order a study that it hopes will come up with new ways of screening silicon semiconductors for time-dependent failure modes. **One approach may be based on short-term noise performance.**

Tovio M. Liimatainen, acting branch chief at ERC, sees the study as part of the technical groundwork for NASA's Grand Tour—an unmanned probe of the outer planets [*Electronics*, June 23, p. 69]. **He feels that the data obtained from present testing methods is insufficient to assure mission reliability.**

Casoff/PLRACTA —a rose by any other name

Remember Casoff, the Air Force program to watch in 1967? Never implemented, it would have provided wide-area positional data, noninterfering communications, and identification, friend or foe—thus the name Casoff, for control and surveillance of friendly forces. A study contract was expected early in 1968, but it never came about.

Now Casoff is back, but under a new name—PLRACTA, for position, location, reporting, and control of tactical aircraft. The objectives are the same, except that as PLRACTA, they are incorporated into the thin-thread experimental I/CNI system [*Electronics*, June 9, p. 37]. PLRACTA simply becomes a list of mission requirements rather than a system.

Hugle gets four outside customers assembly lines

The latest company to join the list of firms housing semiconductor assembly operations dedicated to outside customers [*Electronics*, July 8, 1968, p. 129] is Hugle Industries, the Sunnyvale, Calif., manufacturer of wafer fabrication and assembly equipment for the semiconductor industry. **Under the terms of four development contracts worth at least $1.5 million, Hugle will set up four nonmilitary production lines—three to do automatic assembly of hybrid thick-film circuits using flip-chips, and one automating the die attach and wire-bonding operations.**

Ray 3 TTL used in new computers

Raytheon's Ray 3 transistor-transistor-logic, the so-called super Suhl [*Electronics*, Dec. 23, 1968, p. 34] has been designed into a family of small and medium Univac computers to be introduced next year. Although Univac denies it, **reliable industry sources say the initial order is for 100,000 circuits at $3 apiece; the total could reach 140 million circuits during the life span of the machines.** Fairchild is believed to be a second source, with additional sources to be named later.

No. 6 — 69

SEMICONDUCTOR
newsbriefs

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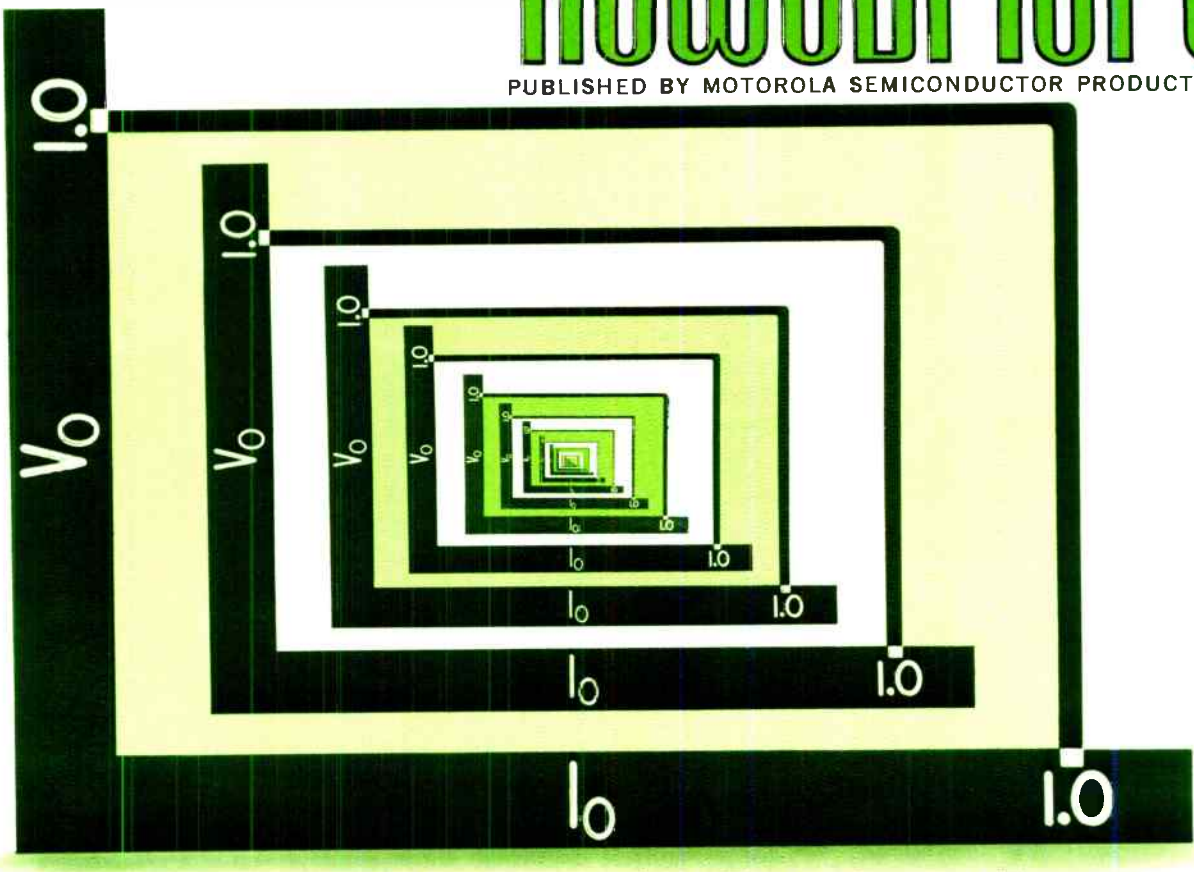


Now ICs That Regulate Voltages Set By External Transistors!

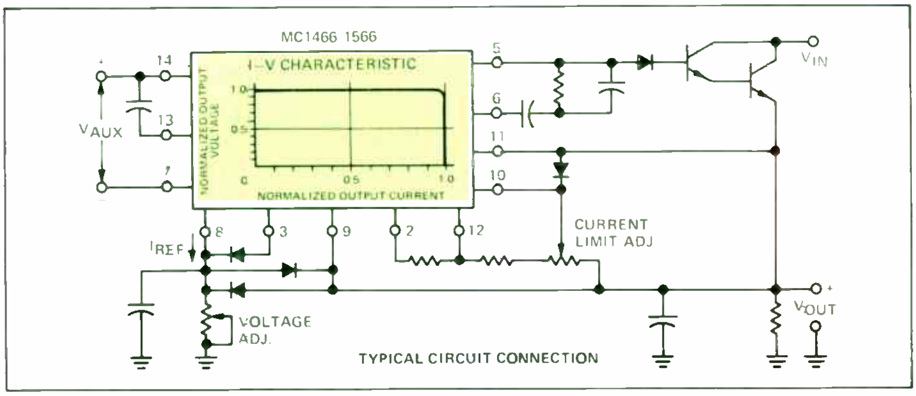
The latest additions to Motorola's growing family of integrated circuit regulators, the MC1566L/1466L, now makes it possible to **regulate any voltage** from zero up to a limit set only by the breakdown voltage of a series-pass transistor at the input (see schematic).

As a result, you can now use just one IC for all your regulation requirements, from millivolt levels to hundreds-of-volts!

Just like its predecessors in Motorola's expanding IC regulator line (MC1560/1460, MC1561/1461), the MC1566L/1466L offers built-in short-circuit protection and an internal reference/regulator stage. The former protects the regulator under sustained output short-circuiting, while the latter provides regulating characteristics that are essentially independent of output voltage.

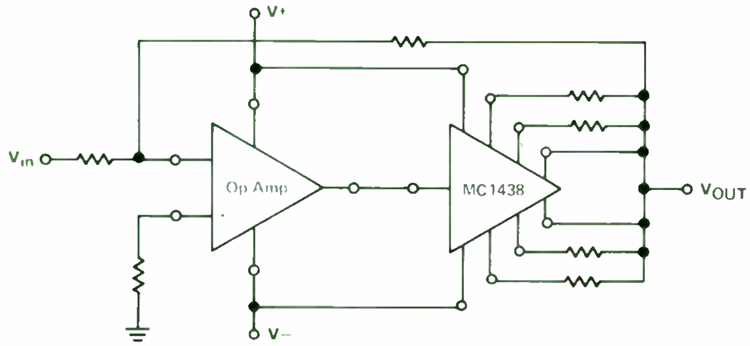
The MC1566L and its limited temperature-range counterpart (MC1466L) are ideal for broad-range adjustable power supplies. Line or load-voltage and current can now all be regulated, over a wide spectrum, all from a single system! And, these ICs have tight tolerances too. Line or load voltage regulation is spec'd at 0.01% + 1 mV while current regulation is 0.1% + 1 mA.

Both units are immediately available from distributor stock in the TO-116 14-lead ceramic dual in-line package. 100-up prices: MC1566L – $24.50; MC1466L – $8.50.



For details circle Reader Service No. **498**

MC1438R POWER BOOSTER INTEGRATED CIRCUIT FOR OPERATIONAL AMPLIFIERS



Power-Booster Ups Op Amp Outputs To 300 mA

The MC1438R is a unity-gain isolation amplifier, which is ideally suited to follow and boost the power of an operational amplifier (such as the MC1439). It can drive low-impedance current loads up to ± 300 mA. This new IC booster-amplifier makes it possible to develop completely integrated power systems, thus eliminating the need for discrete-IC hybrid designs.

The MC1438R features a high input impedance of 0.5 Megohm (typ), allowing the gain of an op amp to approach unloaded open-loop gain and thereby reducing thermal drift (the internal power dissipation of the op amp is independent of output voltage). Its low output impedance — 10 ohms, typ. — permits the MC1438R to drive greatly reduced phase-shift capacitive loads with a substantial increase in output voltage swing. Current limit is adjustable from ±5 mA to ±300 mA. The MC1438R also exhibits a power bandwidth which is considerably higher than present operational amplifiers—1.5 MHz, typ. (bandwidth and slew-rate is limited only by the op amp itself). And, it has an excellent power rejection ratio of 1.0 mV/V, typ.

In addition to its ability to operate as a power-booster, the MC1438R can be combined with op amps to form such functions as ramp-generators, supply splitters and voltage-programmable power sources.

Units are available from distributor stock in the 9-pin TO-66 style package, which is capable of handling up to 17.5 Watts. Its 100-up price is just $6.50.

For details circle Reader Service No. **499**

New MC1741C Op Amp Is Both Monolithic And Internally-Compensated!

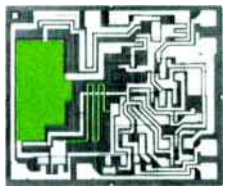
For years Motorola has offered a variety of top-performance Op Amps. All were monolithic, yet they lacked internal compensation.

So, we introduced the MCH1539 — a hybrid version that featured built-in compensation. Still, it wasn't monolithic.

Now, with the MC1741C Motorola provides the best of both . . . internal compensation and monolithic construction!

As a result, no external frequency compensation is required — saving the cost of a resistor and a capacitor as well as eliminating interconnections. The MC1741C also provides built-in short-circuit protection which further reduces external circuitry requirements and increases reliability. In addition, "latch-up" problems are eliminated.

A large capacitor and a resistor, right on the MC-1741C chip, eliminates the need for external compensation.



Some of the other outstanding features of MC1741C include: offset-voltage nulling; low power consumption; wide common-mode and differential-voltage ranges; and, it's pin-compatible with the MC1709.

It comes in the 8-lead, TO-99 metal-can and operates over the 0 to +70° range. Available from stock, the MC-1741C is 100-up priced at just $3.25.

For details circle Reader Service No. **500**

Dual MECL-Output Sense-Amp IC Eliminates Core Memory Interfacing Problems

For the first time, the designer can "leapfrog" interfacing requirements between the sense-amplifier and core memory sections of even the highest speed computers!

The **MC1543L** — An IC Sense-Amplifier with MECL-outputs (emitter-coupled logic) makes it possible to eliminate the need for more costly linear-to-logic conversion circuitry! In addition, because this new circuit has two input channels, you can reduce by as much as one-half, the number of IC Sense-Amp packages required for 0.5 microsecond "memory" applications.

It's a combination that's hard to beat! Both package-count and costs can be substantially reduced and, the over-all system design can be simplified — with a resultant increase in reliability.

Characterized as a dual MECL core memory sense amplifier, the MC1543 is DC coupled with a separate strobe. In addition to having output levels compatible with emitter-coupled logic levels, this new circuit also features adjustable threshold as well as an excellent degree of threshold stability over a wide variation in power-supply voltage.

For details circle Reader Service No. **501**

Highlights

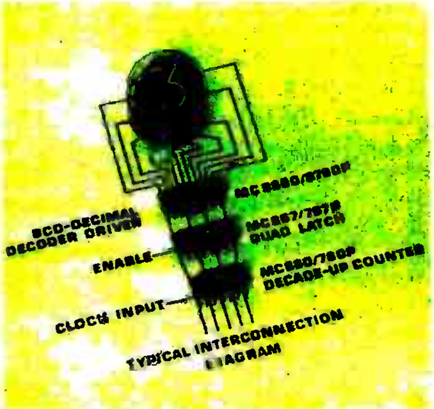
- Threshold adjustable from 10 to 40 mV (for positive or negative signals)
- Both OR and NOR outputs available
- Threshold insensitive to + or − supply variations

The MC1543 is currently available from distributor stock, in the TO-116 14-lead dual in-line ceramic package; and, operates over the −55 to +125°C temperature range.

Price: $18.00 (100-up).

New MRTL Trio Provides Total IC Digital Counting!

Designers can now utilize a new MRTL threesome to develop completely integrated digital readout systems which are smaller, faster, more reliable and much less costly than discrete or hybrid approaches. The combination of just these three MRTL ICs — the MC9760/9860 BCD-Decimal Decoder/Driver, the MC867/767 Quad Latch and a Decade-Up Counter (MC880/780) — does the total job, thus reducing component density, wiring and PC board requirements (see illustration).



Only three MRTL circuits, costing roughly $13.50, can actuate a complete decade readout system, thus reducing both design costs and size.

The MC880/780 is a monolithic 1-2-4-8 Decade-Up Counter, consisting of four flip-flops, internally connected. Memory, or temporary storage is provided by the MC867/767 Quad Latch which "stores" the data while the MC-880/780 is proceeding with the count. The MC9860/9760 converts the 1-2-4-8 code into a decimal output with sufficient voltage to drive a Nixie® or other gas-filled readout device.

These new MRTL circuits are supplied in Motorola's economical Unibloc dual-inline plastic package ("P" suffix); in 16-lead versions (MC9860/9760, MC867/767) and 14-leads (MC880/780). The MC700 series types operate over a temperature range of +15 to +55°C, while the MC800 series covers from 0 to 75°C.

All three of these new low-cost, plastic-packaged MRTL integrated circuits are immediately available from your local Motorola franchised distributor's warehouse stock. Order some of these combinations now and have them ready to reduce both the cost and size of your next digital-readout system design.

[illegible]	Description	Price (1 K-up)
[illegible]	Quad Latch	$3.00/$3.40
[illegible]	Decade-Up Counter	3.00/ 3.40
[illegible]	BCD-Decimal Decoder/Driver	7.50/ 8.70

For details circle Reader Service No. **502**

Dionic Structure Yields New Radiation-Hardened MDTL ICs

Six MDTL radiation-resistant ICs, forerunners of a new line specifically developed for applications requiring a high degree of reliability under severe radiation environments, are now available off-the-shelf. Motorola's Dionic structure (dielectric isolation) minimizes the effects of gamma radiation. As illustrated, individual islands are electrically isolated from the poly-crystalline material (and each other) by a layer of silicon dioxide. In addition, nichrome resistors and a post-metalization passivation process are used to enhance overall radiation resistance.

The result . . . ICs which remain fully functional and meet all pre-radiation electrical specs, even when subjected to gamma dose rates of 10^9 rads/sec. and cumulative gamma dosage in excess of 5 x 10^8 rads — as well as neutron exposure levels of 7 x 10^{13}NVT.

They are available in the 14-lead, TO-86 ceramic flat-pack (−55 to +125°C).

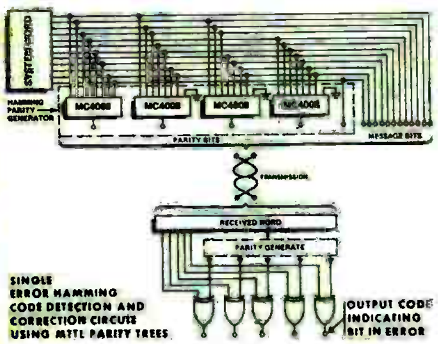
DIONIC STRUCTURE

[illegible]

For details circle Reader Service No. **503**

Parity-Trees Head List of Six New MTTL Complex Functions

Two new "parity-tree" circuits, which provide economical solutions to overall systems reliability, plus four memory arrays, have been added to Motorola's fast growing MTTL complex functions line.



The MC4008L, an 8-bit parity-checker/generator, features an extra 2-input gate to expand the number of bits handled, or as a parity-bit input checker. The second, a dual 4-bit parity-tree (MC4010L), is ideal for checking 4-bit word lengths or increments of 4-bits. It consists of six 2-input exclusive NOR gates, connected to form two independent 4-bit parity-trees. Using these new MTTL ICs, sophisticated detection and correction systems can be developed (see illustration) which not only recognize that an error has occurred, but can also detect which "bit" is in error.

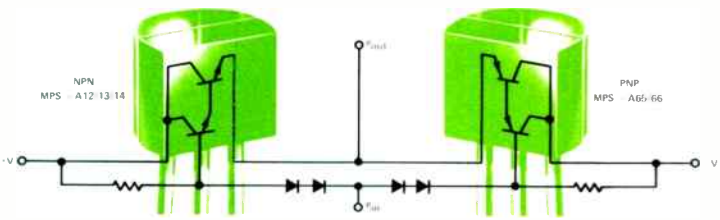
Both the MC4008L and MC4010L are expandable to as many bits as required without additional "gating" circuitry. These TTL/DTL compatible ICs come in the TO-116 14-pin dual in-line ceramic package. The 100-up price is only $7.75 for either unit.

XC-170 128-Bit ROM Derivatives

The MC4038P inverting/non-inverting 1-of-8 decoder has a 3-bit binary address which selects the desired word for the 8-bit output and exhibits address times of less than 45 ns, while the MC4039P is a seven-segment character generator for the direct operation of low-voltage indicators. The MC4040P decoder has two enable inputs and can transform any 4-bit binary number to a 2-of-8 bit code. The MC4041P single-error hamming code detector and generator is a programmed 128-bit ROM. Supplied in the 16-lead Unibloc plastic dual in-line package, the MC4038-41 are priced at $5.10 each (1K-up).

For An Application Note and Data Sheets circle Reader Service No. **504**

Both PNP and NPN monolithic Darlingtons, in plastic, provide greater low-cost design flexibility.



4 More PNP/NPN Unibloc Darlingtons Add Impetus To High-Gain Economy Designs

If you were enthused when Motorola announced its first low-cost Unibloc plastic Darlington Amplifier entry, the MPS-A12, in the fall of 1968 hold on — that was only the beginning!

Now Motorola makes available both PNP and NPN types (two new ones in each polarity), with minimum gains ranging from 5K to 75K, at unprecedented 20¢ - 30¢ price levels!

Whether you work with PNP or NPN polarities, or combine the two (as shown in the illustration), you can now achieve a substantial reduction in piece-parts, wiring and circuit size — not to mention individual transistor costs. For example, the PNP MPS-A65/A66 (which have minimum betas of 50K and 75K, respectively), average out costing less than 15¢ per transistor — while the new NPN types, the MPS-A13/A14, cost even less. And, with a wide choice of betas available, you don't have to pay for more than you require.

Additional highlight parameters include: a high breakdown voltage of 30V (min) at 10 mA, low noise figures — 2dB (typ) at 1.0 mA, f_T (min) = 100 MHz (PNP) and 125 MHz (NPN) at 10 mA and leakages that do not exceed 100 nA.

Type No.	Polarity	h_{FE} (min) @ I_C = 10 mA	Prices (5,000-up)
MPS-A65	PNP	50,000	27¢
MPS-A66	PNP	75,000	29¢
MPS-A13	NPN	5,000	22¢
MPS-A14	NPN	10,000	25¢
MPS-A12	NPN	20,000	32¢

For details circle Reader Service No. **505**

First Micro-T RF FET Expands High-Density Design Options

With the introduction of the MMT-3823 RF N-Channel JFET — the first field-effect transistor to be incorporated into the subminiature Motorola Micro-T package configuration — designers of high-frequency circuits can realize substantial reductions in equipment size without sacrificing efficiency and reliability. The dimensions of the Micro-T's ultra-small body (0.080" dia. x 0.053" thick, nom.) along with its flat, radial leads make it well suited for high-density "drop-in" strip-line PC board mounting and thick-film fabrication.

Although the MMT3823 Depletion Mode (type A) Micro-T JFET can be used as a mixer and switch, its primary applications lie in the RF amplifier area. Among the key parameters of this micro-miniature high-frequency FET is a 100 MHz noise-figure of only 2.0 dB (typ), both low cross-modulation and low intermodulation distortion, a high power-gain of 16 dB (typ) @ 100 MHz, as well as low transfer and input capacitances of just 1.0 pF and 4 pF (typ), respectively. In addition, its drain and source are interchangeable. And, the MMT3823, like other Micro-T devices, dissipates a full 225 mW @ 25°C, ambient.

Low Noise-Figure (NF) @ 15V/1 Kohms/100 MHz	2.0 dB (typ)
Low Input Capacitance (C_{iss}) @ 15V/1.0 MHz	4 pF (typ)
Low Transfer Capacitance (C_{rss}) @ 15V/1.0 MHz	1.0 pF (typ)
High drain current (I_{DSS}) @ 15V	5 mA (min) 20 mA (max)
High Gate-Source Voltage (V_{GS})	30 V (min)
High Forward Transfer Admittance $\|Y_{fs}\|$ @ 15V/1.0 kHz	3000 µmhos (min) 8000 µmhos (max)
Price (100-up):	$3.50

For details circle Reader Service No. **506**

Now a 4A @ 95°C Plastic SCR That Turns-On At 200 µA—for Only 51¢

Designed for low-cost, higher-current applications in rugged consumer/commercial and industrial speed, light and heat-control circuits, the new MCR406/407 sensitive-gate, SCR series has "the best Thyristor value" written all over it!

This new SCR series offers: **High, 4 Amp RMS ratings!** even when operated at +95°C, case temperature (other 4 Amp SCR's are rated at 20°C —75° lower)! This higher-current-at-higher-temperature performance means you can realize a substantial savings in heat-sink requirements and ease your thermal design considerations.

Triggering at only 200 µA! The ability to turn-on at low current levels makes them ideally suited for use with photocells, thermistors and other small-signal transducer sources, without additional stages of signal amplification.

THERMOPAD package! It's the only plastic SCR package having a short 0.032" chip-to-heat-sink thermal path

The MCR406 handles a full 4 Amps at 95°C and triggers at only 200µA levels — yet it's priced in the 50¢ area!

plus low 2.0°C/W thermal resistance for high dissipation. And, it's low-cost!

Annular die structure! Maximum, long-term dependability and performance, over a −40° to 110°C operating temperature range, is ensured through oxide-passivated junction protection and Annular construction. They also display a low 1.6V @ 4A @ 110°C forward voltage drop.

Series No.	V_{RRM} (Volts)	i_F @ 95°C	I_{TSM} (Surge)	I_{GT} @ 25°C (max)	V_{GT} @ 25°C (max)	Price* (1,000-Up)
MCR406	30, 60 100, 200	4 A	20 A	200 µA	0.8 V	51¢
MCR407	30, 60 100, 200	4 A	20 A	500 µA	1.0 V	47¢

*30 V unit

For details circle Reader Service No. **507**

Latest Silicon Power Lines Top 200/300W Class

50A, 60-80V Complements Cut Power Circuit Cost/Complexity

Now Motorola gives the designer of high power amplifier circuits a line of silicon power transistors that are **the highest rated, TO-3 packaged, PNP/NPN complements available — the 2N5683-86 series!**

The latest additions to Motorola's ever-growing Silicon Power lines let you develop economical ultra-high wattage amplifier/switching designs.

This series offers continuous collector-current ratings to 50 Amps, power dissipation to 300 Watts, breakdown voltages of 60 to 80 Volts, high betas, fast switching speeds and low saturation voltages — all at very high current levels. And, you're assured lighter, less-costly heat-sinking due to their low thermal resistance (θ_{JC}) of only 0.583°C/W, max. Used in complementary designs, they can serve to lower costs and complexity by eliminating the need for expensive, impedance-matching transformers in "heavy-muscled" amplifiers.

In addition, they exhibit saturation voltages of less than 1.0 V at 25 A — assuring efficient, low-power-loss performance in high-current applications. And, they are made using Motorola's exclusive **EpiBase** die-fabrication process which reduces costs while maintaining long-term reliability and stability.

Highlights	2N5683/84	2N5685/86
Polarity	PNP	NPN
High I_C (cont.)	50 A	
High P_D	300 W @ 25°C, case	
High h_{FE}	15-60 @ 25 A	
f_T (min)	2 MHz @ 5 A/10 V	
Prices (100-up):	$15.00/18.00	$12.00/15.00

For details circle Reader Service No. **508**

New 100-140V, 10-16A, TO-3 Units Eliminate "Stud" Types

If "high-voltage silicon power" conjures up images of large, cumbersome — and costly "stud" transistors — look again!

Here's inherently-economical low-silhouette, TO-3 packaged, 100-140V, 10-16A — silicon power transistors that can put *tomorrow's* state-of-the-art performance in your rugged, audio/servo amplifier, inverter and chopper designs and switching and series-pass regulators *today* — the NPN 2N5629-31 and 2N-5632-34 series!

With these compact, high voltage/high current silicon transistors you can reduce the size, cost and complexity of input, output and filtering componentry — plus lower your current requirements and eliminate step-down transformers.

Talk about high performance specs! How about P_D's up to 200 W . . . I_C's to 16A . . . 100-120-140V — V_{CEO} ratings . . . saturation voltages of one-volt and betas from 25 to 100 at 8 A.

They make nimble switches, too, with a minimum f_T of 1 MHz at 1A/20V (2N5629-31).

And, "punch through" (second breakdown) problems are minimized, due to Motorola's unique diffusion process which allows the transistors to accept very high voltages without detrimental effects.

For details circle Reader Service No. **509**

Motorola Adds 25-Amp Muscles To Its MAC Triac Line!

There's a new, husky, 25-Amp addition to Motorola's popular MAC Triac line — and that heftier horse- or house-power control application you've had in mind can almost certainly be filled by one of its 25 to 500-volt versions!

Called the MAC21, this 25-Amp RMS series has been developed for the engineer who needs rugged, reliable versatility for a wide range of medium-power commercial/industrial thyristor-controlled applications. They're plug-in perfect for relay replacement, phase-control, zero-point and on-off switching, light-dimming, motor-speed control, motor starting, heater control, sequential light flashing, voltage regulation and temperature control designs.

Packaged in the low-silhouette, TO-41 case (TO-3 with lugs) the MAC21 series delivers outstanding performance, as exemplified by a low junction-to-heat sink value, low 1.5V (max) at 35A on-state voltage, a critical expodential dv/dt of 100 V/μs (typ) at $T_J = 110°C$ and a gate triggering current of 20 mA (typ). Use of all-diffused junctions provides enhanced parameter uniformity.

MAC21 prices start at only $2.90, 100-up (25-volts). Contact your local distributor for delivery of prototype quantities and see for yourself how well these new 2.5-Amp Triacs perform in your critical, medium-current full-wave control designs.

Both a new application note on Triac circuits (AN466) and a data sheet on the MAC21 series are yours for the asking.

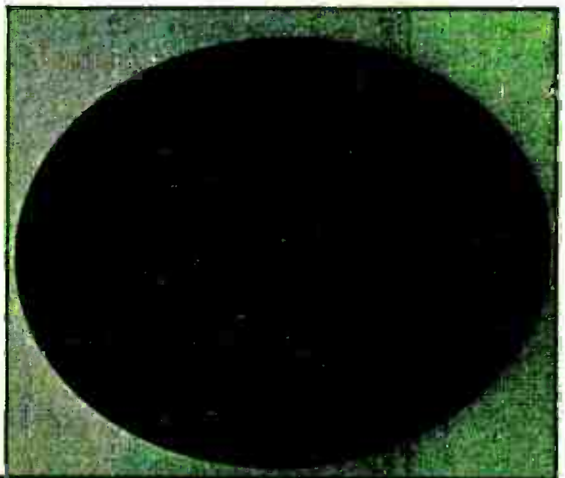
MAC21 Triacs, with 25-500V ratings, are packaged in low-silhouette TO-41 cases to provide currents to 25 Amps.

For copies circle Reader Service No. **510**

PRODUCT BRIEFS

NEW LOW-THRESHOLD MOSFET SWITCHES/CHOPPERS

—Offer Stable, Ultra-High Speeds At Low Power Levels!



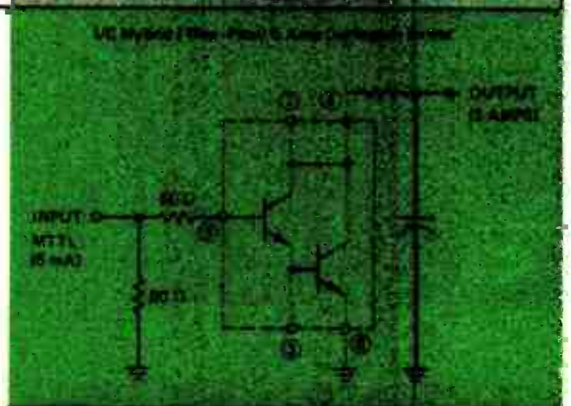
Combining Motorola-developed Silicon Nitride passivation — which assures stability under high temperature and reverse bias — with threshold-voltages in the low 0.5 - 3.0V area, fast switching times (maximum t_r of just 10 ns and t_f of 15 ns) and high immunity to transients, the new 3N169-171 N-channel enhancement mode (type C) MOSFETs are worthy candidates for a variety of critical low-power, high-speed switching applications. They are packaged in the 4-leaded, TO-72 case.

As demonstrated in the accompanying scope-trace illustration, showing a typical low input-voltage pulse (top trace) and a 4-channel multiplexed output (lower portion), these devices are ideally suited for low-level-input switching and chopper applications in a wide variety of multiplexing, modulation and analog-to-digital converter designs. Highlight parameters include a low r_{ds} (on) of just 200 ohms (max) and capacitance values as low as 1.3pF (C_{rss}) and 5.0pF (C_{iss}) at 1.0 MHz. Prices: 3N169 — $4.90; 3N170 — $4.20; and 3N171 — $3.55 (1,000-up).

For details circle Reader Service No. **511**

HIGH-CURRENT DARLINGTON-DRIVER HYBRID MICROCIRCUIT

— Provides High Pulse-Rate Power Gains To 1000!



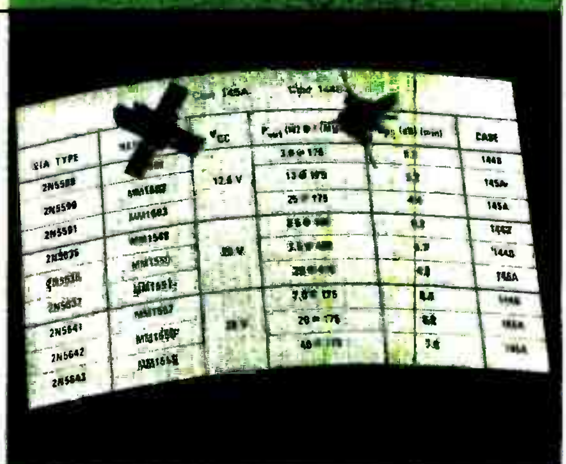
Short-duration pulses up to currents of 5 Amps, from logic level inputs of only 5 mA, are now possible with Motorola's new MCH2005 Darlington-Driver hybrid microcircuit. A transistor-transistor logic input current level of just 5 mA, for example, yields a 5 Amp output pulse — more than adequate to drive high-current ferrite switches in phase-shifter or phase-array radar designs. And, its total turn-on/turn-off time is a fast 800 (max) nanoseconds (switching time spec'd at betas of 1,000)! Priced at only $8.75, (100-up), this hybrid IC is packaged in a 6-lead, TO-86 ceramic flat-pack.

And, it's available immediately from "off-the-shelf" stock. Contact your local Motorola distributor for units and evaluate this Darlington-Driver hybrid IC now!

For details circle Reader Service No. **512**

NINE NEW "BET" RF POWER TRANSISTORS

—Available In Ceramic "Stripline" Packages At Lower-Than-Ever Prices!



Nine newly EIA-registered Motorola BET (balanced-emitter) NPN silicon RF power transistors, all packaged in rugged ceramic "stripline" cases, now cover a broad range of output wattage requirements at VHF/UHF frequencies (175 MHz and 400 MHz), in both 13.6 V and 28 V categories. They also exhibit high minimum power-gain (see table), making them ideal for AM/FM power amplifier or oscillator designs in a variety of industrial and military equipment.

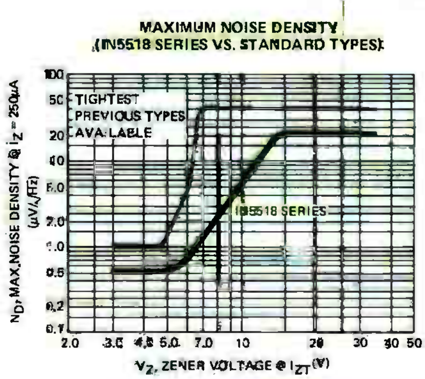
And, Motorola has been able to significantly reduce the prices for these new and improved types. For example, the 100-up price for the new 2N5643 is now only $26.90 (over 30% less than for the previous MM1559).

Multiple-discrete-emitters, each with an attendant Nichrome resistor, provide protection against external destructive factors, such as secondary breakdown, load-mismatching, and mistuning. Their new "stripline" ceramic case structure lowers lead inductances and improves broadband tuning capabilities.

For details circle Reader Service No. **513**

LOW-VOLTAGE AVALANCHE ZENER DIODES

—Have Premium-Performance Specs, Tight Tolerances!



The 1N5518-46 low-voltage avalanche zener diode series is particularly well-suited for critical industrial/aerospace applications demanding the tightest possible regulation. These units feature ultra-low noise density (averaging less than one-half any previous available types), as shown in the comparison curves to the right. This premium series, covering a range of 3.3 to 33 Volts, also features zener impedances as low as 18 ohms (1N5521) and low maximum regulation factors (e.g. ΔVz down to 0.05 V), as well as leakage currents down in the 0.01μA region.

In addition, these new precision zener diodes are available in five standard voltage tolerances — 20, 10, 5, 2 and even 1% — and their oxide-passivated junctions, combined with RamRod DO-7 "glass" package construction, assure long-term stable and reliable performance. Your distributor has units in stock.

For details circle Reader Service No. **514**

NEW LITERATURE BRIEFS

Over 12,000 Types Covered In Motorola's Most Complete, New 1969 Full-Line Catalog!

The most up-to-date and comprehensive listing of product data in the semiconductor industry has just been published — **the 1969 edition of Motorola's full-line condensed catalog!** Bigger and more inclusive than ever, it fills 84 pages (20 more than the 1968 edition) and includes over 850 new standard types!

The catalog is divided into sections for quick and efficient reference. For example, the first section consists of a complete alpha-numerical index listing of all standard Motorola types — including both discrete devices and ICs.

The next section (to which 13 pages have been added)

provides tabular listings with highlight characteristics grouped by general application and product areas.

For a copy circle Reader Service No. **515**

Eleven Logic Families Compared In New Motorola Digital IC Selector Guide!

Covering the broadest line of digital IC families in the industry, Motorola's new "first-of-its-kind" selector guide helps you choose the best possible logic form for your particular requirements . . . at a glance!

To ease comparisons of key parameters, all eleven Motorola logic families have been color-coded by category (MRTL, MDTL, MTTL, MECL, etc.).

Basic operating parameters are shown for the various logic forms and their functions, such as: operating temperature ranges, power requirements, fan-outs, propagation delay times, toggle-frequencies, power dissipation and noise-margins. In addition, basic "gate" and positive logic diagrams are provided for each of the digital IC families. Detailed package drawings, covering all Motorola's monolithic digital ICs, are also included.

This unique, 3-hole punched, multi-colored chart is flexible to use, too. It can be placed in a binder or mounted on a desk or wall.

For a copy circle Reader Service No. **516**

Tear Along Perforated Line and Drop in Mail (No Postage Required)

LITERATURE ORDER FORM

NOTICE: Requests for literature on items described in this publication cannot be honored after **November 1, 1969.**

NEWSBRIEFS No. 6-69

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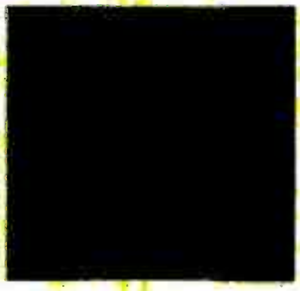

In addition, a brief yet thorough explanation of voltage-variable capacitance tuning diodes and how they operate, as well as a listing of Application Notes covering the subject, is provided on the back of this convenient, easy-to-use selector guide (suitable for use at desk or as a wall chart.)

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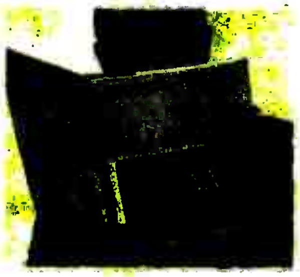

They are categorized by application, and highlight specifications facilitate selection at a glance. Classifications include multipurpose amplifiers, RF amplifiers and mixers, general switching, chopper, matched pairs, and tight (2:1 ratio) I_{DSS} ranges.

Ideal for desk, wall, or binder use, this design aid includes a cross reference listing of industrial types vs. Motorola's nearest equivalent and recommended preferred types. An introductory page describes the Silicon-Nitride passivation process (a Motorola exclusive) which makes high-stability MOSFETs possible. Also included are FET parameter application charts and a listing of current available FET Application Notes.

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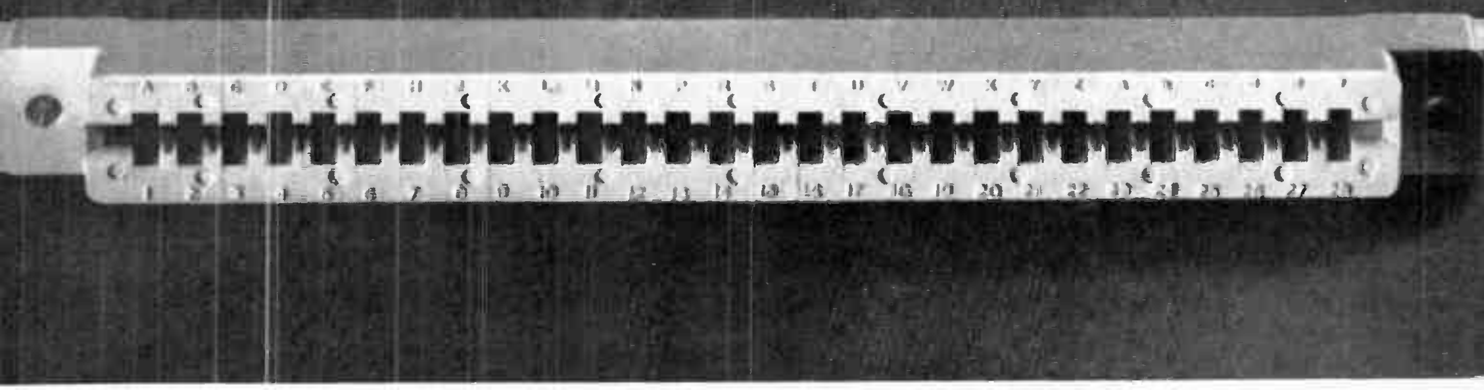

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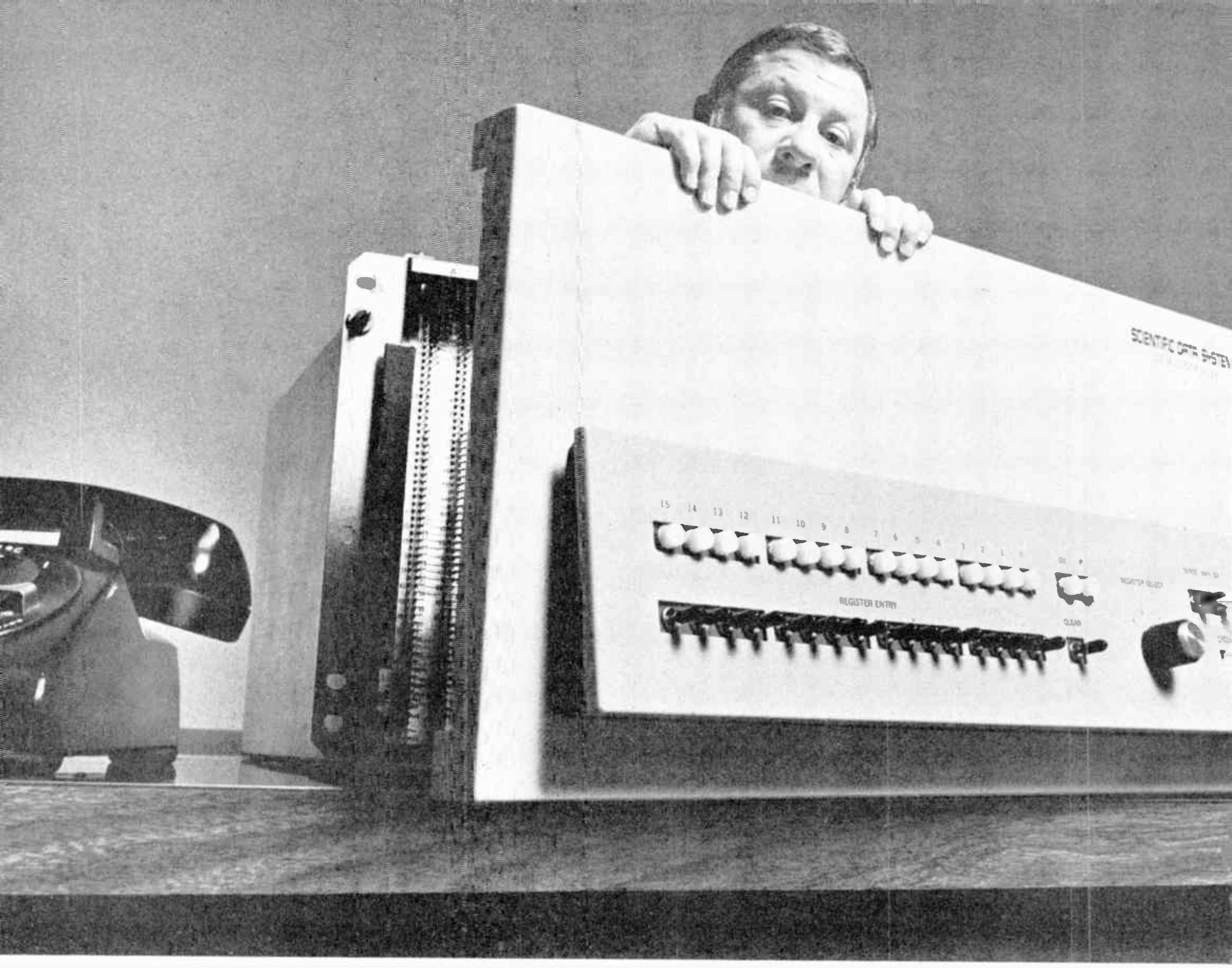

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SDS

Scientific Data Systems, El Segundo, California

Circle 44 on reader service card

Great unbundling sets up new deal

New IBM policy will especially affect peripheral and software areas; 3% hardware price reduction criticized as disguised increase

The computer industry, after holding its breath for six months or more, finally exhaled when International Business Machines Corp. finally made public its plans for "unbundling"—for selling software, systems support, and educational services separately from its computer hardware. But the industry isn't sure yet whether it's breathing easier or just breathing, and it may take a while to find out.

For one thing, IBM's reduction of hardware prices by only 3% was a surprise. The advance betting was that prices would drop anywhere from 10% to 35% (leasing companies already offer such discounts).

"This is really the same as a large price increase," says Richard C. Jones, president of Applied Data Research, a software company. His reasoning is based on a belief that IBM simply is charging enough for software to more than make up that hardware price cut. "As a user of IBM equipment, we think the 3% is ludicrous."

Ups and downs. IBM's only explanation of the 3% cut was that the figure corresponded to "marketing expenses" for services that would no longer be available. IBM did say that the customer's total outlay might either increase or decrease, and that in an increase IBM wouldn't necessarily get it all.

IBM's announcement included the services of system engineers, who assist the customer in setting up a data-processing installation and in running it efficiently, and educational services for executives and employees of IBM customers. Both services were included in the cost of a computer; both will henceforth be charged separately.

But of greatest interest was the pricing of software separately from hardware. Software no longer included in the price of a computer includes all programs written for a specific application, compilers (programs that translate languages like Fortran and Cobol into machine language), and various utility programs for routine tasks like sorting and merging. All new programs within these categories will be available only through a license, good for just a single specified machine, for which a monthly fee will be charged. The customer won't have the option of choosing a bundle.

These programs, which IBM now calls "program products," won't be for sale. IBM considers them corporate assets that couldn't be protected if they were sold; the license offers a level of protection that is necessary with easily-reproduced program products but unnecessary with pieces of equipment. This distinction, IBM feels, keeps the licensing agreement from falling under the 1956 consent decree which, among other things, forced IBM to offer its machines for sale as well as for lease.

Program products don't include all software. Previously announced software is still available for the asking. And essential system control programs will continue to be free. Included are various kinds of operating systems, plus supervisory, data management, diagnostic, and maintenance programs that keep a computer running efficiently.

What's to keep a customer from lending or duplicating a licensed program? IBM says it does business in good faith and expects customers to do the same.

But IBM has had experience with "good faith." In 1963, the company installed time meters on its machines—ostensibly to make regular servicing easier. Some say, though, that the real reason was to keep

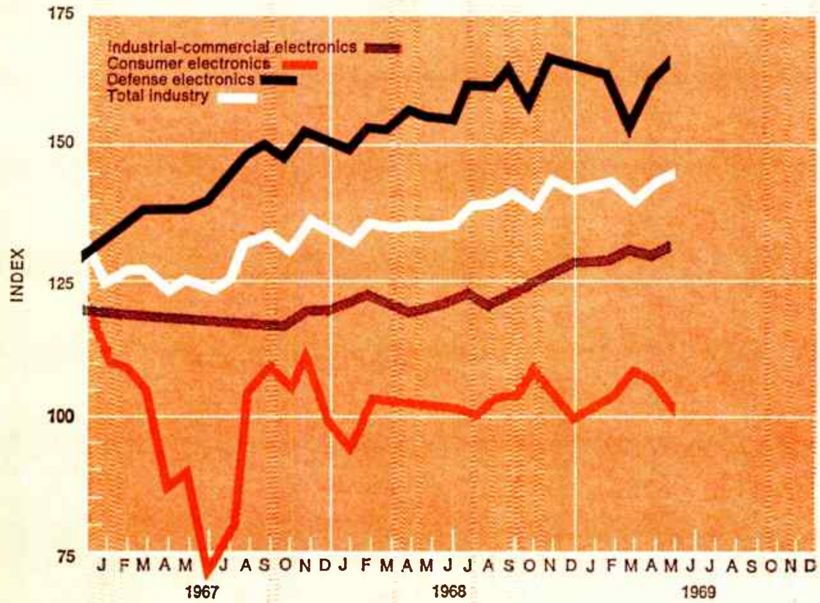
Here they come

Other manufacturers are almost certain to follow suit in unbundling. Scientific Data Systems, now a part of the Xerox Corp., and Control Data Corp. tried separate pricing of a few sample programs two or three years ago, but haven't done anything radical since then; the original programs are still available. The Burroughs Corp. brought out an accounting machine with separately priced software in February, and announced the availability of separate pricing for two existing machines in June, a week or so before IBM made its announcement. Burroughs is cutting the price of the hardware by about 10% in the latter case. Unlike IBM, Burroughs charges only once for its programs, which can thereafter be used on many different machines. The company says it plans to take further steps in unbundling in the near future.

Still, unbundling will be of most benefit to sophisticated users, many of whom are well qualified to write their own software at all levels, and many of whom, in fact, do write software for themselves or their clients. These organizations, of which System Development Corp. is an example, can simply ignore IBM except as a source for spare parts.

Electronics Index of Activity

July 7, 1969



Segment of industry	May 1969	April 1969*	April 1968
Consumer electronics	102.4	107.1	102.2
Defense electronics	166.5	163.5	154.9
Industrial-commercial electronics	132.3	130.7	121.5
Total industry	145.5	144.3	136.1

Total electronics production—up 1.2 points to 145.5—perked up again in May after drooping a bit in April. However, the consumer sector continued its decline, dropping 4.7 points in a month. The defense and industrial-commercial areas helped make up for the consumer electronics downcurve as defense production showed an increase of 3 points and industrial-commercial output rose 1.6 points.

The decreased activity in consumer electronics production came against a report of declining sales in receiving tubes for the first quarter of the year. The Electronic Industries Association reported sales off 10% to a total of 71 million units. Sales to government agencies nearly matched those of last year's first quarter, but the initial equipment, renewal, and export markets fell.

Indexes chart pace of production volume for total industry and each segment. The base period, equal to 100, is the average of 1965 monthly output for each of the three parts of the industry. Index numbers are expressed as a percentage of the base period. Data is seasonally adjusted.
*Revised.

tabs on customers who paid for equipment on a single-shift, 5-day-week basis but were running it considerably longer.

Now's the time› What does all this mean to the computer industry? There will be ramifications in all areas—hardware and software, among manufacturers and users. In the hardware area, the time is probably ripe for IBM's announcement of the two or more new machines it has been readying [*Electronics*, March 17, p. 51]. Furthermore, the unbundling will probably increase IBM's share of the hardware market, because IBM already can turn out machines faster and cheaper than anyone else. And manufacturers of peripheral equipment who tout their wares as being plug-to-plug compatible with IBM's will be hard hit, because they're no longer fully compatible unless then can also provide software.

Software companies whose existence has depended on being able to write, for a price, programs that were available free from IBM or other manufacturers, will have their priorities reshuffled. Up to now they've had to produce a product that was a great deal better—or available sooner—than the free variety in order to be able to charge for it. Now their task is easier—except that the number of competing companies will suddenly increase, perhaps by a factor of three or four, then decrease gradually.

Components

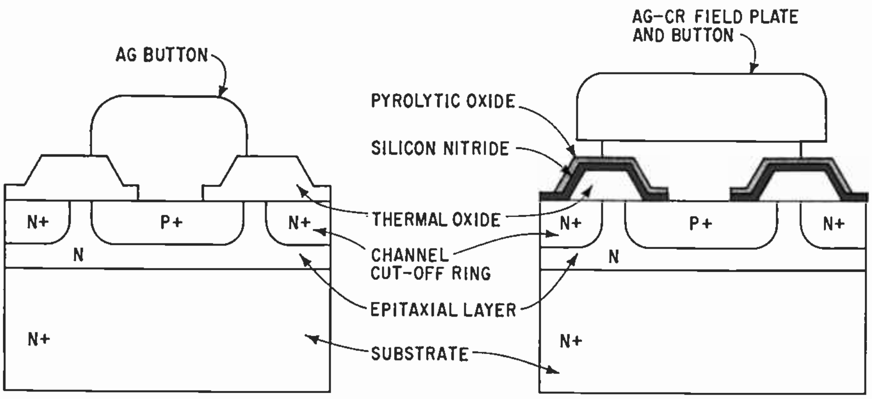
Passing marks

Silicon nitride passivation has been used for standard diodes on a limited basis for some time. But while its advantages were well known, an economical and technically feasible method of incorporating the process into large-scale production remained a major production puzzle.

However, Fairchild Semiconductor of San Rafael, Calif., has solved that puzzle and has started to reap the dividends in the reliability of nitride-passivated diodes. After a year and a half of production and gathering data from more than 14 million device hours, Fairchild engineers report an eightfold reduction in failure rate per 1,000 hours.

Big lead. "The drop in failure rate from about 4% to less than 0.45% gives us the best standard of reliability for any diode on the market, no matter what the price," says Steve Carmichael, Fairchild's manager of reliability and quality assurance. He estimates the firm is more than a year ahead of the industry in development of volume-produced nitride-passivated diodes.

"Many companies are looking at the possibility of mass producing this kind of diode, but I'm not



Something old, something new. Here's the Fairchild FDH-6 chip before and after the switch to nitride passivation and addition of a field plate.

aware than anyone is actually doing it on a large scale yet," Carmichael says.

As with many semiconductor firms, Fairchild's research and development group toyed with the problems nitrides presented as early as 1965, but the effort had little thrust or direction. However, in the fall of 1967, four engineers from the diode plant and two from the company's R&D section in Palo Alto, Calif., teamed up to tackle the problem of improving the yield and reliability of the low cost DO-35 package.

Ions out. "When the DO-35 package was developed a few years ago to meet smaller size requirements, we ran into major problems with sodium ion contamination," recalls Trevor Smith, manager of mono-arrays at Fairchild's diode plant. "At the high sealing temperature [750°C] of this package, sodium ions diffused rather easily through the passivation layer.

"These ions, present in the packaging glass (which has a high sodium content) and lead material (coated with sodium tetraborate) accumulated at the interface of the passivation layer and the silicon, causing the diode's performance to deteriorate at an unacceptable rate."

The group experimented briefly and unsuccessfully with a phosphorous glass developed by IBM. It also tinkered with other glasses that cut contamination but were expensive and difficult to apply and control. After more than a month of testing, the group settled on silicon nitride as the ideal type of passivation.

"It was known as a good barrier, but developing a controllable production process was the big question mark," Smith says. "As it turned out there were no real problems to be solved, it was merely a matter of gathering and applying previous research."

After some experimentation in which silicon nitride was applied directly to the chip, the group went to an oxide-nitride laminate, using a pyrolytic process to deposit a nitride layer on top of a base layer of oxide. A surface oxide layer protects the nitride during etching and masking.

Taking over. When the task force made its report in December 1967, Fairchild wasted little time. By June 1968, 80% of the plant's diodes contained nitride passivation; now the figure is around 95%.

While the nitride passivation process was the prime reason for drastic reductions in failure rate, Smith points out two other changes in the package.

"We improved the back contact metallurgy of the chip to eliminate nonuniform alloying that had occurred and also eliminated some variations of oxide surface contamination by putting a field plate on the oxide surface." By covering the oxide surface with a metal plate, the surface of the oxide can be maintained at the same potential as the reverse bias at all times. This eliminates the charge and discharge of the surface during operation.

Since expensive reliability screening tests were no longer needed, the cost of producing the nitride-passivated diodes did not jump substantially.

Consumer electronics

Factory approved

Late in June, technicians from the Public Health Service's National Center for Radiological Health began moving into the plants of over 20 domestic producers of color television receivers as well as to the receiving points for five major overseas producers.

The purpose of the Federal invasion is to let the National Center see for itself whether or not the manufacturers have licked the problem of radiation emission. An official of the center says: "The manufacturers feel that they've got the problem under control; and it's up to us to make sure that they have, under the provisions of the Radiation Control for Health and Safety Act of 1968."

Rug lifters. Investigators from the National Center are looking at sets in plants, at distribution centers, and in storage areas and measuring them on the spot under various conditions. Out of the many sets that will be subjected to cursory on-the-spot checks, some 200 will be brought back to the center's laboratory in Rockville, Md., for further analysis. Officials at the center plan to have all the test data available by October 1.

Specifically, the tests will include measurement of voltage and current on each component capable of emitting X rays produced by line-voltage changes and set adjustment, measurement of X-ray exposure at accessible locations around the set, and measurement of replacement components recommended by the manufacturer.

According to an official of the center, it is conceivable and desirable that the results will be completely negative—that is, no sets will be found to exceed the recommended safe level of 0.5 milliroentgens per hour. The center will also

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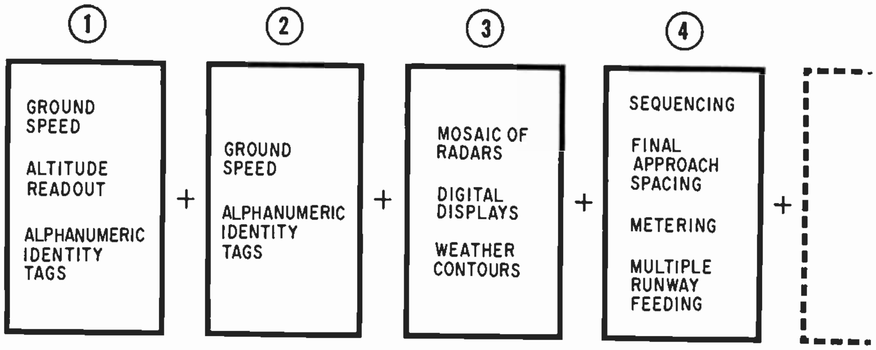
be using the study to give it an idea of where to set the safe standard which will eventually become law. The radiation control act calls for a standard which is "reasonable and technically feasible." Says a center official, "The survey will tell us how far below 0.5 we are able to read with the monitoring equipment now available. If a set's radiation is unmeasurable then we've got to assume that we've reached the optimum level."

It's the law. Meanwhile, with a minimum of fanfare, the first in a series of regulations carrying out the provisions of the radiation control act of 1968 have just become law. Among the regulations now in effect: manufacturers who discover that any of their electronic products are defective must notify the Secretary of Health, Education, and Welfare immediately as well as its dealers, distributors, and customers. The maker is required to remedy any defect without charge, replace the product, or refund the cost of the product. The new rules also call for a sampling of imported electronic products to be tested and for the destruction or exportation of imported products which are not remedied.



Picturing ARTS. The FAA's beacon-tracking system for 64 airports provides the automation base to permit growth by modular expansion.

Air traffic control

State of the ARTS

Given the current air traffic control mess at U.S. airports, it is understandable that more than one cynical airline official has commented that anything the Federal Aviation Administration does to alleviate the problem will be too little and too late. However, the FAA is plugging away, and at least one program looks as though it might offer relief in the not too distant future.

While the FAA's air traffic control development division, in charge of technical development of data-processing and display programs, has several on-going programs, the most promising for modernizing air traffic control is the ARTS-3 (automated radar terminal system) beacon-tracking systems for 64 major airports. Earlier this year, Univac got $35 million for fabrication, testing, delivery, and installation of the systems with deliveries scheduled from May 1970 through October 1972.

ARTS-3 features radarscopes that provide automatic alphanumeric readouts on ground speed, altitude, and identity. Though the ARTS alphanumeric concept has been around for some time, ARTS-3 is now a going concern with some up-to-the-minute concepts. John C. Mercer, chief of the division, says: "As air traffic continues to increase, it's very likely that the most important contribution of ARTS-3 will not be the improved display of radar identity, altitude, ground speed, and other controller aids, but the automation base it provides."

Growth ahead. Under the terms of the contract, Univac must deliver a total hardware-software system, which will consist of a data-acquisition subsystem from Burroughs, a data-processing subsystem provided by Univac, and a data-entry and display subsystem by Texas Instruments. ARTS-3 will be modular; it could be expanded to do more jobs and provide high levels of automation. Moreover, modularity means each system can be tailored to the particular requirements of each airport. The FAA believes that additional expansion of the basic system will yield automatic sequencing, fail-safe capability, digitized map and weather displays, and the other elements needed to give full digital terminal automation.

According to Mercer, work is progressing on computer-aided approach spacing for the system along with efforts to develop software for a multiprocessor executive monitor. The ARTS-3 metering and spacing system will provide time-to-leave data, suggested initial headings, time-to-turn, and other variables in aircraft operations. In addition, planning is under way for automated all-weather ground guidance and control for the system.

The FAA plans to have the initial ARTS-3 working by November 1970 with the other facilities coming on line rapidly. Meanwhile, the airline industry feels that the FAA is finally moving toward its planned automation of air traffic control. One airline spokesman says: "I think for once we are seeing some real progress in this area by the FAA. The real question is why that progress didn't start sooner."

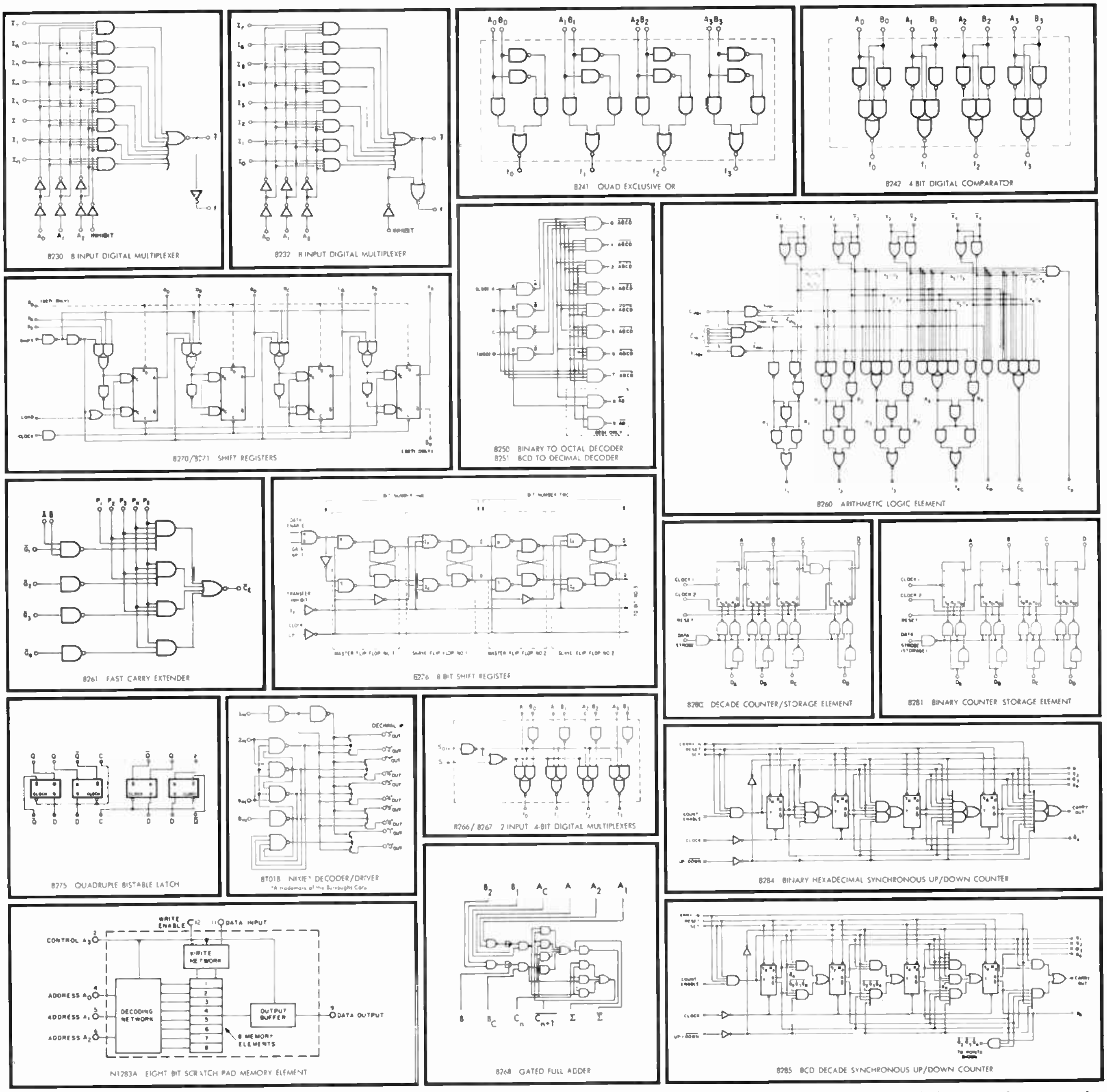
Commercial electronics

Game of tags

When General Electric announced a $10 million contract with J.C. Penney, the department store chain, for the Tradar (transaction data recorder), it was claimed that no other on-line, point-of-sale data system was available. But apparently no one had asked Ricca Data Systems of Santa Ana, Calif. That little company (less than $1 million in projected 1969 sales) has an on-line, point-of-sale system that president Joseph Ricca claims will be much cheaper than Tradar.

More than that, Ricca now has commitments from three large de-

Good heavens. If we still haven't mesmerized you with all the magic arrays Signetics makes, what do we have to do? Conjure up a picture?



P.S. To keep you posted on our whole array of arrays, we've made a king-sized poster of this ad. (Just the thing for your rumpus room—or your purchasing agent's wall.) Offer limited; send today. And please: stop squinting!

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Signetics Corporation / 811 E. Arques Ave., Sunnyvale, Calif. 94086 / A subsidiary of Corning Glass Works partment store chains for about $1 million worth of equipment, one of which will be a completely automated point-of-sale system that, like the GE-Penney system, eliminates the cash register. Both systems employ terminals to automatically read merchandise tags, customer credit cards, and sales clerk identification cards. Both incorporate on-line data processing to check a customer's credit and to control inventory. Both can also be used manually for cash sales.

You're it. Ricca says the chief differences between the two are that his firm has adapted itself to the retailer's way of doing business by using the perforated Kimball Systems merchandise tag already in widespread use while the Tradar requires a new, magnetically-coded merchandise ticket. The Kimball ticket costs about 5 cents; Ricca says retailers have estimated that the magnetic tag costs 10 cents. Further, Tradar uses a central GE 415 computer backed by a second 415; the two rent for about $35,000 a month. The Ricca system can use dual Raytheon 703 computers; such an installation can be purchased for roughly $140,000. The terminal sells for $4,000.

One Penney official, however, points out that the Penney system can control 1,500 terminals vs. 128 for the Ricca system. In addition, the GE 415's can be used both for on-line point-of-sale work or for batch processing as a central complex. The Ricca system simply augments the store chain's central data processing center.

The Ricca system marries fiber optics and phototransistors to optically read the cards its terminal accepts. In an operation that takes several seconds, first the clerk inserts her identification card into the one-slot terminal to unlock it. A high-intensity bulb shines through holes in the card, and the light is "transmitted" by fiber-optic lines to the output stage of a Ricca-developed fiber-optic cell, where it is detected by silicon phototransistors. These are furnished by Fairchild Semiconductor, and their output is linear, the current varying according to the presence or absence of light.

In a cell. The fiber-optic cell was developed by Ricca engineers to cope with the close spacing of perforated dots in the merchandise tag. The dots are detected in an area of the cell that is just 60 by 90 mils. Then the 120 fiber-optic lines that bring the light signals out to the photosensors blow up the dots to an area 2.5 by 3 inches.

There is one phototransistor for each of the 120 fiber-optic light points; their "hole" or "no hole" indication is converted to a digital signal in the automatic reader in the data terminal. The clerk's identification number is printed on the sales slip generated by the terminal and also stored in a disk file included in the system. Or, it can be held in core if the terminal is being monitored on-line for inventory.

When the clerk removes her card and inserts the Kimball tag, the reader again goes to work, illuminating the 1-2-4-7 (nonbinary) code on the tag. The transistor output is digitized and sent to the computer, where it is converted into a binary 0-1-2-4-8 code.

The punched code in the merchandise tag contains such data as the store department number, vendor of the item, style, classification (if clothing, dress, skirt, slacks, etc.,), color, size, and price. The price, which can be overridden by manual entry for marked-down items, is displayed on a 10-digit cold-cathode readout tube display on the terminal. All the data is carried over a single twisted pair of wires for temporary storage in the computer memory and then goes into the disk file for automatic inventory control.

Finally, the clerk removes the merchandise tag, loads the customer's perforated credit card into the slot, manually enters any tax charges using the terminal's 10 numeric keys, and triggers the "total" key—one of 15 programed function keys (verify customer credit, verify inventory, and the like). If the customer has exceeded a prearranged credit limit, the terminal will not release the credit card, and a similar terminal in the credit manager's office will indicate which station is balking. This is one of the strongest features of the system, Ricca says, adding that it can save the user half his bad-debt write-off which could amount to about half the typical after-tax profit of 4%.

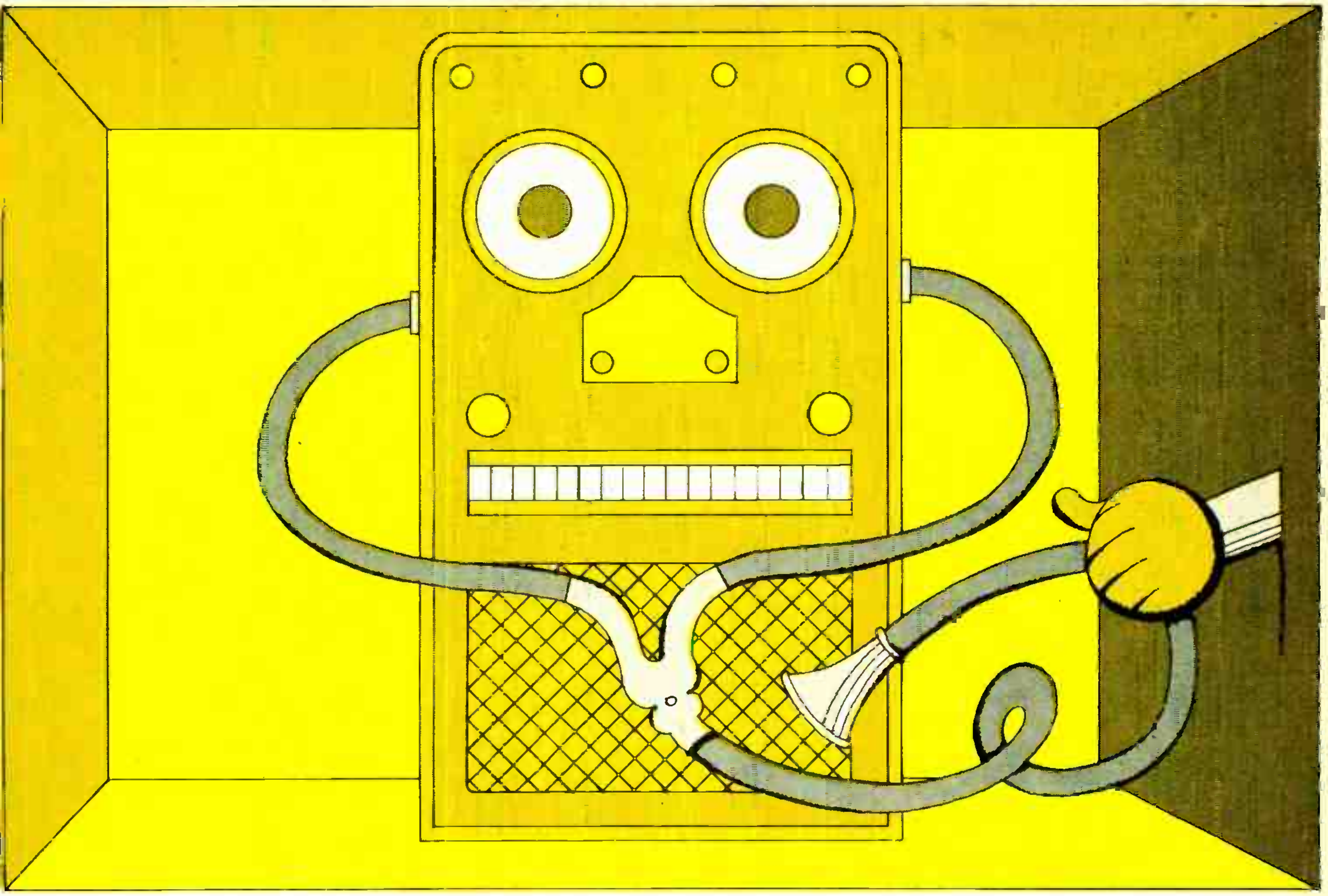
Communications

What if . . .

Two Naval laboratories, six electronics firms, and assorted individuals are currently involved in the early development work on a uhf communications transceiver for mid-1970's—but it probably won't even be plugged in. Those who are directing the multimillion-dollar program for the Naval Electronics Systems Command hasten to explain that the Navy isn't casting bait for waste-watching Congressional investigators; rather, it's setting up a hypothetical system to help coordinate its component research and development program.

"While the odds are that the transceiver will never be built," says one project official, "the odds are good that elements of that transceiver will pop up in a variety of communications systems." He adds, "The transceiver is intended to serve as a cohesive and unifying vehicle for the feasibility of electronics components." The program began with the identification of a hypothetically ideal system. Specifications were written for the ultrareliable (15,000 hours mean time between failures), compact (45 cubic inches), and versatile (capable of operating with all types of modulation) system, and a detailed block diagram of the system was produced. Nine items were identified as necessary for initial development.

On the receiver end the Navy identified the following needs: a microelectronic receiver technique study, gyrator integrated circuit filter development, a 400-megahertz monolithic prescaler, an LSI correlator, an electronic tuning study, a monolithic balance mixed product detector, and an LSI digital frequency synthesizer for uhf. On the transmitter side, it was decided to call for a study of IC's for uhf



No time for downtime

A machine as complex as the Bell System's new Electronic Switching System (ESS) must help with its own maintenance. Consider, for example, that an ESS installation in a single Bell System central office can perform nearly a billion and a half switching, logic, and memory operations per second. And that we expect it to provide service for 99.999 percent of the next 40 years. Also, that the system employs a totally new concept: "stored program control." That is, each of the many actions in connecting one telephone with another is governed by a central digital data processor which draws upon program instructions and other stored data; new and revised features are incorporated by changing memory content rather than by rewiring.

All of this makes traditional servicing obsolete, and calls for advanced ideas in reliability and maintenance of electronic equipment.

Vital units such as the central data processor and the memories operate in pairs: if one unit ever falters, its twin maintains service. But, because there is no standby until the defect is repaired, ESS itself helps with the work. For instance, there are three principal fault-detection schemes:

"Match and Check Circuits" constantly compare critical information in duplicated units.

"Audit Programs" check that the system's temporary memory reflects what is actually going on.

"Exercise Programs" use the brief intervals between telephone calls to check all circuits, including those for maintenance.

If a fault is found, alarms operate and "fault recognition" programs take over. These automatically find the defective unit and reroute the information flow through its duplicate. Or, if the problem is simply a memory error, it is corrected. Such actions take less than a millisecond; office operation is unaffected.

Finally, "diagnostic programs" test any faulty unit, store the results, and print them out with a reference number. A craftsman looks the number up in his "ESS Troubleshooting Manual" and finds a list of possibly defective circuit packs. He replaces one or more of them to clear the problem.

Over half of ESS—circuits and stored program—is devoted to maintenance. But only with modern techniques can so complex a system meet today's communications needs.

From the Research and Development Unit of the Bell System—

Bell Labs

transmitters and a study of high-power metal oxide semiconductor, field-effect transistors.

Spread. Several elements will not be contracted until later this year, but six firms are engaged in work on the transceiver now. Laboratories at the Naval Air Development Center and Electronics Systems Command are working on the program. General Electric is conducting the receiver technique study, ECI is working on IC's for the transmitters, and Collins Radio on the electronic tuning study. Westinghouse is working on the gyrator IC filters, and Motorola on the monolithic prescaler. TRW Systems is working on the LSI correlator.

With the program still in infancy, opinions already have been generated. "For one," says one project official, "I think it's keeping us away from the 'bandwagon effect' where the tendency is to jump on a bandwagon like LSI and put all development money in one area."

The Navy has already begun to see that there is potential in certain elements—like the LSI correlator—and those elements are being considered for inclusion in advanced systems. Another feeling is that the program keeps component development moving in all areas under a single banner of no small importance is the fact that the hypothetical system acts as a focal point for the attention—and the funds—of the Navy hierarchy, whereas component R&D conducted in the traditional element-by-element fashion might generate less enthusiasm.

Memories

Radiating confidence

Building a hardened plated-wire memory capable of functioning at high gamma and neutron radiation levels in an advanced ballistic missile isn't easy. The technological challenge apparently has been met, however, in a plated-wire memory with a capacity of 16,000 words of 32 bits each and a 500-nanosecond access time now undergoing final testing at the Autonetics division of North American Rockwell.

Although under company-funded development for several years, the memory was radiation-hardened in response to a development request-for-proposal from the Rome Air Development Center. While Autonetics didn't get the subsequent contract, which went to Univac and Honeywell, the company is confident that its accumulated plated-wire technology will pay off.

Called the M-2, the memory has a 1-microsecond read and 2-μsec write capability, with nondestructive readout, and features a dual port input to permit interfacing with two systems or computers.

Architecture. A high degree of radiation immunity was achieved through several ingenious design features, according to Tom Bohen, manager of advanced memory systems for the Autonetics Data Systems division. Among them are the timing source—a hardened 20-megahertz oscillator with flip-flops —and a counter. Output to the counter is decoded to generate the time returns. Also, a unique word matrix reduces static bias to zero and prevents loss of stored information while under maximum prompt (gamma) radiation. Overdesign of the circuit permits normal operation even when the discrete transistors are radiation degraded.

Photo current and current source shunts are used in the word matrix to protect the memory array from radiation-produced current. A detector of proprietary design activates a four-transistor network circuit clamp, which in turn short circuits the current source.

The sense matrix/selection matrix is off-line from the bit drive; it employs specially developed low-level switches and dielectrically isolated integrated circuit sense amplifiers that take 5-millivolt input signals from the array and amplify them to 4-volt transistor-transistor-logic levels. The off-line arrangement, says Bohen, minimizes the current. He explains that an in-line configuration would require large junction and bias devices to pass the bit current, resulting in leakage to the array. To

minimize bit-drive leakage under prompt radiation, the bit-drive matrix transformer is coupled and floating, with the positive and negative bit drivers matched, employing the smallest amount of circuitry possible.

Half means double. Half-word selection in the memory gives alternative capability of 32,000 words of 16 bits each. Organization permits use of only eight TTL packages. Because the memory is multiword organized, it can put many words on one access line, making large array plated-wire memories potentially competitive with core electronics, Bohen says.

Multiplexing from the array is performed by five matched 2N4251 npn radiation-tolerant transistor switches in a single 14-lead package.

The problem of displacement current, which results when incident radiation ionizes materials, has received considerable attention from Autonetics engineers. "We took special care to be symmetrical in the design of our sense line loop so that displacement current doesn't affect the signal-to-noise ratio in the amplifier," says Bohen.

Ground up. Other radiation-resistant mechanical design includes low, matched-impedance power distribution, with power cables carrying 1 ohm or less to permit rapid power-supply recovery. Aluminum-to-aluminum bonding is used for all devices, and materials with low atomic numbers are utilized elsewhere to minimize secondary radiation effects resulting from atomic collisions in heavier metals, such as gold. Finally, wire aging has been effectively reduced through several proprietary changes in processing and in the on-line annealing cycle.

Bohen believes that plated-wire arrays will be competitive with core memories in the near future, both in large-scale, high-speed military computers, and in commercial applications where access times faster than 1 μsec are required. Semiconductor memories, predicts Bohen, won't make serious inroads into plated-wire applications for six to eight years.

Management

All in the family

When R.L. Petritz, L.E. Sharif, and L.J. Sevin left Texas Instruments it was obvious that they would go into the burgeoning metal oxide semiconductor business—they were key men in TI's MOS operation.

Now their Dallas-based company, Mostek Corp., has made a deal for the manufacture of large-scale MOS arrays at Sprague Electric Co.'s IC facility in Worcester, Mass. Not only that, but Mostek's products will be marketed through Sprague's distribution network.

Investor. The agreement also includes financial backing by Sprague and a provision for sharing research and development efforts to advance the technology of MOS devices as well as new circuit techniques for their application. Petritz, Mostek's president, says: "This joint participation will bring to the MOS field a large manufacturer of components and circuits with a very broad base in both active and passive technology, and one which is not a competitor of potential Mostek products in the equipment and systems field."

Another substantial investor in Mostek is New Business Resources, a Dallas venture-capital partnership formed about a year ago by Petritz and Richard Hanschen, former marketing manager of TI semiconductor operation. It was New Business Resources that got Sprague and Mostek together. However, this wasn't the first time that Sprague and New Business Resources teamed up.

Pirgo Electronics Inc., a manufacturer of power transistors and triacs in Farmingdale, N.Y., got started the same way about seven months ago. And Sprague, happy with its two new children, has found a way to branch out into new areas without taxing its management, engineering personnel, or capital.

TI moves. Meanwhile, back in Texas, TI was left with a few vacancies, so a reorganization was in order. J. Rodney Reese was called back from a subsidiary presidency to head most of TI's semiconductor

SCIENCE/SCOPE

The first five laser rangefinders for the M60 tank were delivered on schedule to the U.S. Army on April 30, and tests are now being conducted at Fort Knox and the Aberdeen Proving Grounds. When the commander selects his target and his gunner flashes the laser at it, the range appears on a readout and can also be fed automatically into the tank's fire-control system -- greatly enhancing the first-hit capability of the M60's 152-mm. gun.

A holographic technique for detecting flaws in honeycomb panels without destruction or contamination of the structure was demonstrated recently by Hughes Research Laboratory scientists. They stressed a fiberglass-aluminum panel and made a reflection interferogram of the strain pattern. The points where fiberglass and aluminum had failed to bond were easy to detect. They used a Hughes-developed stop-action holography system which provides images with photographic resolution, and can record dynamic strain patterns.

NASA's next Applications Technology Satellite, the Hughes-built ATS-5, has completed its environmental testing and is scheduled for launch in late summer. It will carry out a total of 13 experiments. One of the most significant will determine whether L-band frequencies will give better-quality radio communications between aircraft and between ships and shore stations. Another will test the feasibility of the gravity-gradient principle for stabilizing synchronous satellites.

Using heat pipes to cool high-density electronic packages and flatpack circuits is being studied at Hughes/Fullerton. Heat pipes are cooled by liquid evaporation, and can dissipate 1000 times more heat than solid metallic conductors of the same size. Hughes engineers are determining optimum structural geometry, operating fluid, and wick and shell materials for future applications.

More than 100 engineers from 10 nations met at Hughes recently to coordinate their efforts on the Intelsat 4 communications satellite program. They represented 10 companies which, with Hughes, are building four of the satellites under a $72-million contract awarded by Communications Satellite Corp. on behalf of the 68-member International Telecommunications Satellite consortium. A similar meeting of manufacturing executives is scheduled for September.

Hughes is hiring engineers: Radar Systems, Optical, Electro-optical System Analysis (IR, LLTV, Laser), Digital Systems, Spacecraft Systems, Circuit Design, Missile System & Vehicle Design, Ordnance Specialists (SAF Systems), Electromagnetics Test (EMI/EMC). Requirements: B.S. degree, two years related experience, U.S. citizenship. Please write: Mr. J.C. Cox, Hughes Aircraft Company, P.O. Box 90515, Los Angeles 90009. Hughes is an equal opportunity employer.

The high-reliability component selection programs which Hughes has used for its communications satellites since 1963 have contributed to a phenomenal record: no significant failures in more than 1.5 billion component-hours aboard the 10 Hughes-built satellites now in orbit for DOD, NASA, and Comsat. Programs use Hughes-developed electronic component screening and power aging techniques.

marketing activity. A new division, called advanced technology and strategic planning, was formed in the components group; it will be headed by Glenn Penisten, a vice president formerly in charge of marketing for the components group. Ray Cotton, who was manager of customer centers, will take over Sevin's former job as the head of the MOS technology customer center. Also, the old materials and services group was split into equipment, components, services, and metallurgical and chemical materials.

Avionics

Short subject

The short-haul airliners developed after 1975 will land and take off with as long a run as seagulls need on a dock piling—and with less of a flap. Called V/STOL's for vertical/short takeoff and landing planes, the aircraft will have to carry advanced avionics gear to assure all-weather landing, navigation, and perhaps flight-control capabilities. Landing on a dime is harder than landing on an airstrip simply because dimes are smaller.

NASA's Electronics Research Center in Cambridge, Mass., is developing the necessary avionics techniques in its V/STOL avionics program, while NASA's Langley Center conducts flight tests as part of a cooperative effort. NASA wants to refine approaches which are economical enough for civil use and then make them public property. Thus, no systems as such are slated to come out of the program, just knowhow.

Since ERC began the V/STOL avionics program in 1967 it has become the center's single largest research area, taking an estimated $2 million of ERC's fiscal 1969 expenditures [*Electronics*, Dec. 25, 1967, p. 44]. It already has passed through much of the first helicopter flight-test phase at Langley, Va. Phase I should be completed by September 1970, but ERC already is gearing for Phase II with fiscal 1969 money.

Spinoff. Phase I is using Gemini spacecraft guidance and navigation hardware to plot benchmarks for later navigation studies. Thus the performance of the Gemini G&N equipment has been gauged during takeoffs, landings, and other flight situations. The usual procedure has been to track the H-19 helicopter with radar to see where it really went, then to compare this data with the Gemini equipment's estimate. Often radar positional information is used in flight to update the guidance system.

But while very accurate (Richard J. Hayes, an assistant director of ERC, compares it favorably with the best of today's instrument landing systems), the Gemini hardware costs too much for civil use. Perhaps a less costly inertial system would suffice if coupled with Decca, Loran, or other aids.

In Phase II, ERC will begin to investigate computer-aided control as well as navigation, figuring that V/STOL's will be nearly as much work to pilot as today's helicopters; that is, too much.

Proposal requests were mailed this spring and by the end of this month contracts should be signed for a guidance computer, a data adapter (which would translate control commands, navigational data, and aircraft sensor information into digital form), a cockpit control panel for the computer, and a software package.

ERC hopes to have the computer subsystem hardware (including the data adapter and control panel) in hand by late 1969. An inertial sensing unit will be built in house by early 1970, and a complete software package with provisions for computer-aided attitude control, navigation guidance, steering, flight control, and other functions should be on hand by mid-1970.

With the resultant Phase II package, a digital system with both a strapdown inertial reference (developed in-house at ERC) and inputs from radio navigational aids, NASA would investigate computer-aided flight control.

Busy. While the navigational aids would provide positional updates for the computer and inertial refer-

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The result would be reduced pilot workloads and more accurate navigation and control, but accomplishing this is only half the task. The other half is to do it cheaply.

So ERC is going to chip away at cost. With this in mind, the digital system is being made flexible enough to accommodate not only potentially inexpensive strapdown inertial references, but also laser gyros which might not only prove very accurate, but very inexpensive: "Just a matter of boring holes in a quartz block," says an ERC spokesman, "and that makes for very low parts costs. The laser could also be made redundant very easily merely by boring another system of holes in the same block of quartz," he adds.

Some radio aids are almost certain to be necessary and to determine the best price-performance ratio, ERC is prepared to select among Loran-C, Decca, ILS (instrument landing system), Tacan, VOR (vhf omni), DME (distance measuring equipment), and other systems.

For the record

Short tube. Sylvania is taking orders for 1970 delivery of a 3-foot-long CO_2 laser developing 1 kilowatt; efficiency is 10%. The laser is designed for cutting and drilling, though it can be used for radar. Most kilowatt lasers are about 60 feet long; Sylvania's Electro-optics Organization gained high power density with a blower in the vacuum system that sends gas through a heat exchanger transversely across the laser region for cooling. The conventional way is to send it down the entire length of the tube.

TTL surge. The effects of the Texas Instruments price cut for transistor-transistor-logic circuits is

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TD5441A	TG5450	TG5451	TG5453	TG5454	TG5460	TF5470	TF5472	TF5473
TF5474	TL5475	TF5476	TA5480	TA5482	TC5490	TC5492	TC5493	TG7400
TG7401	TG7402	TH7404	TH7405	TG7410	TG7420	TG7430	TG7440	TD7441A
TG7450	TG7451	TG7453	TG7454	TG7460	TF7470	TF7472	TF7473	TF7474
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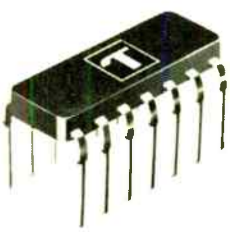

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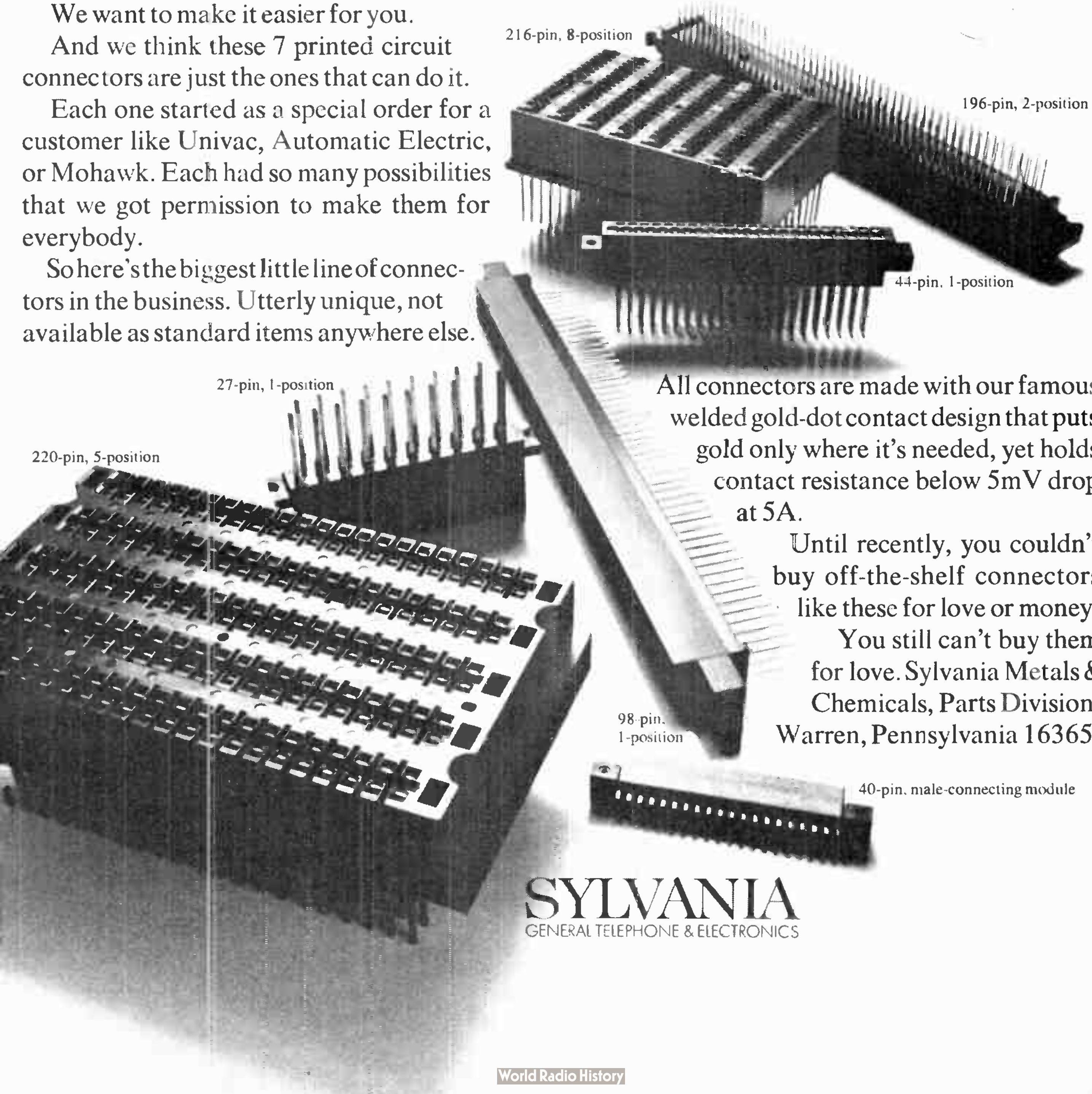

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Washington Newsletter

July 7, 1969

MOL layoffs top Air Force estimates

What used to be a tight labor market for the electronics industry is rapidly loosening as a result of layoffs after cancellation of the Air Force's Manned Orbiting Laboratory project—and it may become even looser than the private Air Force estimate of between 16,500 and 17,500 layoffs indicates.

General Electric, for example, which the Air Force estimated would drop between 1,000 and 1,400 workers, recently gave the ax to close to 1,700 of its Valley Forge, Pa., Space Center staff. If Air Force estimates for the other MOL contractors prove equally conservative, the number of layoffs could rise well beyond the 12,500 projected for prime and major subcontractors, as well as the 4,000 to 5,000 estimated layoffs at lower tier vendors.

In addition to G.E., the Air Force is forecasting cuts of 4,500 to 5,000 for McDonnell Douglas at the firm's Huntington Beach, Calif., facility and another 2,000 at its St. Louis plant as well as 1,600 for Martin Marietta.

NASA's budget has its ups and downs . . .

NASA is still riding a budgetary roller coaster for fiscal 1970. It will probably wind up about where it was in fiscal 1969.

Given a lift when the House voted the agency $3.9 billion [*Electronics*, June 23, p. 69], **space officials are girding for another downhill turn because the Senate is expected to hold the line at $3.7 billion.** This means a compromise appropriation will have to be worked out and chances are that the space agency will come out with slightly less than $3.8 billion.

Even so, NASA will still have $3.9 billion to spend, thanks to the $117 million put in reserve during fiscal 1969.

. . . as job mix falls far short of needs

NASA's budgetary problems are giving rise to yet another headache: an imbalance in the mix of professional disciplines is beginning to take its toll in several in-house research programs. **Among the programs most seriously affected are those dealing with aircraft-noise abatement, air safety, and biomedicine.**

Space officials want to hire additional research talent, but claim they can't unless Congress loosens the purse strings.

FCC investigating its own R&D role

The Federal Communications Commission's small R&D staff is initiating three studies that **indicate a more progressive look for the commission in technical planning and the possibility of a bigger research and development push in the future.**

A two-year survey of frequency assignments for microwave systems is being negotiated with Communications & Systems Inc., a subsidiary of the Computer Sciences Corp. Estimated contract price is about $200,000. Also, the commission will turn over an undisclosed sum to the Commerce Department's Institute for Telecommunications Sciences in Boulder, Colo., for a broadband-technique study; **the study will determine what kind of impact new technology now in the laboratory will have on communications in the future.** The institute, in the course of the study, will assign specific duties to various universities. Finally, Earl Cullum and

Associates of Dallas have been selected for a $38,000 nine-month study of the current and potential future role of the FCC's R&D lab. One basic question to be answered is how large an in-house R&D capability the FCC should have.

In addition to this flurry of studies, the FCC is one of the Federal regulatory agencies with small R&D staffs considering the establishment of their own think tank, the Institute for Regulatory Agencies [*Electronics*, June 9, p. 75].

Self-destruct IC's sought by Navy

If nothing else, the Pueblo incident has taught the Navy that fire axes—and even hand grenades—are unsuitable destruct mechanisms for sophisticated equipment; the vessel was captured with its electronic gear intact. **What the Navy now wants, particularly for its new cryptographic gear, are self-destruct IC's.**

The next round of bids is expected to include various destruct techniques. **Some possibilities: a hermetically sealed destructive high-voltage source in each circuit and a variety of pyrotechniques.**

In other upcoming contracts, the Navy will be zeroing in on functional packaging for LSI, praetersonics, and ionizing radiation as an etching agent for microcircuits.

Samso chief's image may be hurt by profit probe

Revelations of escalating Air Force costs on the Minuteman, and Senate testimony before Wisconsin Democrat William Proxmire's subcommittee, could shoot down the rising star of Lt. Gen. John W. O'Neill, commander of the Space and Missile Systems Organization. O'Neill has been widely touted as the next commanding general of the Air Force Systems Command.

Most damaging to O'Neill's chances is the Proxmire disclosure that A. Ernest Fitzgerald, the Air Force deputy for management systems who has been blowing the whistle on cost overruns, advised O'Neill in writing more than 18 months ago of the cost problems associated with the Minuteman program.

Weigh Tiros-N for early 1970's

NASA may launch two, not one, Tiros experimental meteorological satellites.

With the launching of Tiros-M still three months away, the space agency is considering launching another—tentatively called Tiros-N—sometime between 1972 and 1974. About $1.5 million is earmarked for studies to determine whether Tiros-N should be planned.

Also on the meteorological front, NASA plans to issue requests for proposals for prototype synchronous meterological satellite within six months. The first satellite would be launched in late 1971, and would be used to predict and locate severe storms, analyze cloud movements, and determine wind fields. The satellite would employ hardware developed for the ATS (applications technology satellite) program, and its goal would be near real-time dissemination of weather data.

Addendum

FCC chairman Rosel H. Hyde has confirmed capital reports that he will, at the President's request, stay at his post beyond the expiration of his term [*Electronics,* June 23, p. 34]. **He is expected to stay through summer and into the fall.**

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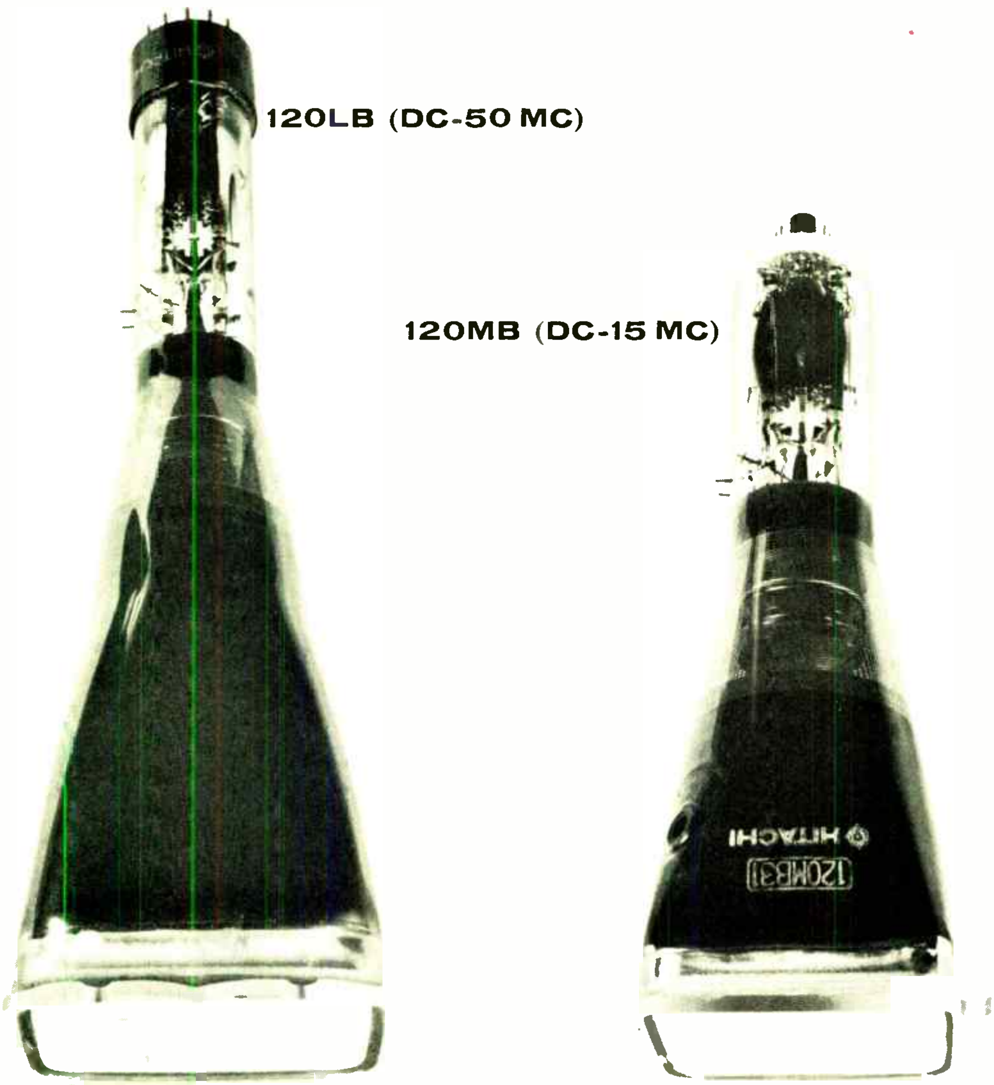
Oct. 1-7



NEW OSCILLOGRAPH TUBES FROM HITACHI

WHAT THEY HAVE IN COMMON:
These Hitachi tubes are rectangular cathode ray tubes for precision instruments, with electrostatic focus and deflection.

They all use a mesh grid and inside scale, giving them high deflection sensitivity and non-parallax observation.

They're all made by Hitachi — so you know they're good. These two, the 120LB (DC-50 MC) and the 120MB (DC-15 MC) are particularly apt for portable equipment.

ONE MAY BE RIGHT FOR YOUR OPERATION:

Item	120LB	120MB	140LB	Unit
Overall Length	423±7	318±7	466±10	mm
Heater Voltage	6.3	12.6	6.3	V
Heater Current	0.3	0.15	0.3	A
Post Accelerator Voltage	10,000	6,000	15,000	Vdc
Accelerator Voltage	2,000	1,400	2,400	Vdc
Useful Scan	80×48	80×64	100×60	mm²
Deflection Factors				
Horizontal	12—16	11—16	12—18	V/cm
Vertical	4—7.5	6—10	3—5.5	V/cm

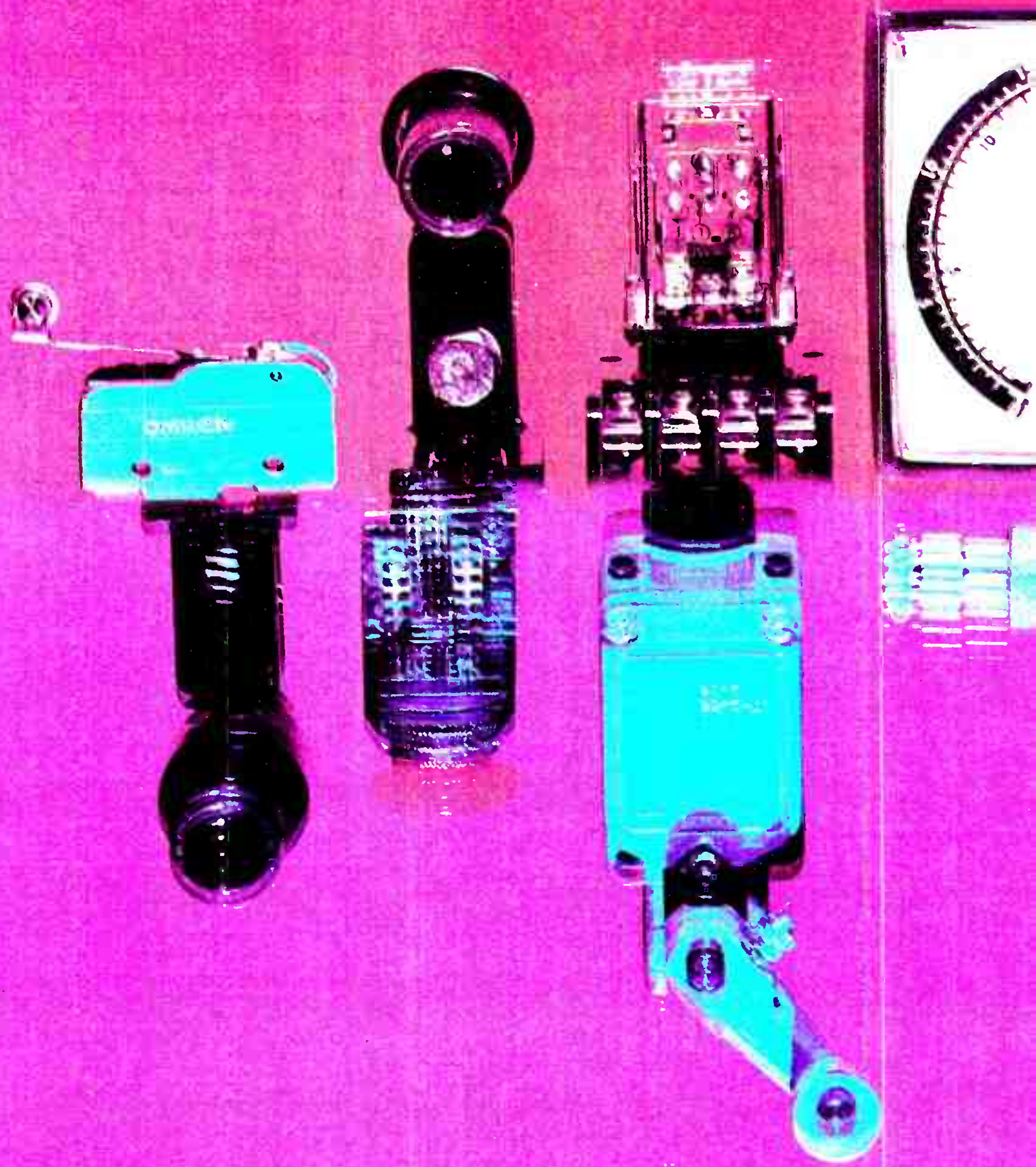
And if these aren't exactly what you're looking for, see the others — including our vidicon tubes and our cathode ray tubes for industry — from Hitachi, the people who make exacting quality available for less.

HITACHI
Hitachi, Ltd. Tokyo Japan

HITACHI NEW YORK, LTD., CHICAGO OFFICE: 333 N. Michigan Ave., Chicago, Ill. 60601, U.S.A. Tel: 726-4572/5
ELECTRONIC COMPONENTS DEPT. HITACHI NEW YORK, LTD., 825 3rd Ave. Room 2620 New York, N.Y. 10022, U.S.A. Tel: 838-7411
HITACHI, LTD., DUESSELDORF OFFICE: Graf Adolf Strasse 37, 4 Duesseldorf, West Germany Tel: 10846

Circle 73 on reader service card

Circle 75 on reader service card →



Reflected lately on controls compatibility?

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OVERSEAS DISTRIBUTORS: ● AUSTRALIA/H.Rowe & Co., Pty., Ltd. ● AUSTRIA/Carlo Gavazzi-Billman G.m.b.H. ● ITALY/Carlo Gavazzi S
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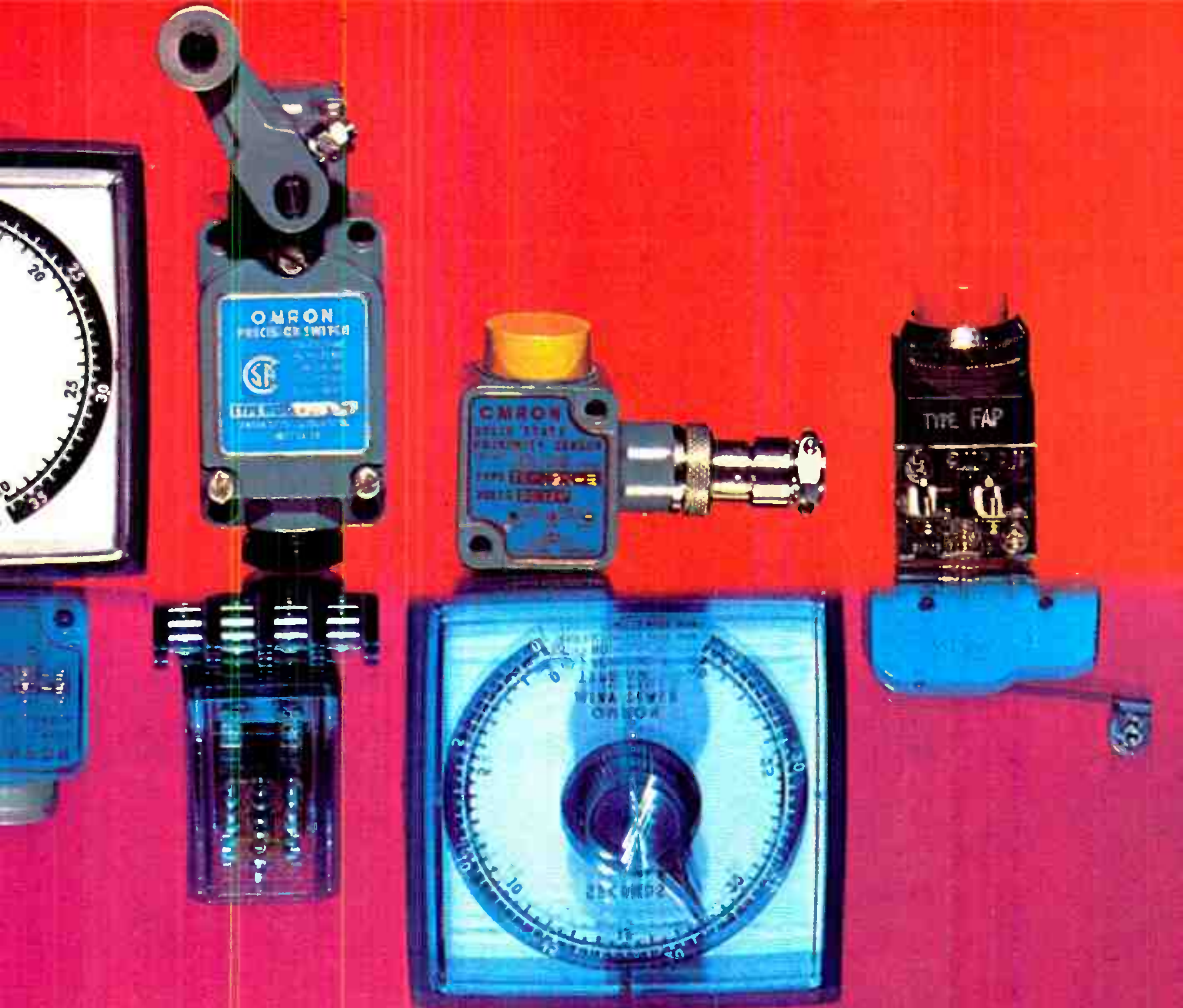

As a specialist maker of switches, relays, timers, and other controls, OMRON is very involved with the problems of inter-relating components. Unusual product-design situations, which one-control manufacturers are often not aware of, are the very starting point of OMRON design thinking. Our design engineers work in independent but closely consulting units; a practice which ensures that every switch, relay and timer is fully design-integrated and more versatile.

This total design approach has led OMRON to conclude that performance relationships between components are often as vital as the components themselves. Think about that a little.

And think of us as the multi-component specialist of world electronics. Because that's exactly what we are.

OMRON

OMRON TATEISI ELECTRONICS CO.

ANNOUNCEMENT!!

Gentlemen:
It is a pleasure for me to inform you of the recent opening of our new liaison office in New York. We have taken this step so that we may better cope with rapidly increasing trading transactions and at the same time broaden our range of customer services.
As you know, we are, and have been since our establishment in 1925, one of the leading manufacturers of electronic components in Japan. Our success, of course, is due directly to the cooperation customers like yourself have extended over the years.
Taking this opportunity, I wish to extend a warm thank you, and express my earnest desire for even greater mutual cooperation through the medium of this new liaison facility.

With kindest regards,

H. Ikeda
President

SMK

SHOWA MUSEN KOGYO CO., LTD.
Head Office: No 5-5, 6-Chome, Togoshi, Shinagawa-ku, Tokyo, Japan.
Cable: "SHOWAMUSEN TOK" Phone: 783-1171
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First, we're top ferrite core makers to the world's communications industry. We turn out between a million and 1,500,000 cores a month.

Second, few makers can match the number of Mn-Zn and Ni-Zn centered materials we use in our product and which we make ourselves.

Third, we offer the widest choice of IEC and other types of ferrite pot cores—at any and all times.

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Investigate New Sources Of Quality Products At

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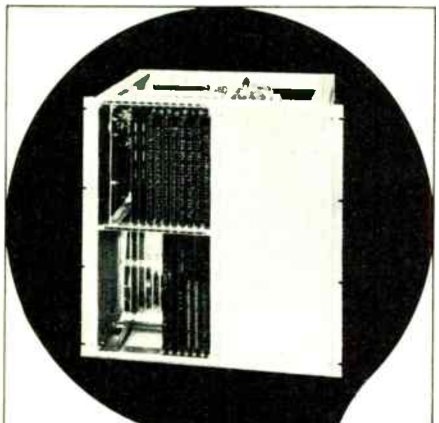

If cycle time is the name of your computer game, read the good news:

Toko Woven Plated-Wire Memory System HS-500 is now available.

Toko's woven plated-wire memory planes and stacks are already well known for their low-cost, high-performance characteristics. Now to be marketed for the first time is Toko's complete memory system, with a capacity of 4096 words by 16 bits expandable to 8192 words and 20 bits. **Cycle time is a remarkable 500 ns.** Other characteristics are 2D organization, destructive read-out operation, and TTL logic level interface. Cost of the system is remarkably low, and fast delivery can be guaranteed.

Besides this standard woven plated-wire memory system, Toko can undertake the manufacture of custom-made systems according to your specifications. Complete technical details from our New York office.

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Head Office: 1-17, 2-chome, Higashi-Yukigaya, Ohta-ku, Tokyo, Japan

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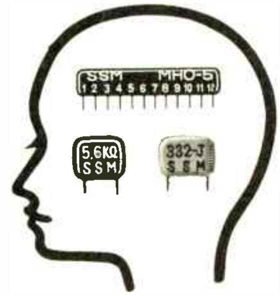
ECONOMICAL Thin Film!



What's needed for memory system is everlasting high accuracy. SSM's components are the very ones satisfying superior reliability.

- Plate-ohm: evaporated metal film resistor.
- Pla-module: thin film modulated C-R circuit.
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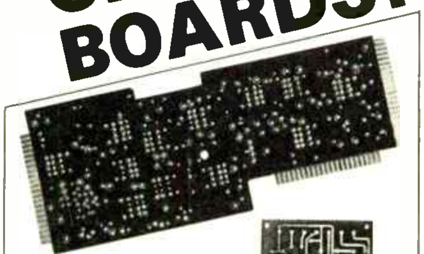
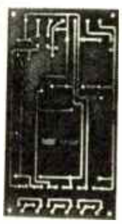


▲ For audio use

For instruments use ▶



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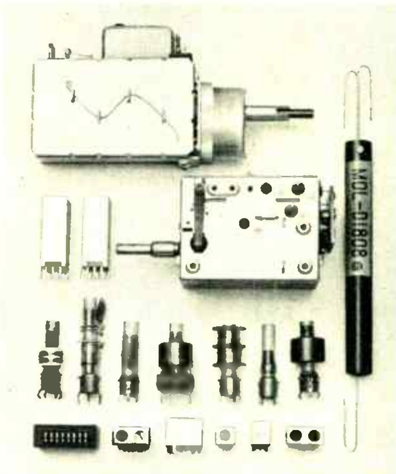
TO USE OR NOT TO USE THE MITSUMI COMPONENTS THAT IS THE QUESTION TO IMPROVE YOUR PRODUCTS



✱ MITSUMI COMPONENTS are manufactured at the most modern production plants where the latest manufacturing equipment and facilities of automatic system are employed, resulting in perfect uniform quality of the products.

PRODUCTION ITEMS

Thick Film ICs, UHF & VHF TV Tuners, Front-end FM Tuners, Car Radio Tuners, IF Transformers, Various Coils, Polyethylene Variable Capacitors, Magnetic Heads, Micromotors, Synchronous Motors, CdS Photoconductive Cells, Trimmer Capacitors, Semi-fixed Resistors, Switches, Terminals, Fuse Holders, Small Mechanical Components

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THE ONLY COMPANY IN JAPAN SPECIALIZING IN THE MANUFACTURE OF IC's

—PRODUCTS—
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* Monolithic IC's
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Do you know—

- that heart attack, the Nation's #1 health enemy, causes almost 600,000 deaths at all ages annually?
- that most patients who recover from heart attack return to their jobs?
- that you can reduce your risk of heart attack by controlling high blood pressure and by following a few simple rules in your eating and living habits?

You can learn more about heart attack and other heart and blood vessel diseases in interesting booklets prepared by medical experts. They are free, an educational service made possible by your Heart Fund. Simply visit, write or call your local Heart Association office.

GIVE...so more will live
HEART FUND®

Contributed by the Publisher

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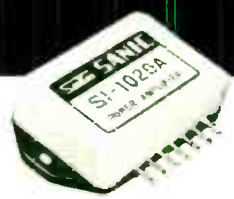
Solid-state music
charms your ears?
Now,
Let's move to
Hybrid IC.



Sanken's
Hybrid Audio Power Amplifiers are 25w and 50w

No external component required. You just put them and forget about protection and temperature.

★ Distortion is 0.5% at full power level.
★ Frequency range 20Hz to 100KHz at 1W output, 20Hz to 30KHz at full power.
★ Withstands output short circuit for more than 5sec.
★ Vcc:48V Zin:70KΩ, Zout 0.2Ω

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Circle 208 on reader service card

Primo
—A Leader in Microphone Field—

UD-900

UNI-DIRECTIONAL MICROPHONE (with tone control)

SPECIFICATIONS
- Cartridge :DM-49
- Impedance :600 ohms
- Sensitivity :—73db ± 2db/μ bar
- Frequency Response :50 to 15000Hz ± 5db
- Dimensions 50mm dia. 250mm Length

● For catalog write to
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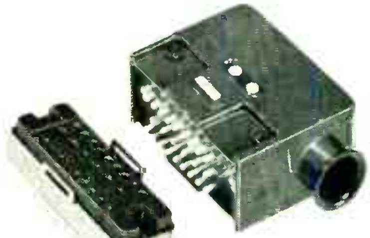
Hirose —
just about your best connection for connectors.



1300 Series
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Hirosse is Japan's leading manufacturer of printed circuit connectors, cylindrical connectors, rack and panel connectors, co-axial connectors, microminiature co-axial connectors, etc. Hirose—a good connection for people in electronics.
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Circle 81 on reader service card

Bring Your Measuring Problems To Tokyo

October 11-15, 1969

13TH JAPAN ELECTRIC MEASURING INSTRUMENTS—AUTOMATION EXHIBITION

Panasonic Presents Its Sensitive VP-549A Oscilloscope– 5mV/cm: DC-150MHz

This carefully constructed solid state model offers a sensitivity from 5mV/cm to 5V/cm throughout a frequency range from DC to 150MHz. 1 mV/cm, DC to 35MHz with CHI and CH2 cascaded. Plus a host of advanced innovations.

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PAN-AM Building, 200 Park Avenue, New York, N.Y. 10017 TEL 212-973-5700
O'HALLORAN ASSOCIATES
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Circle 212 on reader service card

Superimposed Noise Problems

Solved!

-TR-5589L
250MHz Universal Counter

This counter employs a unique ANS Circuit (Automatic Noise Suppressor...patent pending) in its input circuit. If a large signal to be measured and superimposed noises are fed to a counter, the counter may count both the signal and noise since the trigger threshold level is extremely narrow.

The ANS solved the noise problems by keeping the input signal level constant at all times regardless of the magnitude of the input, thereby maintaining the trigger threshold level at the optimum value.

When considered from the input side, the trigger threshold level will increase when a large signal is received, or, decrease when a small signal is received. This operation reduces the error due to noise mixed in the input signal. Since the counter has an input sensitivity of 10mV rms, frequency measurement of an extremely low voltage signal is possible, and measurement of 100V rms signal is also possible with the single range without the use of an attenuator because of the 80dB dynamic range.

FREQUENCY RANGE—Counts directly up to 250MHz in decimal, up to 500MHz with prescaler plug-in unit, covers 10Hz to 12.5 GHz with frequency converter plug-in unit.

HIGH STABILITY—Long term stability 5 parts in 10^{10} per day.

HIGH SENSITIVITY—10mV to 100V rms in a single range...wide dynamic range...80dB.

DISPLAY—9-digit storage display.

BCD OUTPUT—8-4-2-1 code output.

PLUG-IN VERSATILITY—9 plug-in units increase the counter's versatility as required.

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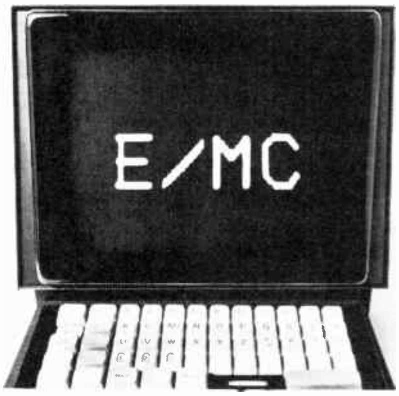
Electronics Profit.

How McGraw-Hill's new Electronics/Management Center can help you improve it.



We've created a unique information system for the management of companies in and around electronics.

We call it the Electronics/Management Center.

E/MC combines the specialized experience of the publishers of ELECTRONICS Magazine, with the broadly-based facilities of McGraw-Hill, one of the world's largest corporations devoted to increasing man's knowledge.

In thirty years of electronics experience, we've accumulated the background and talents to produce the problem-solving tools you need. The kind that are essential when living with lasers, making your way through the implications of Large-Scale Integration, and meeting the technical revolutions yet to come.

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For your company, we'll plan, execute, and analyze custom projects—to meet an objective of general, technical, or marketing management. Or to establish a new objective.

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We can help you reduce marketing risks, too.

It's difficult to move around the electronics industry without bumping into both customers and competitors in the same corridor. We can probe new market potentials without revealing your identity. Or conduct research in an area not too familiar to your own staff.

We can do it in a neat package that combines access to the market with complete maintenance of confidence.

We can also supply those complex services you'd like to have created outside if you could find someone who speaks your language. Services like seminars, to educate customers, or train technical and marketing staffs, or develop management skills.

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Management will also find our weekly news service an invaluable working tool. In minimum reading time each week, the *Electronics/Management Advisory Service* can keep your company current on the important electronics developments around the world. Market changes, prices, contracts, finances, significant trends, even a telephone number to call for person-to-person consultation—all the essentials to provide an information base on which to make top management decisions. For the next week. Or the next five years.

If you believe, as we do, that better information can help make your company more profitable, and you would like to know more about our services, write to: Electronics/Management Center, 330 West 42nd Street, New York, New York 10036.

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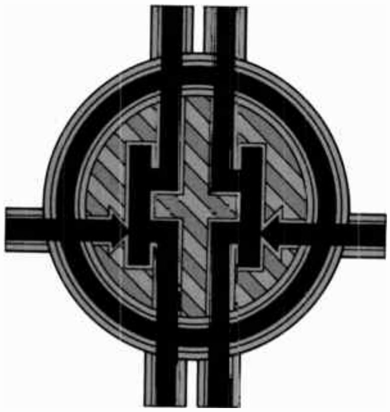
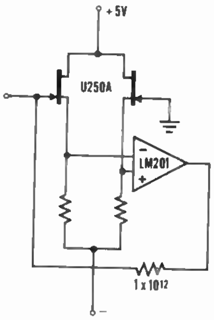


Applications Power*

2 NEW DUAL FETs for electrometers and low noise diff amps

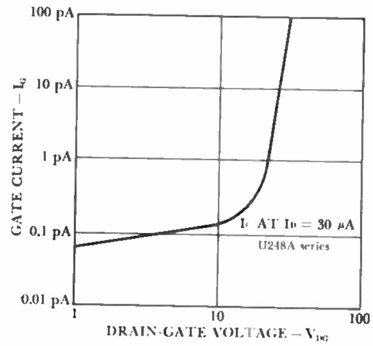
Electrometers The low gate current of the U248A series makes them ideally suited for this application. In the circuit shown, input current is typically less than 0.1 picoamp (10^{-15} amp). By operating at lower gate-drain voltages, lower gate input currents may be achieved; the only restriction is that $V_{DG} > V_P$. On special order, we'll select low V_P devices for you.



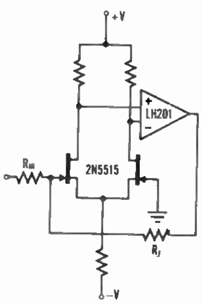
1pA ELECTROMETER

Characteristic	Symbol	Min	Max	Conditions
Gate Current	I_G		1 pA	$I_D = 30\ \mu A$ $V_{DG} = 10V$
Transconductance	g_{fs}	50 μmho	150 μmho	
Offset Voltage	$\lvert V_{GS1} - V_{GS2} \rvert$		5 mV*	
Differential Voltage Drift	$\Delta \lvert V_{GS1} - V_{GS2} \rvert / \Delta T$		5 μV/°C*	
Breakdown Voltage	BV_{GSS}	−40V		$I_G = 1\ \mu A$

* The U248A–U251 series presents a range of devices with offset voltages from 5 mV and drift from 5 μV/°C.



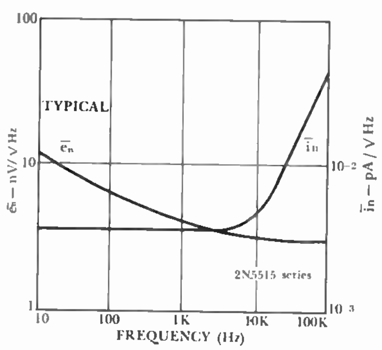
Low Level Differential Amplifiers The 2N5515 series gives you low noise and high common mode rejection. Short circuit input noise voltage is less than 10nv/$\sqrt{Hz}$; common mode rejection ratio (CMRR) is greater than 100 dB. Differential voltage drifts are available from 5 μv/°C.



LOW NOISE DIFFERENTIAL AMPLIFIER

Characteristic	Symbol	Min	Max	Conditions
Common Mode Rejection Ratio	CMRR	100 dB		$I_D = 200\mu A$ $V_{DG} = 10V$ to $20V$
Short Circuit Input Noise Voltage	e_n		15nv/$\sqrt{Hz}$ @10 Hz (2N5520-24)	$I_D = 200\ \mu A$ $V_{DG} = 20V$
Gate Current	I_G		100 pA	
Transconductance	g_{fs}	500	1000 μmho	
Offset Voltage	$\lvert V_{GS1} - V_{GS2} \rvert$		5mV*	
Differential Voltage Drift	$\Delta \lvert V_{GS1} - V_{GS2} \rvert / \Delta T$		5 μV/°C*	
Breakdown Voltage	BV_{GSS}	−40V		$I_G = 1\ \mu A$

* The 2N5515–2N5524 series presents a range of devices with offset voltages from 5 mV and drift from 5 μV/°C.



* These are just *two* ways of using *two* series of Siliconix duals. We also have a general purpose series and a high frequency series; If you're involved in any type of design problem requiring duals, just give us a call. We'll deliver the service as well as the goods. That's *applications* power!

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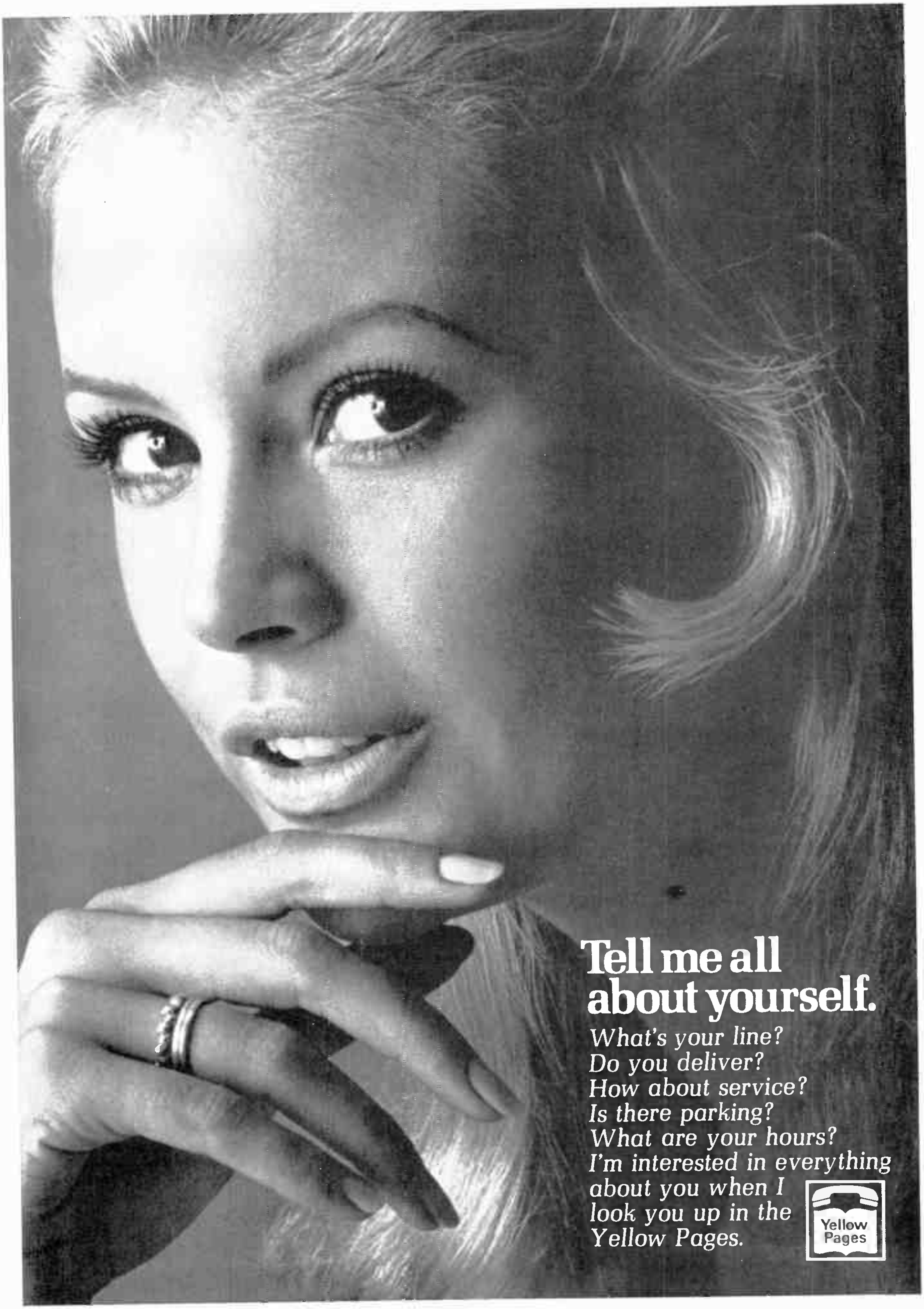
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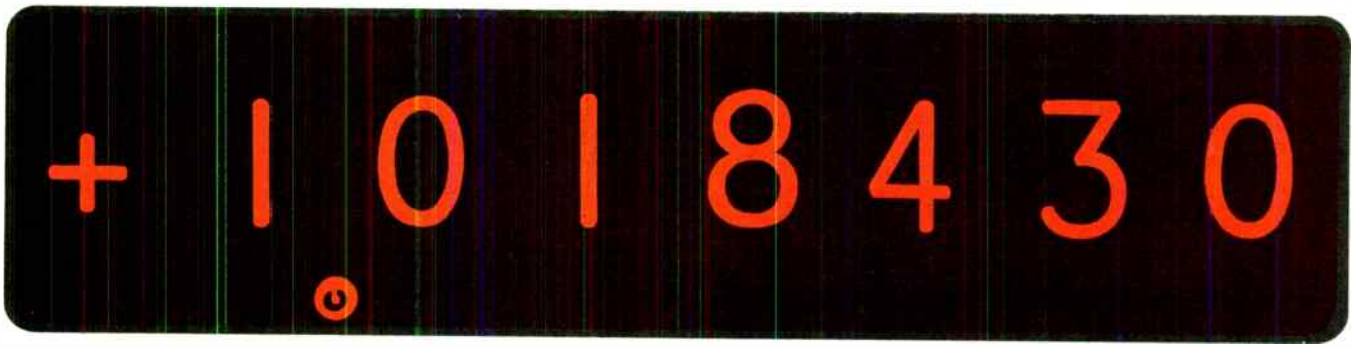

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Technical Articles

Helical transmission lines bend the beam
page 90

Distributing the deflection is the best way to build a cathode-ray tube that can track fast-rising signals. Unfortunately, however, handling the distribution with inductors and small deflection plates involves making a lot of glass-to-metal seals. In a new 250-megahertz oscilloscope, the vertical deflection is distributed by a couple of helical transmission lines. The result is a crt with only four seals whose cutoff is well over 500 Mhz. An amplifier made of monolithic transistor arrays that can handle signals with frequencies as high as 250 Mhz drives the deflection system. On the cover are views of the transmission lines used as vertical deflection plates in the crt of a new 250-Mhz scope from Hewlett-Packard.

The case for patenting software
page 96

The U.S. Patent Office, which has the support of hardware manufacturers, is under fire for its policy of rejecting software applications on the grounds that they're mental processes. The matter will be resolved by a decision in a pending court case. The authors, both patent attorneys, argue that computer programs are patentable and should be protected, providing they are new, useful, and not obvious.

Color-tv wheel takes a spin in space
page 114

To convert the serial red-blue-green signal received from space missions to standard parallel color television format, engineers at NASA's Manned Spacecraft Center used digital logic circuitry to control a multiheaded magnetic disk recorder that produces a broadcast transmission indistinguishable from that generated by a conventional three-tube color television camera.

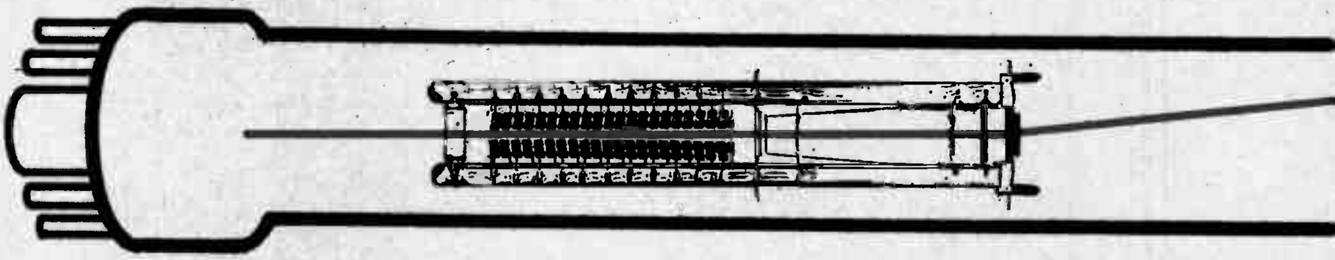
Active filters: part 10 Synthetic inductors from gyrators
page 118

By early next year, gyrators should be available in competitively priced integrated-circuit form. Engineers will then be able to make far greater use of this component in designing active filters. Sophisticated communications systems are among the prospective volume applications. Gyrators are attractive elements because they are inherently insensitive to variations of component parameters, and can be used to build filters that are highly selective. Moreover, when used to form a synthetic inductor, these units exhibit high Q.

Coming

Schottky diodes come of age

Schottky diodes offer a lot to digital integrated circuits: faster switching, lower power dissipation, and more functions in less chip area, for example. What's more, they can even help boost yields; they require no special processing to be integrated on a chip with bipolar transistors.



Helical transmission lines bend the beam

Unique deflection system shares the credit for a 250-Mhz scope with a vertical amplifier made with monolithic transistor arrays

By Alan J. DeVilbiss
Hewlett-Packard Co., Colorado Springs, Colo.

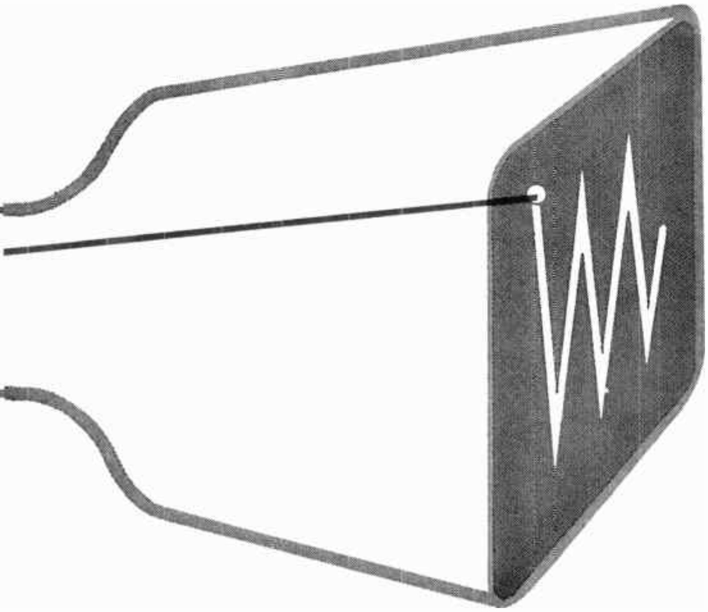
Faster! Faster! That's the cry always heard ringing in the ears of oscilloscope makers. But the appeal for speed has taken on new meaning as more and more engineers in the computer and digital-communication fields demand real-time scopes that can handle signals in the high-megahertz range. By modifying the design of cathode-ray tubes and by taking advantage of solid state technology, scope designers have been pushing up the speed—50 Mhz, 100 Mhz, and within the last three years scope speeds that come close to the 200-Mhz mark. Now there's an oscilloscope that displays signals with frequencies as high as 250 Mhz.

Credit for this speedup goes mostly to a few chips and a pair of helical transmission lines. The chips are the monolithic transistor arrays designed specifically for the scope's vertical amplifier. Up to at least 250 Mhz, these arrays aren't troubled by parasitic effects, drift, and thermal problems.

The two transmission lines are the vertical deflection plates in the scope's crt. They provide distributed deflection of the electron beam, giving the tube a high cutoff frequency. And since time delay is built right into transmission lines, this crt is easier to build than tubes that need extra discrete delay elements.

Designing the deflection assemblies as well as selecting operating voltages for any crt is difficult due to the complex interrelationships of many parameters. In this particular case the task was all the more difficult because the design goals require the excellent performance of several parameters simultaneously.

To insure a high writing speed and an ability to display 250-Mhz transients, the tube needs a beam power of 2 watts. Furthermore, compatibility of the tube with the deflection amplifiers requires the horizontal and vertical deflection factors to be low, around 6 and 3 volts per centimeter, respectively. Also, the tube's vertical-deflection assembly needs



a high cutoff frequency. As it turns out, the frequency response of the scope, 250 Mhz, is limited by the vertical amplifier. The crt's cutoff is well over 500 Mhz.

But how do you design a crt with a response like that? The physical laws governing electron ballistics are cruel; an improvement in any crt parameter is usually achieved at the expense of some other parameter or parameters.

A computer helped to build this crt. First the designers guessed the optimum values of 25 electronic parameters in a crt (e.g. spot diameter, deflection factors, beam power, space-charge defocusing). The computer plugged these values into the ballistic equations and calculated 50 physical parameters (e.g. interelectrode spacing, aperture diameters, electron lens parameters, tube length, and available voltages).

Next, the designers put limits on these 75 parameters, and the computer went to work. First, using the initial values of the parameters, it computed a figure of merit. Then it changed the value of one parameter and computed a new figure; if this figure was higher than the first, the computer kept the change. This process of change-compute-compare was repeated until a maximum figure of merit emerged.

However, several sets of parameter values resulted in this maximum figure. The designers then selected the most important parameters and fed them to the computer to be optimized. With this information, the computer came up with the best set of parameters for the tube. Except for a few changes made to simplify the manufacturing process, the design from the computer was the design used for this crt.

Some of the physical properties of the vertical deflection structure determined by computer optimization are low-frequency deflection factor, physical length, and electron transit time.

Transit time is the key to crt design. It s the time needed by a single electron in the electron beam to pass from one end of the deflection plates to the other.

Once the crt's parameters were set, it was apparent that the specified transit time, 2 nanoseconds, was so long that deflecting the electron beam vertically with a single pair of conventional deflection plates was impossible. These plates are no good at high frequencies.

If the deflection plates, as shown on pg. 92, are of length "a," and electrons move between them at velocity "v," then the transit time T is a/v. Assume that at time t_o there are five electrons between the plates. As electron 1 leaves the deflection structure, electron 5 enters; and uniformly distributed between them are the other three electrons. Now say that at t_o the potential difference applied between the two plates goes from 0 to K. Electron 1 never sees K and proceeds to the screen undeflected. Electron 5 and all the electrons that follow it are deflected an angle θ whose value depends on the strength of the electric field between the plates generated by K. But electron 4 is only deflected ¾ θ because it's between the plates only ¾ as long as electron 5. Likewise, electron 3 is deflected ½ θ, and electron 2 is deflected ¼ θ.

Electron 5 strikes the phosphor screen T seconds after electron 1. Now, a pulse's rise time is the time it takes for the voltage to go from 10% to 90% of the pulse's height. So when a pulse with a rise time of 0 is applied to the vertical deflection plates, the trace on this scope has a rise time of 0.8T.

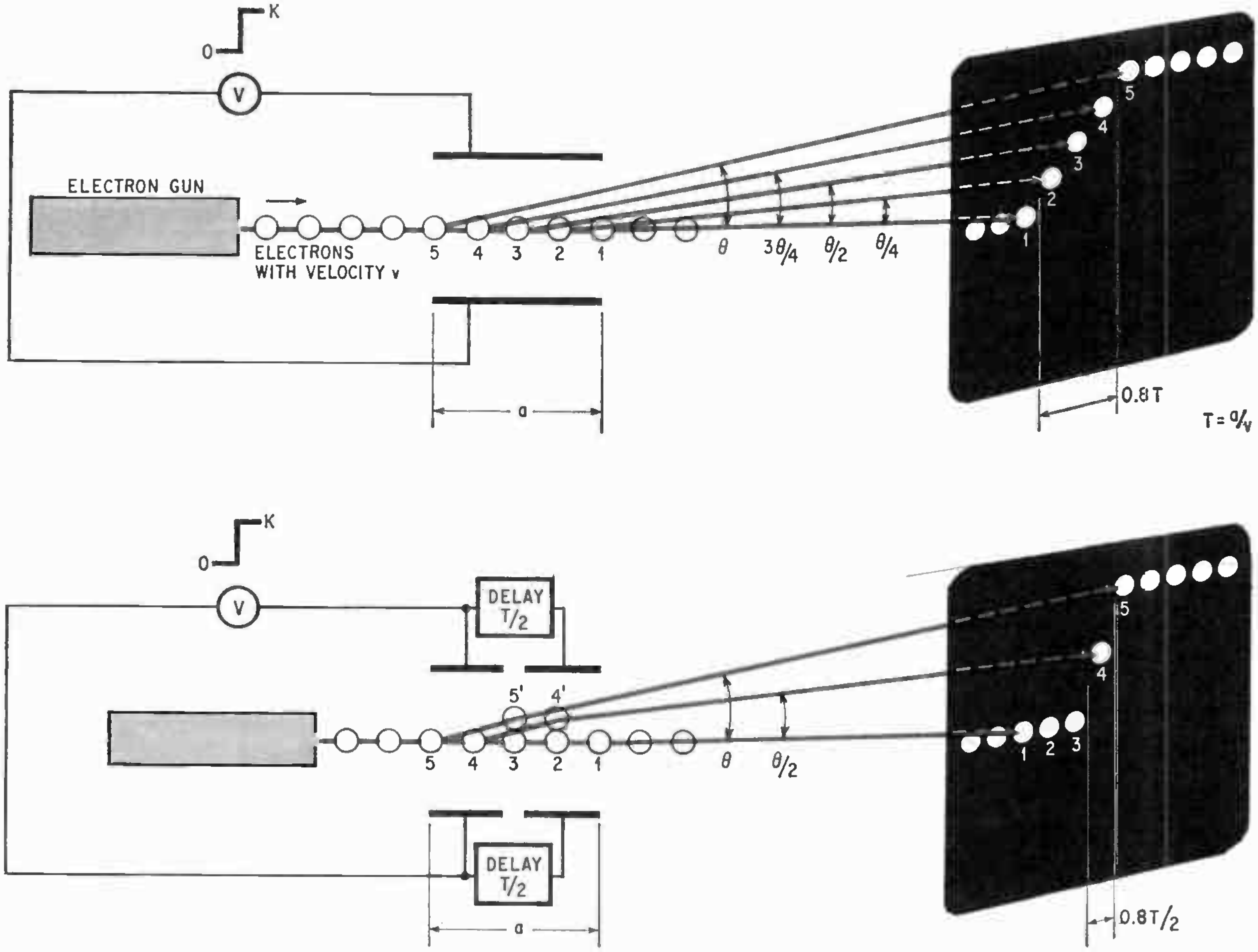
Looking for shortcuts

One way to shorten the trace's rise time is to reduce the transit time, either by increasing v or decreasing a. But speeding up the electrons or shortening the deflection plates degrades other tube properties, such as the deflection factors.

Another way to speed up the crt is with a distributed deflection structure, as shown on pg. 92. Each plate is broken in half, and the halves are joined by a delay line. At t_o, electron 1 is just leaving the deflection structure, and electron 5 is just coming in. Electron 3 is right in the middle, leaving the space between the first pair of plates and entering the space between the second pair. If V goes from 0 to K at t_o, electrons 1, 2, and 3 aren't deflected since it takes T/2 for the step voltage to reach the second pair of plates. By then electron 3 is out of the deflection structure.

From t_o to $(t_o + T/2)$, electron 4 is deflected ¼ θ, and electron 5 is deflected ½ θ; both electrons are at positions 4′ and 5′ respectively at $(t_o + T/2)$. At this time, the step voltage leaves the delay lines and is applied to the second pair of plates. Electron 4 is deflected by another ¼ θ for a total deflection of ½ θ, and electron 5 another ½ θ for a total deflection of θ. So the rise time of this tube's trace is only 0.8T/2.

The inclination then is to break the plates into smaller and smaller plates. Theoretically, if each



On the rise. The top figure shows a step voltage being applied to a conventional vertical-deflection structure. Electron 1, just leaving the structure when the step is applied, is undeflected; electron 5, T seconds behind electron 1 and just entering the structure, is the first electron to be completely deflected. The rise time shown on the scope face is 0.8T. If the plates are broken in two and joined by by delay lines, as shown in the bottom figure, the rise time is 0.4T. Theoretically, breaking each plate into "n" pieces and delaying the step T/n at each piece results in a displayed rise time of 0.8T/n. So the larger n is, the smaller the rise time.

plate is broken into "n" pieces, and if the pieces are connected by elements that delay a signal T/n seconds apiece, the trace's risetime, T_r, will be $T_r = 0.8T/n$, where T is still the transit time through the whole deflection structure.

In many tubes that have segmented deflection plates, the delay element joining adjacent plates is an inductor. Since each opposite pair of plates forms a parallel-plate capacitor, each small plate and inductor forms an LC section, which in turn is a single section of a lumped-parameter delay line. As the number of segments increases, the whole deflection structure takes on the appearance of a distributed transmission line, whose propagation velocity must match the velocity of the electrons in the beam.

Characteristic impedance

The propagation velocity depends on the product of an LC section's capacitance and inductance. The capacitance and inductance also fixes the line's characteristic impedance, R_o, which in turn affects the gain of the scope's vertical amplifier. In this scope, the vertical amplifier's output is an almost constant current; so the way to increase the gain is to increase the impedance at the amplifier's output.

This impedance is the parallel combination of R_o and the amplifier's own output impedance, which is capacitive and whose value is fixed at about 2 picofarads. So for the maximum gain at 250 Mhz, R_o should be greater than the amplifier's output impedance, about 300 ohms at this frequency. Going way above 300 ohms brings marginal results since R_o then starts to look like an open circuit compared with the amplifier's output. Besides, in general, the higher a line's R_o is, the harder the line is to build.

Another factor considered in the choice of R_o was the compatibility of the crt with existing plug-in vertical amplifiers, which are designed to drive a load capacitance of 8 pf. The crt's transit time is 2 nsec. Because of the scope's configuration, another 0.6 nsec of transmission line is needed to connect the deflection plates to the vertical amplifier. So the line's total length is 2.6 nsec.

The characteristic impedance of any transmission line is related to its electrical length and total capacitance by $R_o = x/C$, where C is the total line capacitance in farads, x is the electrical length in seconds, and R_o is in ohms. On the basis of this relationship and of the gain requirements, the designers chose R_o to be 330 ohms.

Limiting factors

The number of segments needed in the vertical deflection structure is determined either by the deflection structure's transmission-line characteristics or by the bandwidth limitation arising from the transit time phenomenon.

Look at the transmission-line aspect first. For a constant-k lumped-parameter line, the number of line segments needed to attain a rise time T_r in a line of electrical length x is found by the relationship $n = 1.1\ (x/T_r)^{1.5}$. Design goals called for a trace rise time of 0.3 nsec when the input to the vertical deflection structure has a rise time of 0. Since x is 2.6 nsec, the value for n is about 20. If this value goes into the transit-time equation, $T_r = 0.8T/n$, the rise time is only 0.08 nsec.

Therefore, transmission-line characteristics, not bandwidth considerations, are what limit the ability of a crt with a 20-segment deflection structure to track a fast-rising pulse. And this 250-Mhz scope needs 20 segments.

In a crt built with lumped-parameter deflection structures, the needed inductors are placed on the outside of the tube. In the case of a 20-section line, however, this means 40 glass-to-metal seals—a manufacturing nightmare. In the new crt, since each of the vertical deflection plates is a flattened helix, the inductance is on the inside, an inherent part of the helical transmission lines.

Each helix is analogous to a lumped-parameter line, and each loop of helix may be looked at as two 50-picosecond-long transmission lines of differing characteristic impedances. The half-loop section nearest the tube axis has a low impedance, derived from the ratio L/C. While the inductance in both halves of the loop is the same, the bottom

The speedy scope

Oscilloscopes, unlike race horses, aren't bred for speed alone; a scope has to be versatile. Look at the Hewlett-Packard Co.'s new 183A. With a bandwidth of d-c to 250 megahertz and the ability to track a pulse with a 1.5-nanosecond rise time, the 183A is the fastest real-time scope in its class. But it also does the routine chores. In fact the 183A can do just about anything H-P's older 180 can do, for the simple reason that the 183A's mainframe accepts any 180 plug-in.

And the 183A has the price of a general-purpose scope—around $3,000 for a complete unit. The main frame by itself costs $1,750.

Credit for the 183A's speed goes to the scope's unique vertical deflection system and to the wide bandwidth of the vertical amplifier.

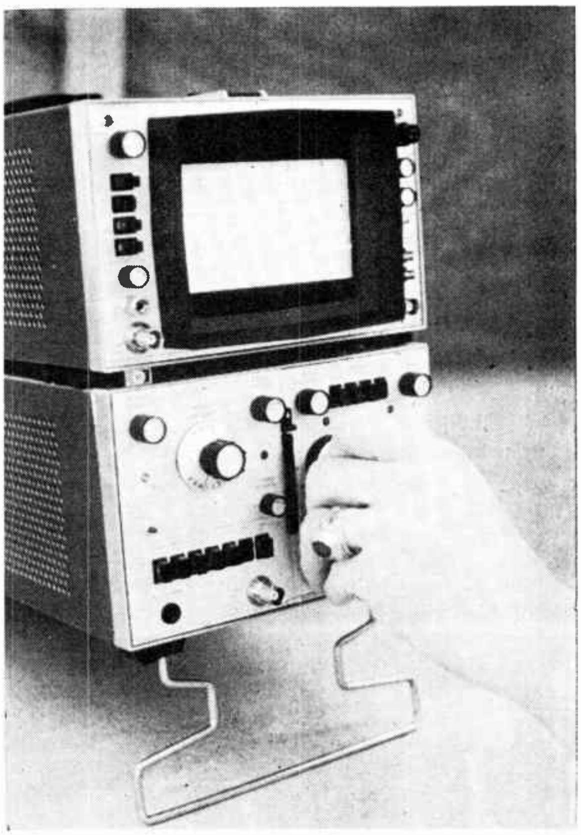
The amplifier also gives the scope high sensitivity; the maximum is 10 millivolts per centimeter.

The 1840A time-base unit, designed specifically for the new scope, has sweep speeds from 1.0 nsec to 0.1 second per centimeter. And an external signal as weak as 20 mv peak-to-peak and as fast as 250 Mhz can trigger the sweep.

Engineers will find the scope's speed particularly useful for looking at fast one-shot signals, such as those encountered in nuclear, laser, and digital systems. And photographing these signals is easy since the scope's writing speed is 4 cm. per nsec.

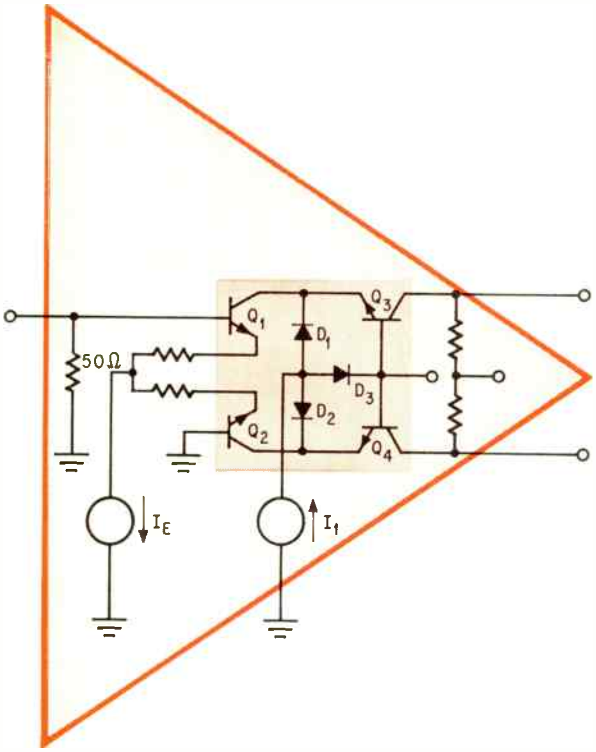
Built into the 183A is a flood gun, used to sensitize film. Flood guns aren't new, but the one in the 183A is connected in an unusual way. It's tied to the sweep circuit, and can be flashed every time there's a sweep.

The 183A's input impedance is 50 ohms; also available, for $350, is the 1120A probe whose input impedance is 100 kilohms and 3 picofarads for frequencies up to 500 Mhz.



The 183A will bow in at Wescon, and deliveries are scheduled to begin in November.

Hewlett-Packard Co., 1900 Garden of the Gods Rd., Colorado Springs, Colo. [380]



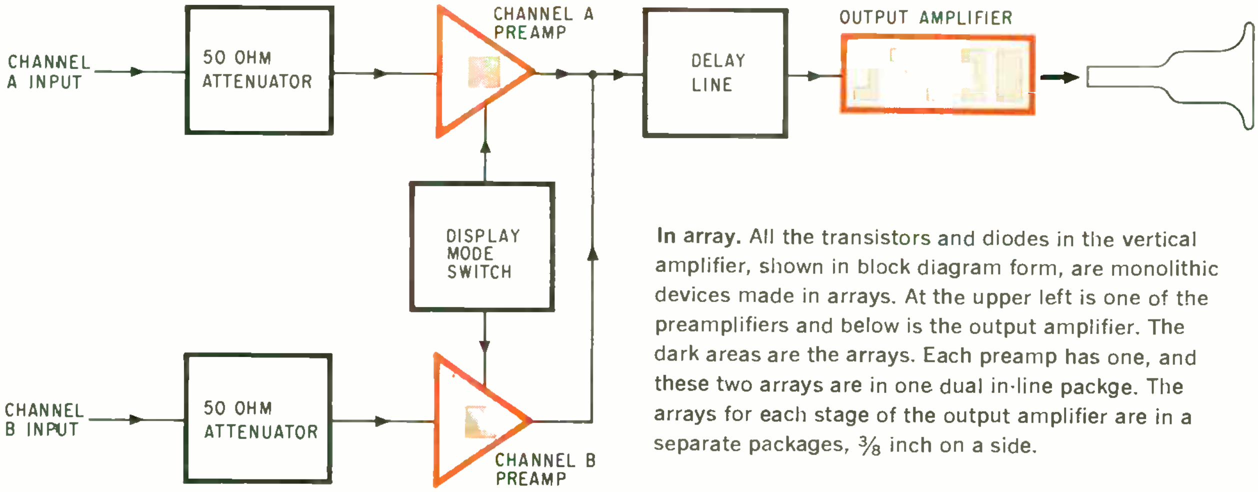
half has a higher capacitance because of its closeness to the other helix. (The capacitance of two parallel plates goes up as the distance between them goes down.) The ratio L/C is therefore lower for the bottom half.

When both halves are considered together, each complete loop has an average characteristic impedance of about 330 ohms.

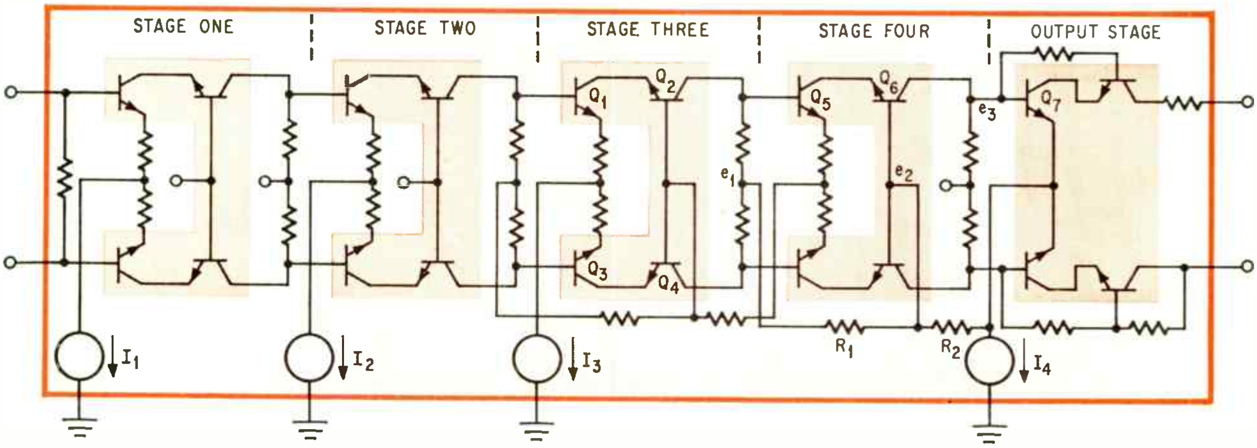
Each of the two helixes is a continuous strip of metal, mounted rigidly to glass beading rods in the electron-gun assembly. Once mounted, the helixes need no mechanical adjustments to give them the desired electrical characteristics. And only four feedthroughs in the neck glass of the crt are needed to connect the amplifier to the deflection structure.

Key to wide bandwidth

The performance of the vertical amplifier is, of course, every bit as critical as the performance of the crt. This scope's vertical amplifier, a dual-trace unit pictured below, handles inputs from d-c to 250 Mhz. The key to this wide bandwidth is the performance of the two preamplifiers and of the output amplifier. The performance of these three



In array. All the transistors and diodes in the vertical amplifier, shown in block diagram form, are monolithic devices made in arrays. At the upper left is one of the preamplifiers and below is the output amplifier. The dark areas are the arrays. Each preamp has one, and these two arrays are in one dual in-line packge. The arrays for each stage of the output amplifier are in a separate packages, 3/8 inch on a side.



circuits depends on the speed and size of their transistors. All are monolithic, so the three amplifiers have the stability inherent in integrated circuits. At the same time the transistors are very fast; their switching speed is around 0.4 nsec.

The active portions of the two preamps and of each of the output amplifier's five stages are separated monolithic transistor arrays. The preamps are in one dual-in-line package and the five stages are each in a package, ⅜ inch on a side.

A vertical amplifier built with monolithic arrays yields a number of advantages over one made from discrete devices or as a hybrid integrated circuit. In a monolithic array all the transistors in any one amplifier stage are within a few thousandths of an inch of each other. Crowding the transistors assures the matching of parameters such as beta, offset voltages and temperature coefficients. The closer the transistors are to each other, the smaller the temperature difference between them.

Proximity combined with the high thermal conductivity of an array's silicon substrate also assures that the transistors and diodes work at nearly identical junction temperatures. This rules out almost all amplifier drift and the need to put in the parasitic-producing circuit elements often used to minimize thermal problems.

Each transistor in an array is electrically isolated both from the substrate and other devices. A good thermal connection between all transistors and a heat sink won't increase stray capacitance, as it does when heat sinking is done through a transistor's metal can.

The interconnections between transistors introduce little stray capacitance or series inductance since these connections are made with metalization layers on the surface of the chip.

All on one chip

In a simplified diagram of one of the preamplifiers, shown at the top of pg. 94, transistors and diodes are all on one chip. These form a differential amplifier that has controlled, variable gain, and a constant bandwidth of d-c to 250 Mhz.

If I_1 is 0, this amplifier has a maximum gain. As I_1 goes up, D_1 and D_2 are forward biased and join with the common-base transistors Q_3 and Q_4 to form a current divider. Part of the differential signal current generated at the collectors of Q_1 and Q_2 is shunted through D_1 and D_2, and the remainder appears as emitter currents in Q_3 and Q_4. The percentage of the signal current shunted in D_1 and D_2 is determined, approximately, by the ratio of I_1 to I_E. Current source I_1 is controlled from the scope's front panel by the "Sensitivity Calibration" and "Sensitivity Vernier" controls.

If I_1 is greater than I_E, then Q_3 and Q_4 cut off, and D_3 is forward biased. When this happens, all signal current is shunted into D_1 and D_2, and the input signal is isolated from the preamplifier's output terminals by the reverse-biased emitter-base and collector-base junctions of Q_3 and Q_4. Current source I_1 is controlled in this mode by the "Display Mode" switch, which is used for the channel switching functions, such as "Chop" and "Alternate."

The first four stages of the output amplifier, at the bottom of pg. 94, are identical arrays of four transistors in a differential cascode connection. This configuration is an excellent approximation of a unilateral amplifier, which provides high frequency stability and which efficiently uses each stage's high-frequency gain parameters.

At the output

The output stage has a current feedback connection, which minimizes the signal-voltage swings at the stage's input terminals and which divides the output signal voltage among the stage's four transistors. This connection also provides a low output capacitance; so with the proper choice of resistor values in the feedback network, the output stage can have an output impedance that matches the characteristic impedance of the crt's deflection system. The output stage will then absorb reflections from minor discontinuities in the deflection system, giving the scope a smoother pulse response than would otherwise be possible.

A resistive termination, at the output of the amplifier and the input of the deflection system, could also be used to match impedances. However, with this type of termination, the power dissipation in the output stage would be twice as high as it is with the feedback connection.

A low collector-to-emitter breakdown voltage V_{CEO} is better because a high V_{CEO} is usually achieved at the expense of decreasing the high-frequency current gain.

The output amplifier is connected so that the combined collector currents in stage three, I_3, are a major part of the emitter bias currents $(I_3 + I_4)$ in the output stage. This connection significantly cuts the power dissipation in the biasing networks by eliminating stage three's need for an external-collector supply voltage. And the emitters of the output-stage transistors can then use the high collector impedances of stage three as an efficient current source. In addition, the desired bias voltage, e_2, for the common-base transistors in stage four, is conveniently available in this connection at the base of Q_6.

Small voltage drops, provided by resistors R_1 and R_2 ($I_3R_1 = I_3R_2 = 1$ volt), keep the transistors in stage four from being saturated under large signal conditions. If the amplifier is overdriven to the point that Q_1 and Q_2 cut off, then the collector current in Q_3 and Q_4 is equal to I_3, and the base voltage e_3 of Q_7 is at its minimum. Under this condition, the common-base bias voltage e_2 is kept lower than e_3, and transistor Q_6 is not saturated. Since e_1 is 1 volt less than e_2, saturation of transistor Q_5 is also prevented.

Whatever the conditions may be, the amplifier transistors will not saturate; this permits rapid amplifier recovery to an on-screen display after the amplifier is over-driven. ■

The case for patenting software

Two patent attorneys question the validity of denying computer programs patent protection, calling such action both arbitrary and discriminatory

By Michael I. Rackman
Amster & Rothstein, Counsellors at Law, New York
and Howard R. Popper
Bell Telephone Laboratories, Murray Hill, N.J.

Submit a computer program to the Patent Office and see what happens. Your application will be turned down. But submit a jumble of wiring diagrams for circuits that do the same job and chances are that you may get a patent. Make much sense? Perhaps not, but it's common practice for the Patent Office to reject any application that is directed to an innovation in data processing and written so that a programer could understand it. The reasoning is that because a computer performs many processes that can also be done by a human mind, all computer programs are really, at bottom, mental processes and therefore cannot be given patent protection.

This position is unsound. Computer programs are descriptions of machine processes and, provided that the processes are new, useful and not obvious, there is no reason why patents should not be granted. Just because the steps in a program "could be" done mentally does not disqualify the underlying invention from patentability.

But having a direct bearing on the stance taken by the Patent Office is its feeling that treating software as other inventions would entail new search procedures. Moreover, the office feels this would cause other administrative problems.

Nevertheless, opposition to this no-patent policy is growing. And in the wake of the Court of Customs and Patent Appeals overruling the Patent Office last November in the Prater and Wei case, the issue has touched off a heated controversy. Charles D. Prater and James Wei, both of the Mobil Oil Corp., had applied for a patent on a spectrographic process that could be accomplished on a programed computer. The claims in the application had been turned down and Prater and Wei subsequently appealed this decision to the court, which overruled the Patent Office. The Patent Office has since petitioned the court for a rehearing, which was granted. The outcome of the rehearing is expected shortly.

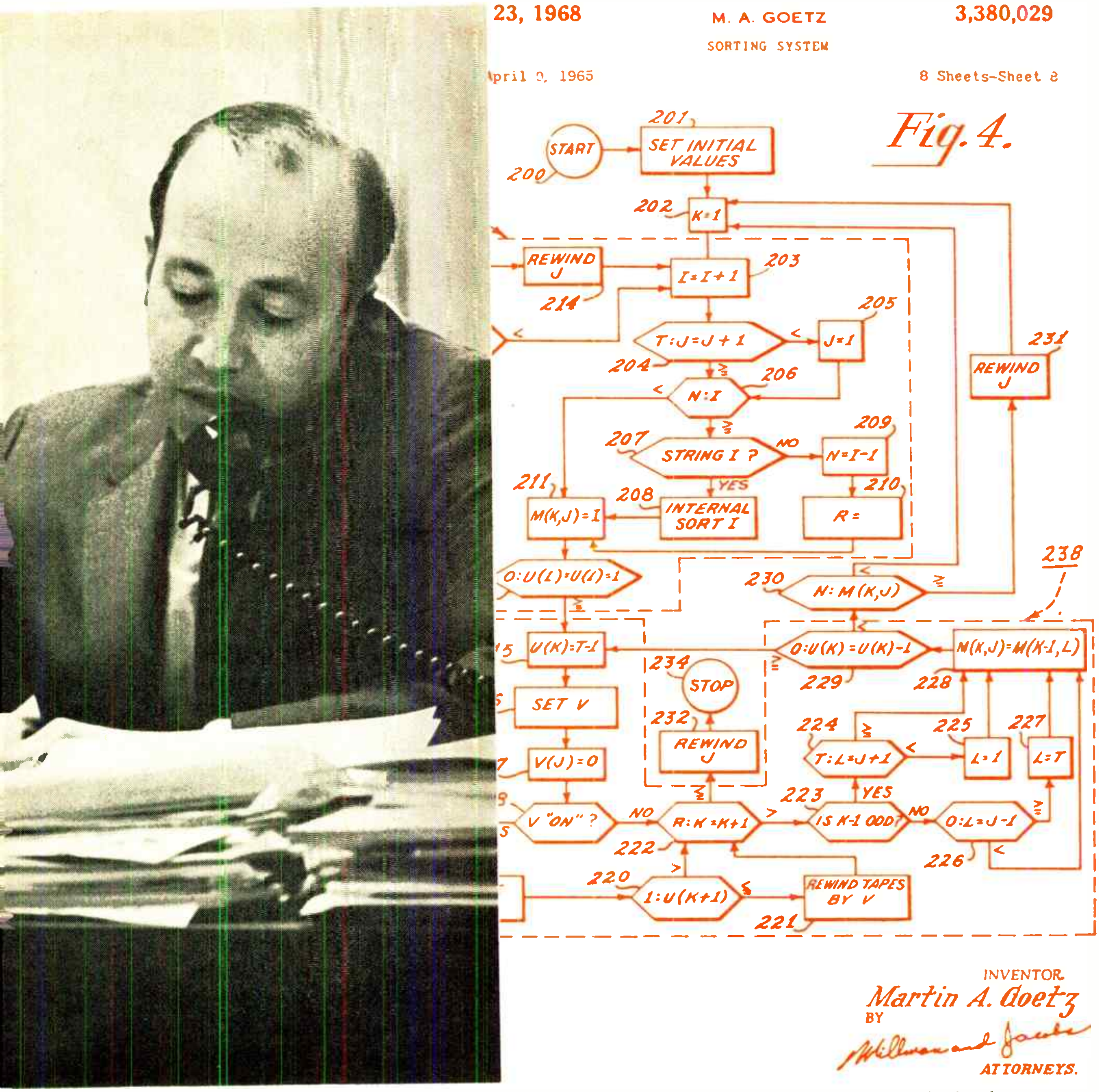
Should the court reaffirm its ruling and a patent is eventually granted to Prater and Wei, it would set a precedent that would have vast implications for the electronics industry and other industries in which electronics is an integral part.

Design engineers are becoming increasingly concerned with software. In a system using both software and hardware, significant operating advantages are often gained because of the way the hardware is controlled by the stored program software. Therefore, a reaffirmation of the court's ruling in the Prater-Wei case could lead to design engineers obtaining patents on novel systems designed to incorporate software.

With no law on the books dealing specifically with the patenting of computer programs, the electronics industry is focusing its attention on the Prater-Wei case. Staunchly supporting the Patent Office's present policy are the computer manufacturers, and with good reason. Their business is either selling the machines outright or renting them, not software. Many companies distribute programs free of charge via program-sharing pools to encourage wider use of their computers.

Vigorously opposed to the Patent Office's practice, however, is the growing software industry, whose programs are developed more often than not at considerable cost. Without legal protection, their listings and flow charts are fair game for piracy. A program costing $100,000 to develop can, in some cases, be copied for less than $100.

Software is serious business. Since the mid-1950's, it has been responsible for a sizable share



Unique. The only acknowledged patent for software—described by flowcharts—was issued to M.A. Goetz of Applied Data Research. The program sorts data on different tapes. But Patent Office policy bars such awards.

of computer research and development costs. It is estimated that today the cost of software development has reached a point where it exceeds that of hardware.

It is evident that software firms need adequate legal protection of their proprietary rights. Without such protection, they cannot be expected to trade their programs for access to the programs offered in the manufacturer-sponsored, program-sharing pools.

In the world of computers, programs and hardware are merely opposite sides of the same coin; tradeoffs between them are commonplace in the design of any general-purpose machine. Even before the design of a special-purpose computer is set down, the economics of such a machine is weighed against the economics of programing a general-purpose computer for the same function.

Why, then, is there a difference in the way software and hardware are treated vis-a-vis patents? There shouldn't be any. It is arbitrary to deny protection to the programer and yet grant it to the designer when the basic invention is the same in both its hardware and software embodiments (see "Hardware or software, which should it be?", p. 99). This is particularly true in view of the ill-defined distinction between hardware and software, and precisely because either implementation can be derived from the other. If an engineer first designs a machine, he could secure patent protection on the underlying invention. Then he can forget about the machine and write a program to do the same thing, assuming that is what he wanted to do from the outset. It makes no sense to argue that if, instead, he first writes the program and then designs an equivalent machine, he shouldn't be able to secure protection on the invention.

Furthermore, the Patent Office's policy on what patent applications must contain outrightly discriminates against the little guy who cannot afford a staff of patent engineers to reconstruct a program back into a voluminous set of hardware wiring diagrams. Such an application, however, seems to be the only kind that is acceptable under the Patent Office policy as it has existed for the past several years. Of course, these reams of wiring drawings do not help anyone to understand or use the invention.

Flow charts, which are the kind of drawings that programers would understand, are not considered by the Patent Office to show "structure" and so the Office, even when it concedes that an invention has been made, refuses to grant claims based on them. The Patent Office won't grant claims to "apparatus" that is based on flow charts because it says that its rules require apparatus claims to be supported by a drawing of "structure." Yet it won't grant claims to the method portrayed in the flow charts, even though case law holds that "method" claims need not be accompanied by any drawing, because the Patent Office holds that all programable methods are mental processes.

From a patentee's viewpoint, method claims would be preferable because they are likely to both point out the real contribution of the program and cover the activities of any would-be infringer. But though the inventor would prefer this approach, he must now follow the ponderous apparatus disclosure route if he hopes to obtain any sort of patent for his invention.

Why the Patent Office goes along with this type of presentation is almost anyone's guess. The answer may lie in the fact that, although apparatus disclosures make for lengthier and more cumbersome descriptions than program flow charts, they are closer to the sort of disclosures patent examiners are accustomed to handling. Or, as some patent experts have suggested, they are acceptable because they tend to hold down the input of new applications; they require much time in writing.

This doesn't mean that apparatus disclosures are always accepted. There are some zealous examiners who, should they suspect the disclosure couches a software invention, would reject such applications out of hand. At times, they even reject applications affecting electronic systems in which software is the furthest thing from the mind of the designers.

This attitude is carried to such an extreme that some claims, drawn to special-purpose machines, are rejected on the grounds that the inventions could be practiced on general-purpose computers and, therefore, cannot be patented. Such a practice, should it become widespread, could just about wipe out protection completely for almost any electronic system. Most systems can be simulated on a general-purpose computer.

Even computer manufacturers would argue against the contention that special-purpose machines are unpatentable if an equivalent program could be written for a general-purpose machine. This contention, should it become Patent Office

Trade secrets vs. copyright vs. patent

There are three approaches that can be taken to protect a computer program—trade secrets, copyrights and patents.

Under the law of trade secrets, a branch of the law of unfair competition, a proprietary program can be treated as a secret, provided employees do not divulge the program to outsiders. As a practical matter, however, particularly because of the great mobility of programers, it may be difficult to prevent unauthorized disclosures of programs. And as for a lawsuit, trade-secret cases are among the most difficult to win.

Copyright protection is the easiest of the three to secure. All that is necessary is a copyright notice attached to the program. Copyright litigation is also generally less costly because the issues are less technical. However, the copyright form of protection suffers from a basic frailty.

Limited protection. A copyright protects only the form of the writing, not the underlying idea. And, in most cases, the underlying concept far outweighs the writing in importance. Once the basic algorithm becomes known—and it must become known since copyright protection is secured by publishing the material with the attached copyright notice—anyone can write another program to carry out the algorithm without fear of infringing upon the original copyright. And where there are only a limited number of ways of expressing an idea, copyright protection may not be available in the first place.

A patent, on the other hand, can serve to protect the underlying principles of an invention. But compared with copyright protection, obtaining a patent can be expensive; and patent litigation is generally very costly.

However, a patent affords broad protection. Those in favor of patents for "programable processes" (the correct terminology, according to legal scholars) say patents, in most cases, are the only solution to the piracy problem facing the software industry. A patent will give the inventor or his company exclusive rights to the use of his program or, alternatively, permit him to receive royalties from users licensed under the patent.

Hardware or software, which should it be?

To demonstrate the equivalence of hardware and software, consider how the same job can be accomplished by either a wired logic technique or a programed digital computer.

The problem is to introduce information from a binary signal source into a shift register in such a way that a "1" enters as a "0" if the last stage of the register contains a "0." It is further desired that a counter be used to count the number of successive "0's" entering the register, and then be reset whenever a "1" is entered.

This can be achieved with a circuit comprising an N-bit shift register, an input control gate, an N-bit counter, and a relay that is triggered when the counter reaches the count of N. As in the diagram, there are two inputs: the bit signals from the binary source and the bit signal fed back from the last stage of the shift register.

The input-control gate permits a "1" to enter the register only when the last stage of the register contains a "1." When it doesn't, a "0" is inserted into the register. Initially, it may be assumed that the shift register contains all "1's." Whenever a "0" is stored, the counter is incremented via line 0. Whenever a "1" is stored, the counter is reset via line 1. When N "0's" are counted, the relay "return" is energized to control another circuit.

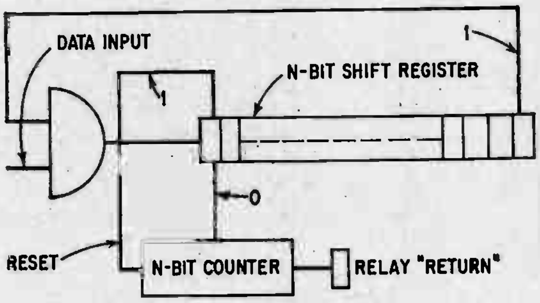
For the purposes of this discussion, it isn't necessary to ascertain the practical utility of the circuit. It is suffice to say that such a circuit can be built with conventional components.

Program route. The same result—entering binary data into a storage array, the comparing of input and output bits, and the incrementing and resetting of a counter—can be obtained through the use of a stored program.

A program, written in Fortran IV, for example, executes certain logical and arithmetic operations on a digital computer. The arithmetic operations are performed with quantities called indexes, which are used to define the input and output locations of the shift register. Logical operations are performed with the input data bit and with the contents of the output stage of the register defined by an output index. Instead of shifting data bits through the register, for example, arithmetic operations are performed on the indexes, which keep track of the input and output data bits.

Different, but. Although the examples as presented are somewhat simplified, it is apparent that either approach is a practical way toward solving the problem at hand. Both achieve the same results, albeit each in its own way. Assuming both are available to the engineer, his choice of which to employ will depend on economy, size, and speed of operation—and whether a stored-program computer is available.

In light of these examples, authors Rackman and Popper contend that inclusion of a program should not prevent issuance of a patent covering a hardware disclosure. Moreover, they believe the program should in itself lend support to the patentability of the invention.



Committed. Hardware like wired-logic shift register, left, can be patented; but software to do the same job can't.

policy, could preclude patent protection for all new apparatus coming out of the computer industry; the operation of practically every new computer could be simulated on an existing machine.

The case against

Those opposing the granting of patent protection for software argue that a claim, particularly a method claim, which defines the steps in an algorithm, necessarily defines the same steps that could be performed in the mind or with pencil and paper. Mental processes, they point out, are not subject matter for patents. If these processes were patentable, the rights afforded by the First Amendment to the Constitution—namely freedom of speech, as broadly construed—would be abridged. A corollary to this argument is that mathematical formulas are not subject to patents.

This argument certainly appears logical. After all, how can a patent be granted with a method claim that could be construed to cover the practice of an invention with pencil and paper when everyone knows that the First Amendment takes precedence over the patent statutes? In other words, how can exclusive rights be secured for a process that could be accomplished mentally?

The flaw in this argument is in the area of what could be construed as a mental process. And some-how, software's real contribution to technology is lost in the shuffle.

The answer, of course, is not to construe a programable process so as to mean anything but a machine-executed process. As for abridging freedom of speech, this contention doesn't ring true.

Just as a computer patent cannot prevent a person from imitating the machine's operation with pencil and paper, a program patent cannot bar anyone from carrying out the program's steps with pencil and paper. The mere fact that a process can be performed mentally neither makes it in itself a mental process nor constitutes an infringement of a patent on the process.

Another argument against patenting software, one that has been voiced quite vigorously, is that a designer of a computer envisions all possible uses of his machine. This includes anticipating all programs that it would require. This contention, however, holds no merit whatsoever. The transistor manufacturer, for example, envisions use of his devices wherever amplifiers, gates, and the like are required. Does this foresight bar the granting of patents on subsequently designed, nonobvious circuits? Of course not! And the same should be true for computer programs. Moreover, the 1952 Patent Act specifically sanctioned the method-type disclosure for claiming a new use of an old machine. And this is precisely what many new computer programs entail.

The distinction between what is obvious and what is patentable subject matter must always be borne in mind. As with any other invention, a program must not be obvious if patent protection is to be granted. If, in the light of other programs or existing machines, a certain program is obvious, it shouldn't be amenable to patent protection. But simply because the majority of programs, like the majority of hardware inventions, may be obvious, it does not follow that all program inventions, per se, are unpatentable.

Still another argument heard often is that a claim directed to the operation of a computer in accordance with a program based on a mathematical principle developed by the inventor should be unpatentable in view of the principle itself. This kind of reasoning could, in effect, bar patent protection for all programs inasmuch as it treats the underlying principle of any program as prior art. It would also follow from this that every digital system is unpatentable. This argument has been rejected by the Patent Office Board of Appeals.[1]

But what about the ban against mathematical formulas? This prohibition is certainly valid. The formula $E=mc^2$ cannot be patented. Does it follow, therefore, that an apparatus or method that can be described by mathematics should not be patentable? What must determine the statutory nature of an invention is not the mathematics, which is only a language, but what it describes. In this regard, the Supreme Court[2] stated 20 years ago:

"While a scientific truth, or its mathematical expression, is not a patentable invention, a novel and useful structure created with the aid of knowledge of scientific truth may be."

Suppose that the Taylor's series went unknown until now and someone only now discovered how to compute e^x. Should he be granted patent protection on a computer program for calculating the series? Yes! Moreover, he should be allowed to prevent the public from using his algorithm in

The 'Rules of Abrams'

When it comes to the nonpatentability of mental processes—the argument often used against software—the case usually cited by the Patent Office as the precedent is the Abrams case, which dates back almost two decades.[3]

Armand J. Abrams sought a patent for an invention that could be used in the prospecting for petroleum deposits. His application was rejected by the Patent Office and the case was appealed to the Court of Customs and Patent Appeals. The court upheld the Patent Office in 1951 and disallowed Abrams' method claims.

These claims included the steps of sinking a number of boreholes, sealing each hole at a specific depth, reducing the pressure in each, measuring the rate of pressure rise, determining the rate of pressure rise at a standard reference pressure, and comparing the rates for different boreholes to detect anomalies indicative of the presence of petroleum deposits.

In the course of his appeal, Abrams and his attorney proposed three rules or guidelines as to what should or shouldn't be patentable. These rules, though never formally adopted by the court, came to be called the "Rules of Abrams" and included:

- When all the steps of a method claim are purely mental in character, the subject matter is not patentable.
- When a method claim embodies both physical and mental steps, and an advance in the state of the art lies in the mental steps, the claim is unpatentable.
- When a method claim embodies both physical and mental steps, and a state-of-the-art advance lies in the physical steps—with the mental steps merely incidental parts of the process essential to define it—the matter is patentable.

Abrams argued that his invention came under his third rule. The court, however, upheld the Patent Office on the grounds that Abrams' application did not disclose apparatus. And even if the rules were applied, contended the court, Abrams' invention came under the second rule —namely, the state of the art was advanced by steps that had to be performed mentally.

Abrams' invention required the exercise of human judgment. However, authors Rackman and Popper contend the opposite is true of a computer program; human intervention is not required. A programed-machine operation, say the authors, stands in marked contrast to the Abrams invention.

either special- or general-purpose machines.

Perhaps software's first breakthrough in the patent field occurred in April of last year when the now-celebrated Goetz patent, assigned to Applied Data Research, Inc., was issued. The patent award to the Applied Data vice president was the very first for a publicly acknowledged programing invention. The program was one for sorting data on a group of tapes. The drawing—eight sheets in all—discloses, in one figure, a block diagram of a system that includes no more than a control unit, a memory, an arithmetic unit, and a group of tape units. Another figure shows the program flow chart, with the remaining figures showing how the data is transferred between the various tapes.

Two claims were made, both of which were directed to apparatus. Each claim, after defining the tape units, the memory, and the arithmetic and control units, sets forth a control system that comprises various iterative control-signal loops, which are used for different functions.

A change in the making

The award of the Goetz patent turned out to be confusing not only to the industry but to the Patent Office [*Electronics*, Sept. 16, 1968, p. 33]. Officials in the Patent Office were unable to explain the award in light of the policy of barring patent grants on computer programs. In October, the office announced a set of guidelines that ruled out apparatus claims for programs. Then, a month later the Court of Customs and Patent Appeals handed down its decision in the Prater-Wei case.

Prater's and Wei's spectrographic process is used to provide accurate data on the proportions of known components in gas mixtures. Using the Prater-Wei process, concentrations of the components are displayed on a spectroscope as traces showing peaks and valleys. The process isolates the optimum set of peaks, thus forming a set of equations that accurately determines the relative concentrations. The record before the court contained no reference showing any prior recognition of this mathematical observation.

The application submitted by the oil-company employees disclosed electrical and mechanical components of a machine that could perform the required steps, and suggested that the process could be accomplished on a digital computer that is properly programed. Several method claims and one apparatus claim were included.

In overruling the Patent Office's arbitrary rejection of the Prater-Wei claims, the court stated:

". . . We find nothing to indicate an intent of Congress or the courts to deny patent protection to process claims merely because they could alternatively be read on a process performed through the mind by the use of aids such as pencil and paper. It is therefore an appropriate point to correlate the development thus far traced with our decision in Abrams. [See "The 'Rules of Abrams'" p. 100.]

"We do not feel our reasoning need be encumbered by the so-called 'rules' of Abrams. . . . However, it is noted that in Abrams, unlike the present situation, the claimed process could only be performed in the mind, so far as was apparent from the specification. The Abrams situation may thus be distinguished from that presently before us, in which there is adequate disclosure how the process can be performed without mental calculation. This distinction from Abrams leads us to our present holding, which is that patent protection for a process disclosed as being a sequence or combination of steps, capable of performance without human intervention and directed to an industrial technology—a 'useful art' within the intendment of the Constitution—is not precluded by the mere fact that the process could alternatively be carried out by mental steps. . . . For the reasons discussed in this opinion, we reverse the rejection of all the claims before us."

Subsequently, the Patent Office filed a petition for rehearing, which was granted. In a dissenting opinion, Judge Giles Rich took a close look at the rationale and impact of the court's decision:

"It has been suggested that this case is one of the most complicated, technically and legally, with which we have ever had to deal. This is not so. While the technology is perhaps mathematically awesome, the economic impact of our decision tremendous, and the administrative problems of the Patent Office horrendous if it is obligated to abide by our decision, the case really boils down to a simple question or two of law. . . . Should computer programs be patentable? That is the problem the Patent Office presented to Congress, where the question belongs, submitting a bill implementing the recommendation of the President's Patent Commission that they be declared to be not patentable. But we are not at all concerned with what ought to be. We are not a policy-making body but a court of law. The simple question which has been before us is whether appellants' claimed process and apparatus are patentable under the existing statutes."

Judge Rich expressed his opposition to a rehearing by asserting: "We have thoroughly considered the statutes, the cases and the arguments and we have rendered our decision to the best of our ability. If we go through the process again, we can do no more."

Should the court reaffirm its earlier decision and barring any overruling legislation or reversal by the Supreme Court, the way would be clear for the granting of patent protection for all software. The next question, of course, would center on how the electronics industry will react. ■

References

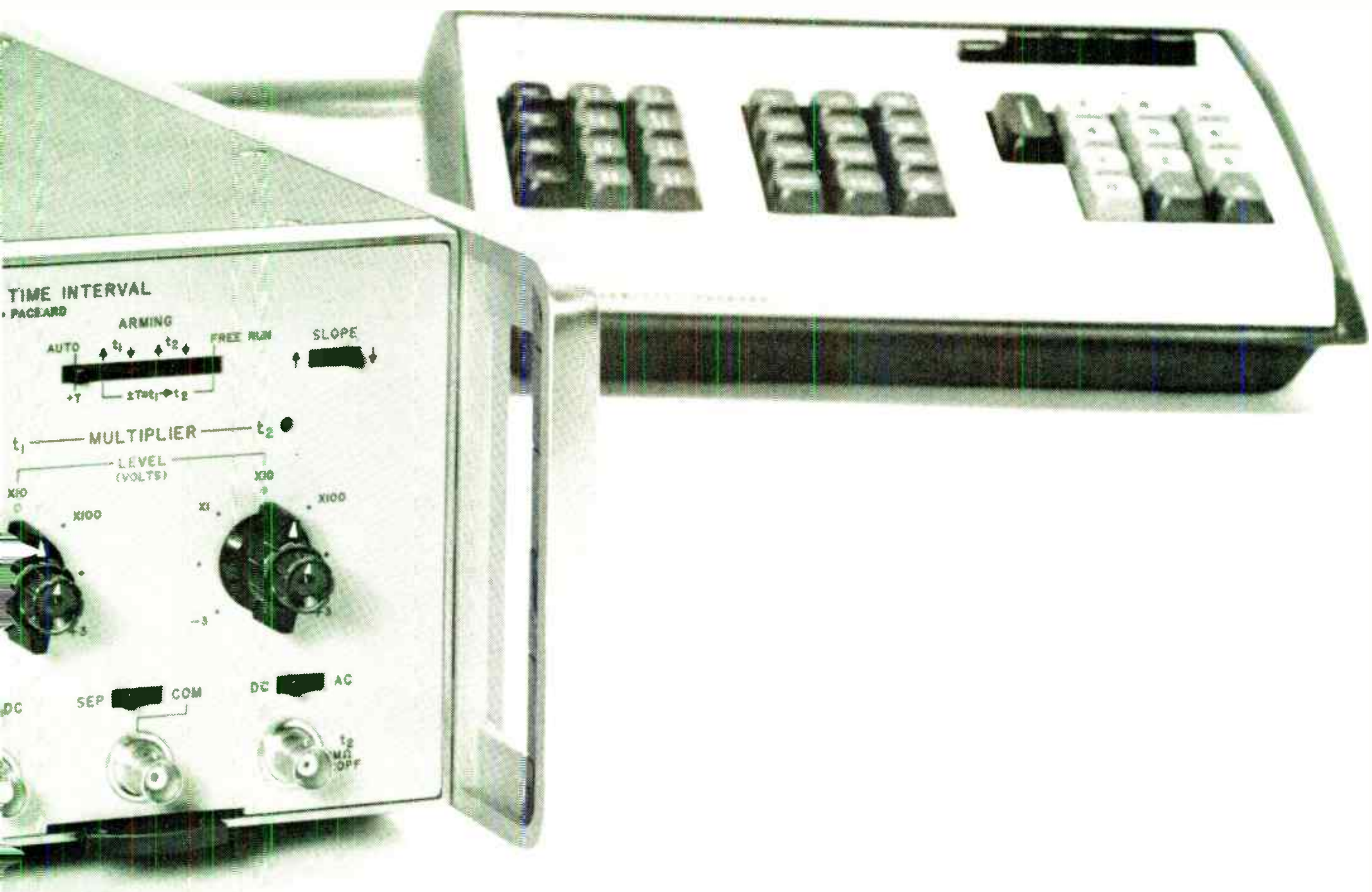
1. Ex parte King and Barton, Vol. 146, U.S. Patent Quarterly, 1964, p. 590, Patent Office Board of Appeals.

2. Mackay Radio & Telegraph Co. vs. Radio Corporation of America, vol. 306, U.S. Reports, 1939, p. 86.

3. In re Abrams, Vol. 188, Federal Reporter 2nd series, 1951, p. 165, Court of Customs and Patent Appeals.

Take a look... this counte

speaks for itself



A word from the new HP 5360A Computing Counter:

Measurement and computation
The revolutionary new Hewlett-Packard 5360A Computing Counter, the most significant advance in counter technology since 1952, uses built-in interpolation with computation to eliminate the traditional ±1 count ambiguity. It combines an IC period-measuring counter and an internal computer in a compact, easy-to-use package. Lets you measure frequency 1000 times faster, much more accurately and over a wider range than ever possible before. Basic measurements, 0.01 Hz to 320 MHz are automatic, with period and time interval resolution to 0.1 ns — a resolution never before offered in a counter. The 5360A's computing capability lets you automatically and in real time solve equations whose variables are the counter's measurements!

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The previous ±1 count accuracy limitation is decreased by a factor of 1000 by interpolators and digital computation within the 5360A.

Widest range
Besides the basic 0.01 Hz to 320 MHz measurement range, the 5360A accepts all the heterodyne converters of the popular HP 5245L, 5246L and 5248L Counters and lets you make spurious-free measurements to 18 GHz. Basic measurements without prescalers, too.

Finest resolution
No previous direct-reading digital instrument has given you the 0.1 ns resolution available in the 5360A for time interval and period measurements. In addition, with the 5379A Time-Interval Plug-in (not required for period measurements) you get more versatile input controls than ever before, automatic error detection and measurement of positive or negative intervals down to zero seconds, at rates over 1000 measurements per second.

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With none of the tedious transfer oscillator manipulation and calculation, the 5360A will measure pulsed signals up to 320 MHz with pulse length as short as 1 microsecond — and do it automatically and directly.
Using the frequency converter plug-ins, you can measure pulsed carriers all the way to 18 GHz. And you can even measure a single burst of signal, which you can't do with transfer oscillators.

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The 5360A and its accessory plug-in program module (available now) or its keyboard (available later this year) let you get direct answers in final form, real-time solutions to equations...without additional costly processing equipment and interface design. Two simple examples are direct readout measurements of phase or the rms value of a series of measurements.

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Front-panel controls provide new dimensions of versatility, yet the 5360A is easy to use. There's a new minimum in the need to manipulate controls. Range selection, for example, is automatic over the entire frequency range, no matter what the setting of the Measurement Time switch. The 5360A gives you a fixed-decimal display, with automatic blanking—your reading is always in the same position, with up to three digits to the left of the decimal, up to 11 digits in resolution...all via internal calculation. It's virtually impossible to read the 5360A incorrectly.

Questions?
The 5360A Computing Counter with the 5365A Input Module costs $6500. The 5367A Time-Interval Plug-in costs $750. Accessory keyboard, approximately $1000. Accessory plug-in program module, $190.
For all the information on this break-through instrument in counter technology, call your local HP field engineer. Or write for our fully illustrated brochure and data sheet: Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

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Designer's casebook

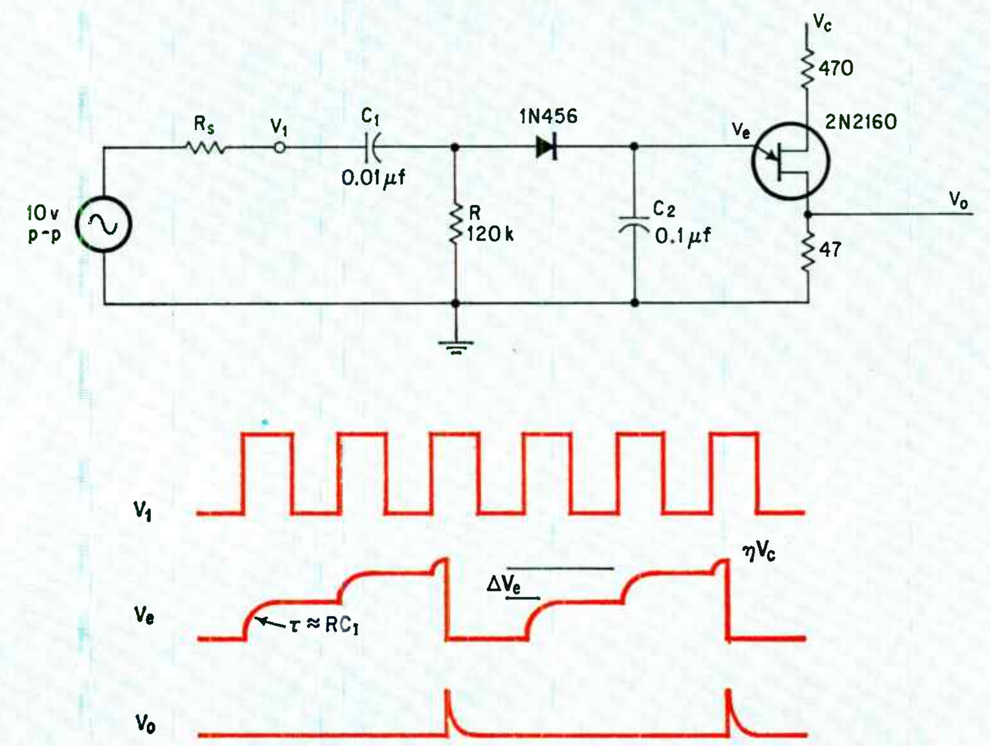
Designer's casebook is a regular feature in Electronics. Readers are invited to submit novel circuit ideas and unusual solutions to design problems. Descriptions should be short. We'll pay $50 for each item published.

UJT gives frequency divider an immunity to input jitter

By John P. Budlong
Bedford Institute, Dartmouth, Nova Scotia

Although there are many circuits that divide the frequencies of pulse trains, the input frequencies of these circuits must be stable without much jitter. A frequency divider built around a unijunction transistor, however, serves the same purpose while tolerating large amounts of jitter. And by varying the control voltage to the transistor, the UJT circuit—which operates over a frequency range of from 20 to 150 hertz—divides input pulse trains over a range of from 2 to 20.

Each cycle's trailing edge charges capacitor, C_1, to a level equal to C_1V_1 where V_1 is the amplitude of the input signal. The following leading edge transfers most of the charge to C_2. Thus, $C_1V_1 \approx C_2\Delta V_e$ and $\Delta V_e \approx V_1C_1/C_2$ where ΔV_e represents the change in voltage across C_2. When the voltage at the unijunction's input, V_e, reaches the value ηV_c, where η is the unijunction's intrinsic standoff ratio, the UJT fires, discharging C_2 and producing an output pulse. Since η is a constant, V_c determines the number of input pulses needed to produce one output pulse.



Keeping calm. The supply voltage V_c determines the number of input pulses that will produce one output pulse. By adjusting the values of the components and by using the relation $f = 1/10RC_1$, with f being the input frequency, almost any frequency range can be achieved.

D-c restorer clamps random pulses to a reference

By William E. Peterson

ITL Research Corp., Northbridge, Calif.

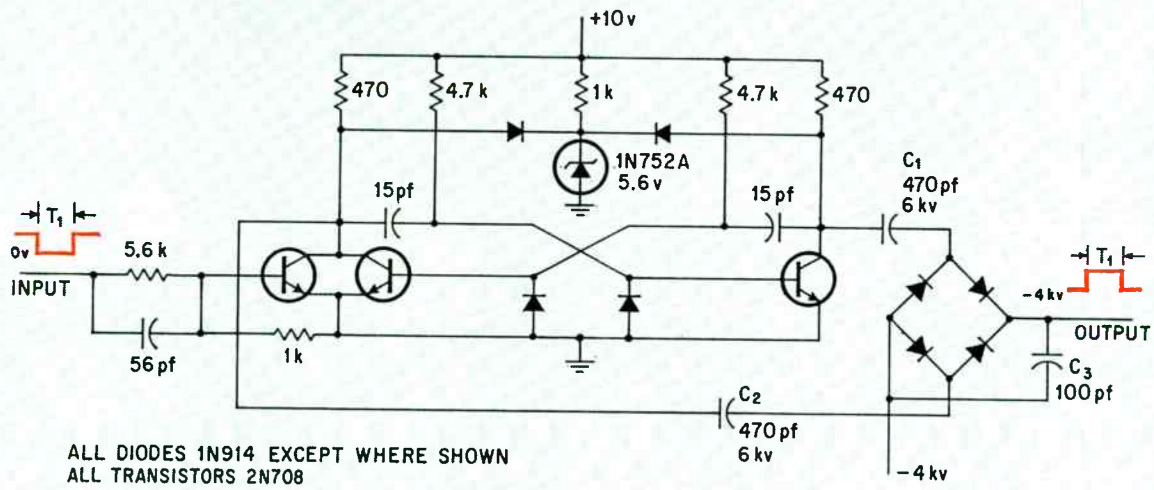
A diode bridge circuit coupled to an astable multivibrator eliminates many of the problems found in the conventional diode-capacitor d-c restorer circuit. Digital signals are clamped to a d-c level without suffering distortion common in the diode-capacitor circuit, especially when the signals are random in frequency and pulse width.

Designed for a specific application, this circuit was used to unblank a cathode ray tube where the grid was biased at —4 kilovolts below ground. The pulse width determined the duration that the information would be displayed on the screen.

Transistors Q_1 and Q_2 form the astable which oscillates at radio frequency. Q_3 acts as a gate and turns the oscillator on and off according to the input digital signal. The radio frequency pulses from the oscillator are coupled to the diode bridge through two capacitors capable of withstanding a stress of —4 kv.

The bridge is referenced at —4 kv, the level to which the waveform is to be clamped. Capacitor C_3, located at the output, filters the pulses that are detected by the bridge circuit.

This technique directly couples the digital signal to a d-c level, and thus the input pulse width may be of any length without a loss due to coupling. The entire circuit is easy to assemble because no transformers or other costly parts are used in its construction.



Restoration. Transistor Q_3 gates the astable multivibrator on or off corresponding to the pulse width of the input r-f signal. The pulses are delivered to the diode bridge circuit which is clamped at a d-c level, which for this application is —4 kilovolts. The output waveform thus rides on a d-c level of —4 kv.

Ladder network converts binary input to a-c output

By Donald J. Gawlowicz and Robert A. Fisher*

* Now with General Electric Co., Binghamton, N.Y.

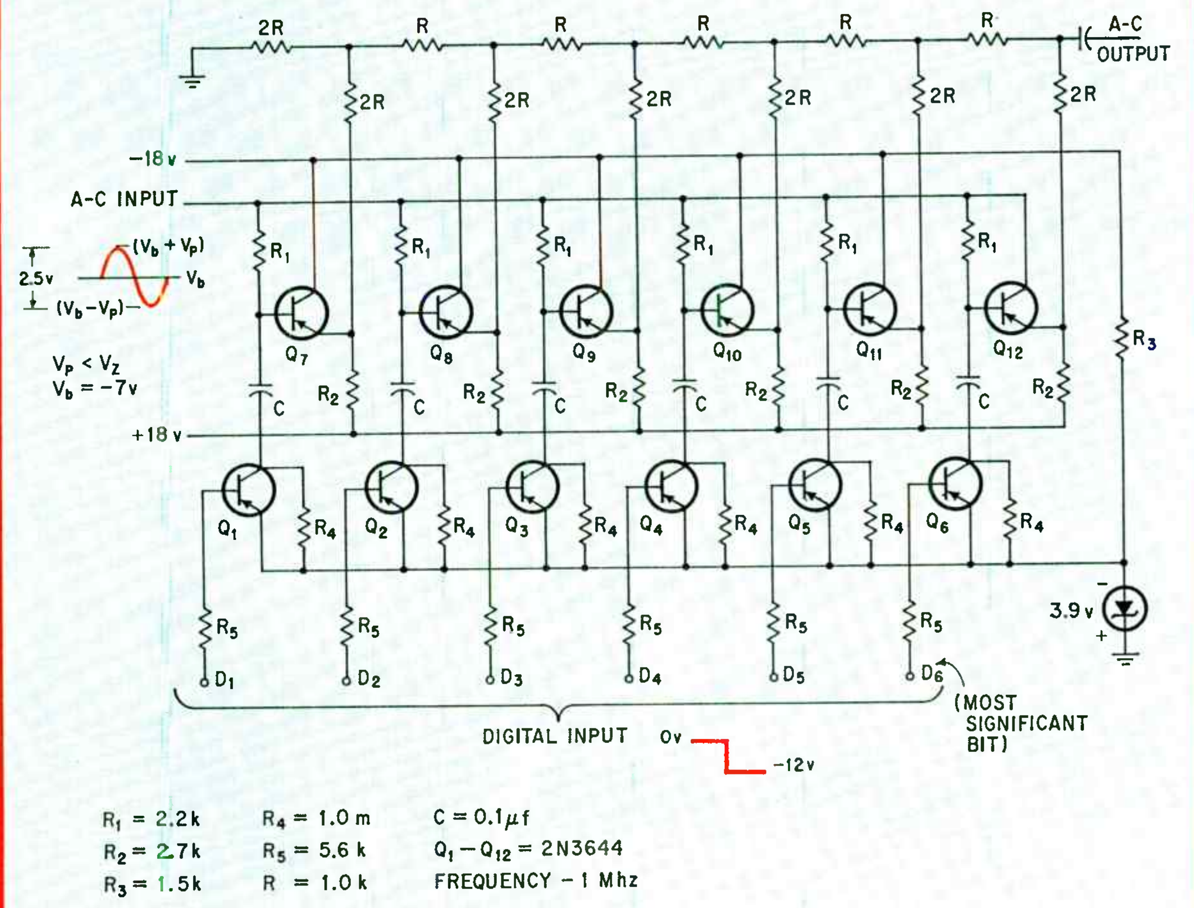
When an alternating current output is desired whose amplitude is proportional to the weight of a set of binary inputs, such as may be used in a-c servo systems, a transistor ladder network can be used. The binary input operates upon an a-c input signal having a desired frequency and full scale amplitude.

The a-c input drives the base inputs of transistors Q_7 through Q_{12}. These transistors operate as emitter followers. Binary bits D_1 through D_6 cut off (logic 1) or saturate (logic 0) the switching transistors Q_1 through Q_6; the saturated transistor state short-circuits the a-c signal. The a-c voltage on the emitters of transistors Q_7 through Q_{12} is either the steady state a-c input voltage, or approximately zero. These voltages are then weighted by the same type of resistive ladder network that is conventionally employed in commercial digital-to-analog converters.

To design the converter for a particular application, the following must be considered. The total impedance resulting from the parallel combination of resistor R_4 and the input impedance of a typical emitter follower must be much larger than R_1 to ensure that the a-c input voltage is not attenuated. The impedance of capacitor C at the input frequency plus the series resistance of the saturated input transistor must be much smaller than R_1 to effectively short-circuit the a-c input signal to ground. The peak-to-peak voltage of the a-c input, $2V_p$, must be less than twice the biasing zener diode voltage to keep the input switching transistors out of saturation when a logic 1 input is applied.

By a-c coupling the collectors of switching transistors to the bases of the emitter followers, the d-c levels at the outputs of the emitter followers are not affected by the state of the switching transistors. Therefore the d-c level at the output of the ladder network is independent of the switching operations. This makes it possible to a-c couple the output without causing switching transient problems.

The circuit can be made phase sensitive for use with a-c servomechanisms by supplying the most significant bit (Q_{12}) with an a-c voltage of the same amplitude and frequency as that used for the other bits, but 180° out of phase. It would then be possible for a two's complement, binary-input code to be used.



Ladder. Binary D_1 through D_6 saturate or cut off transistors Q_1 through Q_6 whose bases are driven by an a-c signal. Those transistors that are saturated by the binary inputs, deliver the a-c signal to the output with a voltage weighted by a conventional resistive ladder network.

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How's that register?

DYNAMIC		
Dual-25	MM400	—55°C to +125°C
	MM401	—55°C to +125°C (Internal 20K pull-up resistor)
	MM500	—25°C to +70°C
	MM501	—25°C to +70°C (Internal 20K pull-up resistor)
Dual-50	MM402	—55°C to +125°C
	MM403	—55°C to +125°C (Internal 20K pull-up resistor)
	MM502	—25°C to +70°C
	MM503	—25°C to +70°C (Internal 20K pull-up resistor)
Dual-100	MM406	—55°C to +125°C
	MM407	—55°C to +125°C (Internal 20K pull-up resistor)
	MM506	—25°C to +70°C
	MM507	—25°C to +70°C (Internal 20K pull-up resistor)
Dual-64	MM410	—55°C to +125°C
Accumulator	MM510	—25°C to +70°C
Triple-60+4	MM415	—55°C to +125°C
Accumulator	MM515	—25°C to +70°C
STATIC		
Dual-16	MM404	—55°C to +125°C
	MM504	—25°C to +70°C
Dual-32	MM405	—55°C to +125°C
	MM505	—25°C to +70°C
8-bit	MM408	—55°C to +125°C
Serial to Parallel	MM508	—25°C to +70°C
8-bit	MM409	—55°C to +125°C
Parallel to Serial	MM509	—25°C to +70°C
Dual-32	MM419	—55°C to +125°C
Split clock	MM519	—25°C to +70°C

Circuit monitors energy of laser photocoagulator

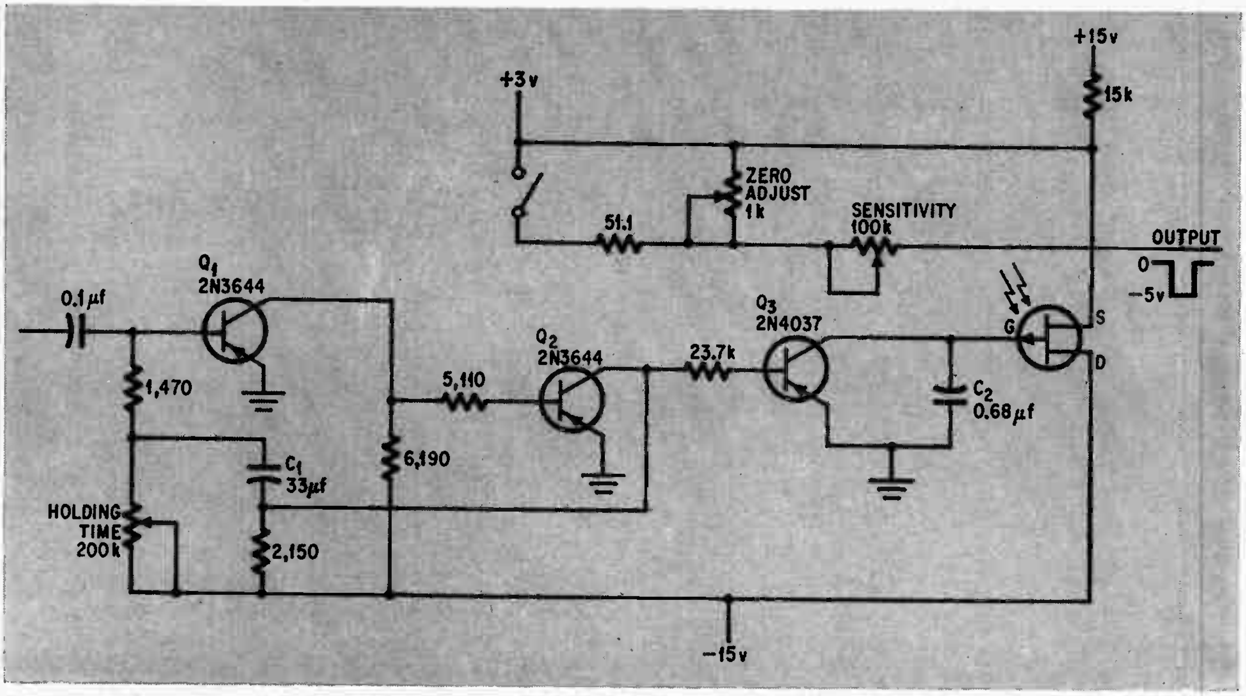
Ophthalmologists can record the laser energy entering a patient's eye

By Earl J. Scribner
Stanford Research Institute, Menlo Park, Calif.

Monitoring and recording the energy output of a pulsed ruby laser can be done by a simple transistor circuit that includes a zero control (if required for the recorder) and maintains the integrator in a zero condition until a signal is applied to the input gate. This gate signal allows the integrator to function and hold a value for an adjustable period of time (5 seconds or less). The circuit then automatically re-zeros the integrator and prepares the recording instrument for another reading. Firings can thus be made in quick succession without the need of constantly referring to individual readings.

This circuit was specifically designed for use in a ruby laser photocoagulator. It works with a hot-stylus type recorder to provide an opthalmologist with a permanent record of energy entering a patient's eye on each laser exposure.

A field effect phototransistor is mounted within the hand-held ophthalmoscope of the photocoagulator. A small fraction of the laser beam is reflected off a dichroic beamsplitter and is then passed



Eyeing the energy. The circuit provides an accurate and rapid method for obtaining the total energy output of a pulsed ruby laser photocoagulator each time it is fired. Thus a permanent record of the total energy entering a patient's eye is available to the ophthalmologist for study.

through a plastic diffuser, a Kodak 70 filter, a neutral-density filter, and an infrared-absorbing filter (Corning 1-69), and is applied to the lens of the FET. A narrowband filter could also be used in the optical path. The purpose of the infrared filter in this case is to remove the large amount of infrared radiation from the 150-watt tungsten source used to illuminate the eye.

The circuit for the energy monitor consists of a switching circuit, an internally adjustable monostable multivibrator, and the FET integrator circuit. In the circuit's quiescent condition, switching transistor Q_3 is on, and is thus applying a virtual short circuit across the integrating capacitor, C_2, and holding the instrument and recorder in a zero condition. When a signal is applied to the input, Q_2's collector is driven to ground, turning Q_3 off. With Q_3 off, incident light within the sensitive range of the FET generates a photocurrent across the gate-channel.

The FET's high input impedance yields long time constants with small capacitor values. At the same time, the low gate-reverse current gives a minimum of drift to the integrated photocurrent.

Since the integrated photocurrent is proportional to the total energy in the laser beam, the voltage at the gate of the FET is proportional to the laser photocoagulator's output energy. The output of the FET (taken from the source terminal) is used to drive the recorder. The output voltage should be held to a maximum of 5 volts so that good linearity can be maintained.

At the end of the holding time period—determined by the RC time constant of the trim pot and capacitor C_1—Q_2 turns off and Q_3 turns on, shorting the integrating capacitor again. The recorder stylus therefore automatically returns to zero and stays there until the laser is again fired.

Any positive pulse occuring before the last laser action can be used to turn Q_1 off at the input gate. This pulse can originate in the laser flashtube ignition circuit.

The amplitude of the output signal is controlled by the sensitivity control adjustment.

Energy calibration is done by comparing the total energy in the output of the photocoagulator, as measured on a thermopile, with the indicated deflection of the trace on the recorder as measured by the phototransistor. Energy levels from 2 to 200 millijoules can be read on the recorder.

Industrial control

Multipoint recorder serves as time-shared amplifier

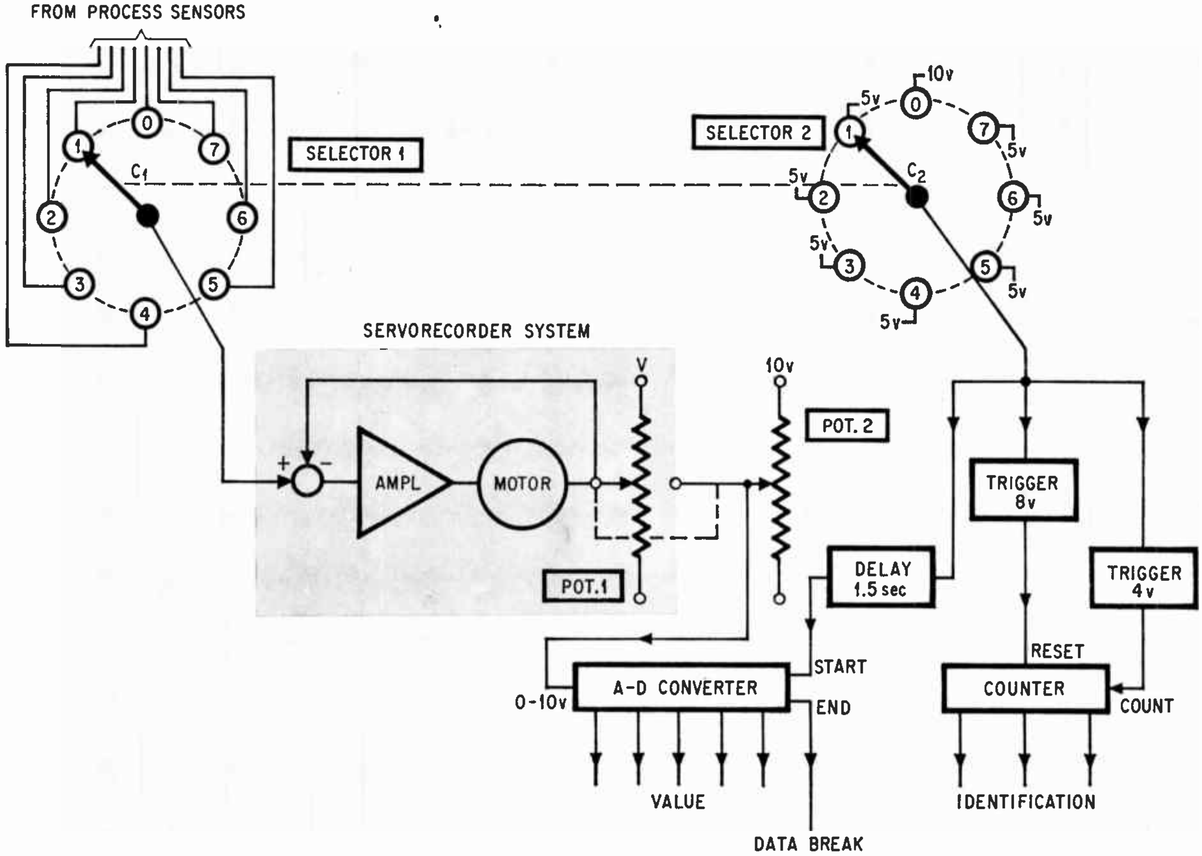
It saves the need for a low-level multiplexer and a converter

By Marcel Nougaret
University of Sherbrooke, Canada

Many control processes use a digital computer in conjunction with an analog recorder and a controller. In general, process sensors such as thermocouples yield signals in the millivolt range, meaning that a low-level analog-to-digital converter is required to interface between process and computer. It also means that low-level, high-precision d-c amplification is needed in the analog recording system. The costly function of low-level amplification is thus needlessly duplicated in the a-d conversion and analog recording.

Use of a coded disk mounted on the shaft of an analog potentiometric recorder avoids the cost of a low-level a-d converter, but coded disks with high resolution are expensive units. A better method that can be used employs the arrangement shown in the diagram.

The electromechanical system of a conventional



Useful recorder. Each input is sampled for 2 seconds, transmitted to an a-d converter, and then delivered to the digital computer. Different control programs are initiated in the computer by an identification number accompanying each input signal. System timing and synchronization are handled by the second selector.

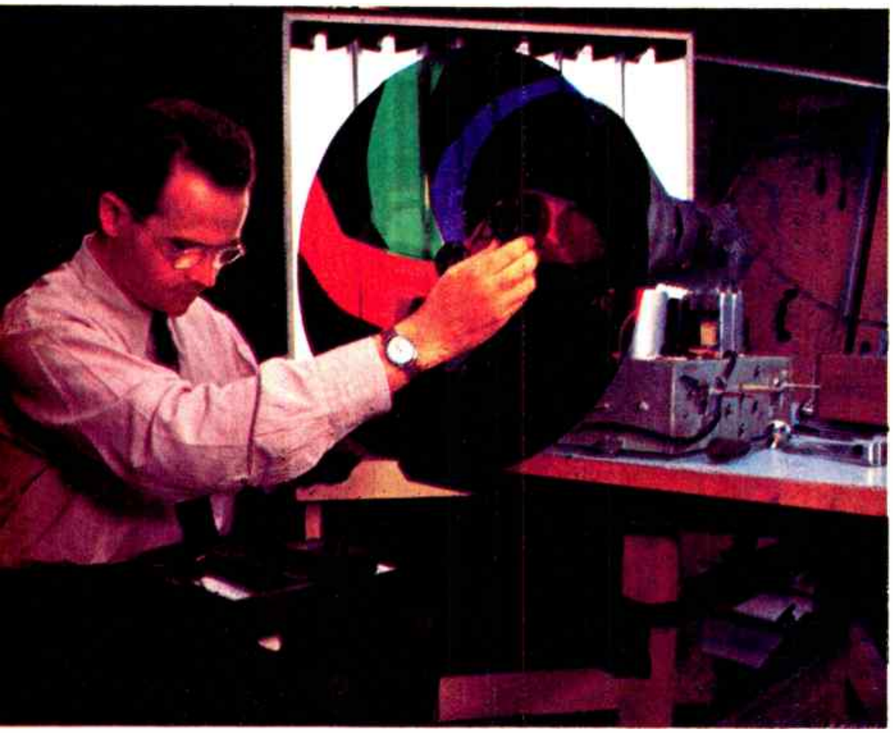
multipoint recorder, a frequently encountered setup in physical and chemical process controls, is made of a servodriven potentiometer that's time-shared between the different analog inputs (one to eight) to be recorded. Driven by a mechanical cam, wiper C_1 steps from one position to another, remaining approximately 2 seconds at each point to make sure that the transient response of the servosystem has enough time to settle. A rotary printing wheel synchronized with wiper C_1 then prints a symbol identifying each input signal on the paper chart of the recorder. Thus for an eight-point recorder, each input is sampled within about 16 seconds.

For easy numerical control, the recorder system is equipped with an auxiliary potentiometer (pot 2) and a second selector (2) mounted on the same shaft as the input selector (1). The slider of pot 2 is mechanically linked to the servopotentiometer slider; by connecting pot 2 to a reference voltage of 10 volts, the potentiometer delivers a signal proportional to the input. This system can be described as a time-shared amplifier with the added feature that the output signal is totally decoupled from the input signal.

A high-level (0-10 volts) a-d converter is connected to the slider of pot 2 for digital control. The converter has one control input to initiate conversion and another to emit a logic signal when conversion is completed. The timing and synchronization of the system is ensured by selector 2, each position of which is connected to 5 volts, except point 0, which is connected to 10 volts. The counter, which is connected to the wiper of selector 2, is reset each time wiper C_2 reaches point 0. The counter is incremented once for each position on selector 2 that the wiper moves through.

To avoid picking up the analog signal of pot 2 while the servosystem is in a transient condition, the a-d conversion is initiated for each position after a delay of about 1.5 seconds. When conversion is completed, the converter delivers the signal, the coded process variable, and its identification number (given by the content of the counter) to the digital computer. Different control programs are initiated as specified by the identification number accompanying each input signal.

The advantage of such a system is that it needs no low-level multiplexer and converter. Another advantage is that the computer's electrical system is independent of the process sensing system, thus side-stepping most of the frustrating grounding, shielding, and filtering problems associated with the installation of a digital computer in industrial process control.



Circa 1940. Peter C. Goldmark, then CBS' chief engineer for tv development, with first color-wheel system.

Spacebound. Westinghouse's color camera weighs a scant 15 pounds.

Communications

Color-tv wheel takes a spin in space

Digital logic is used to channel serial color signals on separate tracks of multihead disk recorder that reads out the signals in parallel format

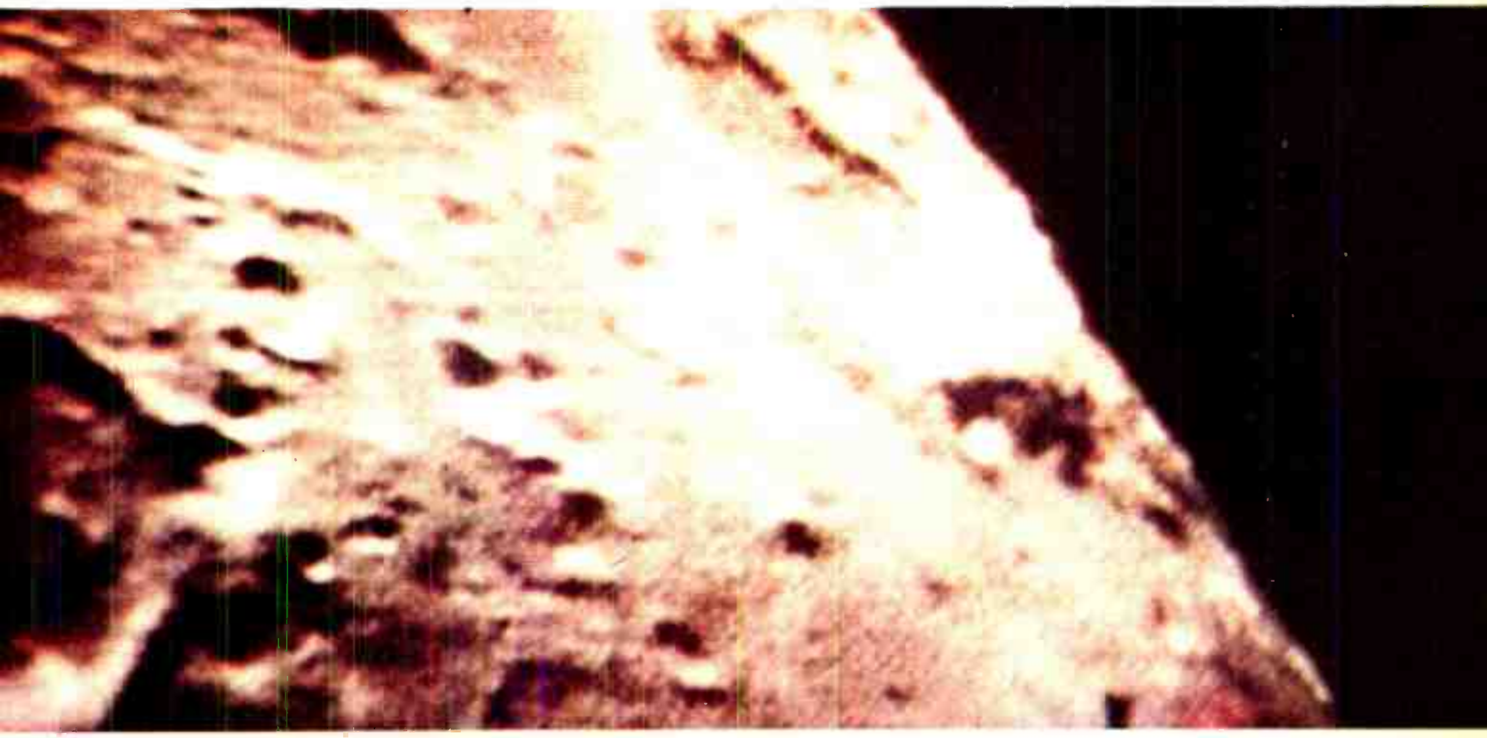
By John D. Drummond
Associate Editor

When Apollo 10 sent live color pictures of the moon into living rooms around the world in May, it was as much a glorious day for Peter C. Goldmark, President of CBS Laboratories, as it was for the U.S. space agency. For at long last, Goldmark's concept of a field-sequential system for color television proved to be more than the cockeyed scheme his critics thought it was.

True, the system aboard Apollo 10 is far different than the one Goldmark demonstrated in New York back in the early 1940's, but it nevertheless shares its genesis with the earlier design. The Apollo 10 camera, just as Goldmark's, employed a color filter wheel to produce a color signal.

A field-sequential system uses a rotating filter wheel to expose a camera's pickup tube sequentially, at the desired broadcast scan rate, to the red, blue, and green components of a scene. Thus the need for complex optical paths and color registration adjustment, both of which are akin to commercial color cameras, is eliminated.

Since the output of a field-sequential system is

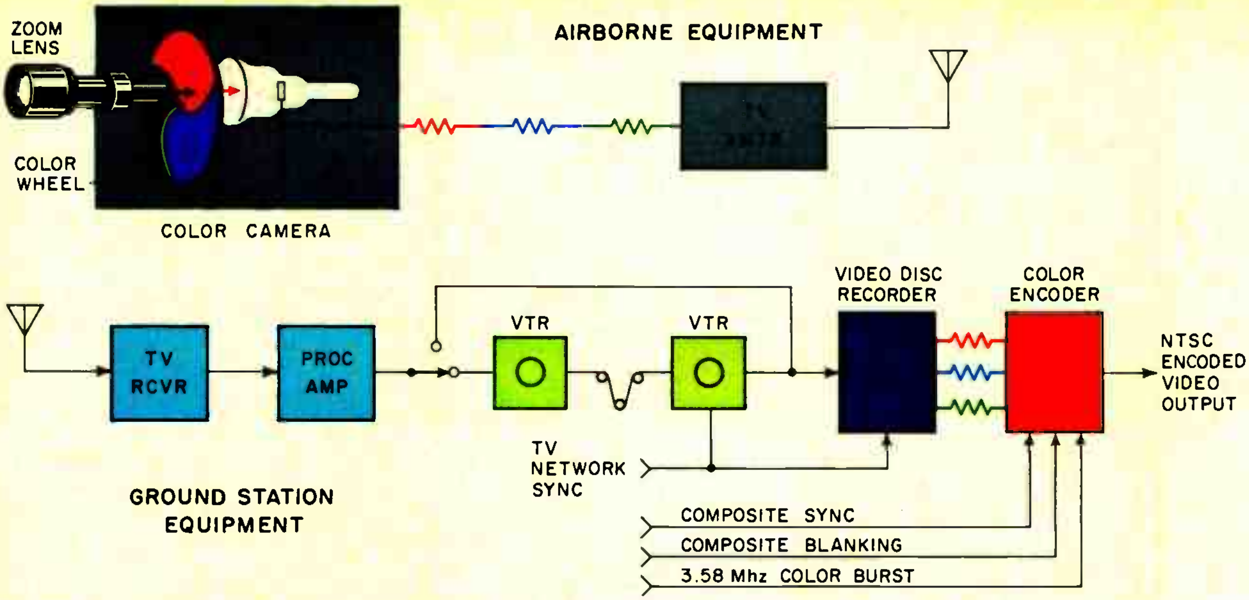


Moonglow. Closeup of the moon taken from the Apollo 10 command module; below, astronauts Stafford and Young in horseplay to demonstrate weightlessness in space while Cernan shoots the picture.

in serial red-blue-green form, it's not compatible with present broadcast standards. Hence, engineers at the Manned Spacecraft Center in Houston were confronted with the problem of making it compatible with the parallel NTSC (National Television System Committee) color tv format so it could be rebroadcast by commercial stations.

The first decision was that the conversion would have to be done on the ground since a converter could not be carried aloft. The second was to use a magnetic disk recorder of the type used for instant replay of sport events. They then came up with a scheme using digital logic to sequence the incoming colors to the appropriate tracks on the recorder, and then read them out, all at once, to obtain a parallel output.

Why pick a simple color scheme, then go through all that trouble to make it compatible? For the simple reason that NASA wanted a light-weight camera that would require very little power and be capable of operating in the low light levels of the command module as well as in the high light



Bridging the gap. The field-sequential tv signals produced by the spinning color wheel, above, are beamed to earth over a 20-watt, S-band transmitter. Ground-processing equipment, below, convert the serial color signals to the parallel color format.

levels of the lunar environment. And, basically, all that's required to convert a black-and-white camera to a field-sequential color camera is the addition of a wheel.

A compatible NTSC color camera couldn't be used either since the weight and size of the package required for beam-splitting optics, dichroic filters and three pickup tubes, plus their associated circuitry, would far exceed both the space and weight limitations of the spacecraft. Furthermore, a limited size NTSC color camera couldn't be expected to have the low light level capabilities of the Apollo camera.

What convinced NASA at the last minute to go color was a demonstration by the Gyro Dynamics Corp. of Salt Lake City, Utah, of a field-sequential system using optical techniques, instead of a whirling wheel, to obtain the separate red, blue, and green signals.

Both the Gyro Dynamics system and a color wheel system from CBS were evaluated at the Houston spacecraft center under conditions simulating tv transmissions from distances in the vicinity of the moon, and both appeared to be acceptable for the Apollo mission.

However, NASA chose the color wheel because it could easily be integrated into a low-light level camera that Westinghouse had already built for another application, within the short time available before the flight. A second camera, an RCA black-and-white type, was carried aboard Apollo 10 as a backup, but it was never used during the flight.

Zooming in on the moon

The heart of Westinghouse's color camera is a secondary emission conduction (SEC) pickup tube, which operates in light levels as low as 0.007 foot-lambert to as high as 12,600 foot-lamberts, without saturation. The tube has a very low lag, or persistence characteristic, enabling the color exposed during one scan to die down before the start of the next scan. This feature assures color purity.

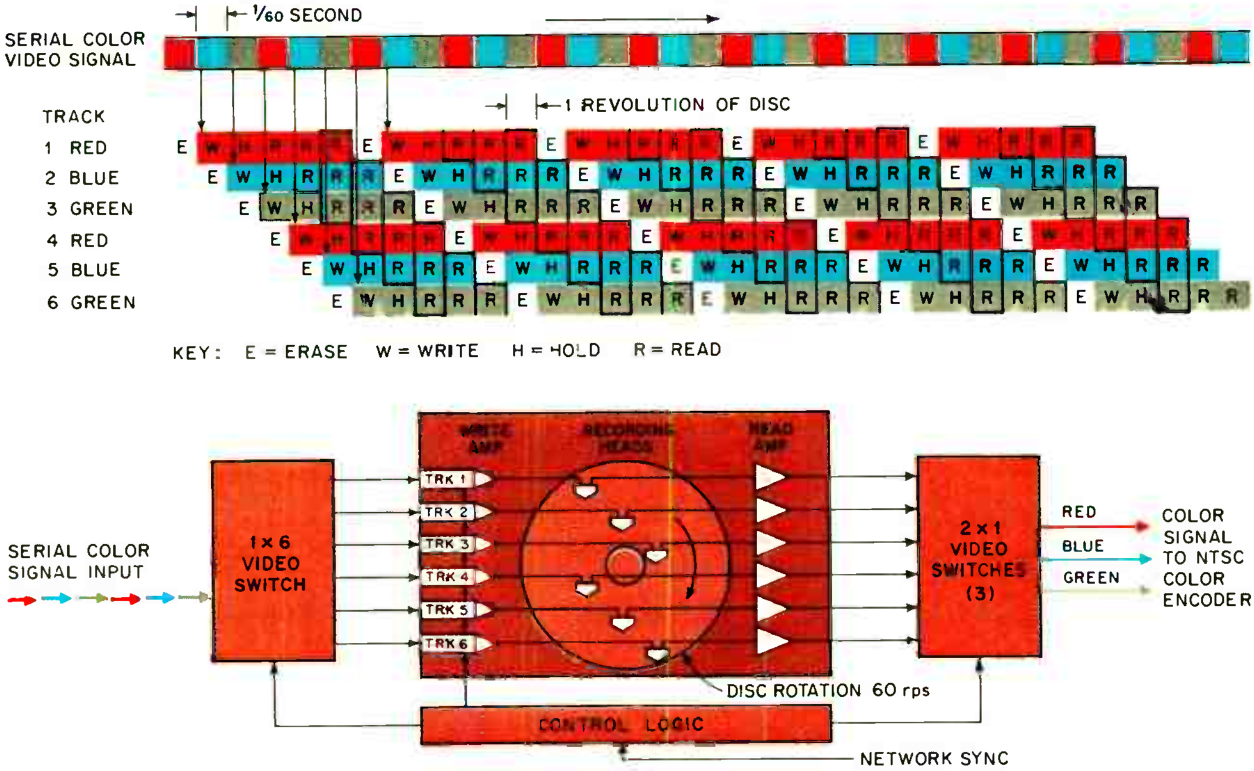
A last-minute change in the camera specs called for a zoom lens, rather than the quick-disconnect, fixed-focus type used on the Apollo 9 camera. Because of this addition, a monitor was required so the astronaut could zoom in on a target and focus the picture without relying on ground control for directions.

The job was assigned to Westinghouse, who came up with a tiny monitor that could operate on, or off, the camera. It weighed less than four pounds, required about three watts of power, and had a black-and-white screen. It had four operating controls: brightness, contrast, vertical, and horizontal.

The color wheel was put between the SEC pickup tube and the zoom lens. To simplify the problem of synchronization, the scan rate of the wheel, as the color filters pass in front of the pickup tube, must be the same as that of the tv networks, which is 60 fields per second. This was achieved by dividing the wheel into six sections, with the colors arranged in red-blue-green, red-blue-green order, and by driving the wheel at 60 revolutions per second. The motor speed is held constant by the timing of the camera's sync generator.

The serial color signal, which is transmitted by a 20-watt, S-band transmitter on the spacecraft, is picked up and amplified by a receiver at the Houston spacecraft center. It's then clamped in a processing amplifier to restore the d-c component and reestablish the average light value of the reproduced image.

To compensate for the doppler shifts produced



Color converter. Using digital logic to direct the red, blue and green color signals to the assigned tracks, the disk recorder reads out the signal in parallel format. Tracks delivering parallel color output are boxed in.

by the relative velocities of the spacecraft and the ground receiver, the signal is recorded on tape by a recorder whose speed is regulated by the incoming sync pulses. It's then passed through a loop which gives it a maximum 10-second delay before it's played back on a second tape recorder whose speed is synchronized with a 3.579545-megahertz oscillator in the ground processing equipment. By this storage and replay technique, the time base is automatically corrected, and the effects of doppler shifts are cancelled.

The video is now routed through a "gen-lock" to a stabilizing amplifier which removes the incoming sync from the signal. It then goes to a distribution amplifier which feeds the magnetic disk recorder that changes it from field sequential to the simultaneous color format.

The recorder's servo system is synchronized by the horizontal drive or the sync pulses, depending on the selected operating mode. The commutating logic that directs the fields of the sequential color signal to their respective tracks on the recorder is under the control of the system's sync generator which, in turn, is locked to the NTSC color standard.

The colors are put on six different tracks. The red signal is routed to track 1, the blue to track 2, the green to track 3, and so on. When a field of each color has been recorded on its designated track, the three colors are simultaneously read out the same way as the output from a three-tube NTSC color camera to a color encoder which processes it to form the composite video signal. The tracks are completely erased and updated every 20 revolutions of the disk.

Behind the scenes

Apollo commander Thomas P. Stafford is credited by NASA with providing the impetus that lead to the decision to use a color camera.

Project coordination came from Olin Graham, NASA's tv section head, and Max Engert, the space agency's technical supervisor. Westinghouse credits Larkin L. Niemyer for the camera design, and Lloyd B. Gangaware for the monitor.

CBS Laboratories, which served as consultant to Westinghouse and the space agency, credits Renville H. McMann Jr. and Arthur Kaiser for coming up with many of the schemes adopted.

The space agency also credits Lockheed Aircraft's technicians for modification of the basic video disk recorder, and the interfacing of the color equipment with existing station distribution equipment. Taft Broadcasting gets credit for operating the station equipment during the Apollo 10 flight.

Looking ahead

In the Apollo 11 flight, scheduled for July 16, a similar field-sequential color camera will be aboard the command module while a black-and-white camera will be on the hatchway door of the lunar module to send back pictures of the first man—an American—as he sets foot on the moon. ■

Active filters: part 10
Synthetic inductors from gyrators

Appealing because they can be used in building highly selective filters, gyrators are expected to become even more attractive in monolithic-IC form

By Gerald Aaronson
General Telephone & Electronics Laboratories Inc., Bayside, N.Y.

Despite an inherent insensitivity to component parameter variations, gyrator-capacitor active filters are sometimes frowned upon because they tend to be costlier than other filters—both active and passive. But this cost argument is about to be tossed out of a window. Within a matter of months, about six or eight, gyrators are expected to become available in monolithic-IC form, which, aside from reducing size, should bring the cost down to about the same ballpark level as other filters. And when this happens, chances are that designers will make greater use of gyrators in filter networks. Moreover, it should pave the way for applications heretofore untapped by gyrators—particularly in today's sophisticated communications systems.

But regardless of whether in discrete or integrated-circuit form, gyrator filters hold some clear-cut advantages over other types of active filters. Aside from their insensitivity to parameter variations, gyrators exhibit high Q's when used to form synthetic inductors. This characteristic is essential for highly selective filter networks.

For a high-Q inductor, a gyrator's conductance, g_0, should be large as should its input and output impedances. When a stable Q is needed, the high Q is attained first and then damped to the desired value. Since even the slightest phase shift in the gyrator loop can lead to oscillations in some high-Q circuits, it's best to add phase compensation.

In the design of most active filters other than a gyrator, the perennial bugaboo confronting the engineer is the circuit's sensitivity to parameter changes. Therefore, the engineer must expend considerable effort in coming up with a scheme that would prevent the circuit's active components from changing their values.

A gyrator, however, is a negative-feedback device and therefore inherently stable. It has an impedance-inversion property that converts a capacitive load into an inductive reactance. This gyrator-created synthetic inductor replaces the passive inductor in conventional LC filters. Thus, the need for lossy and bulky inductors, particularly in low-frequency applications, is nonexistent.

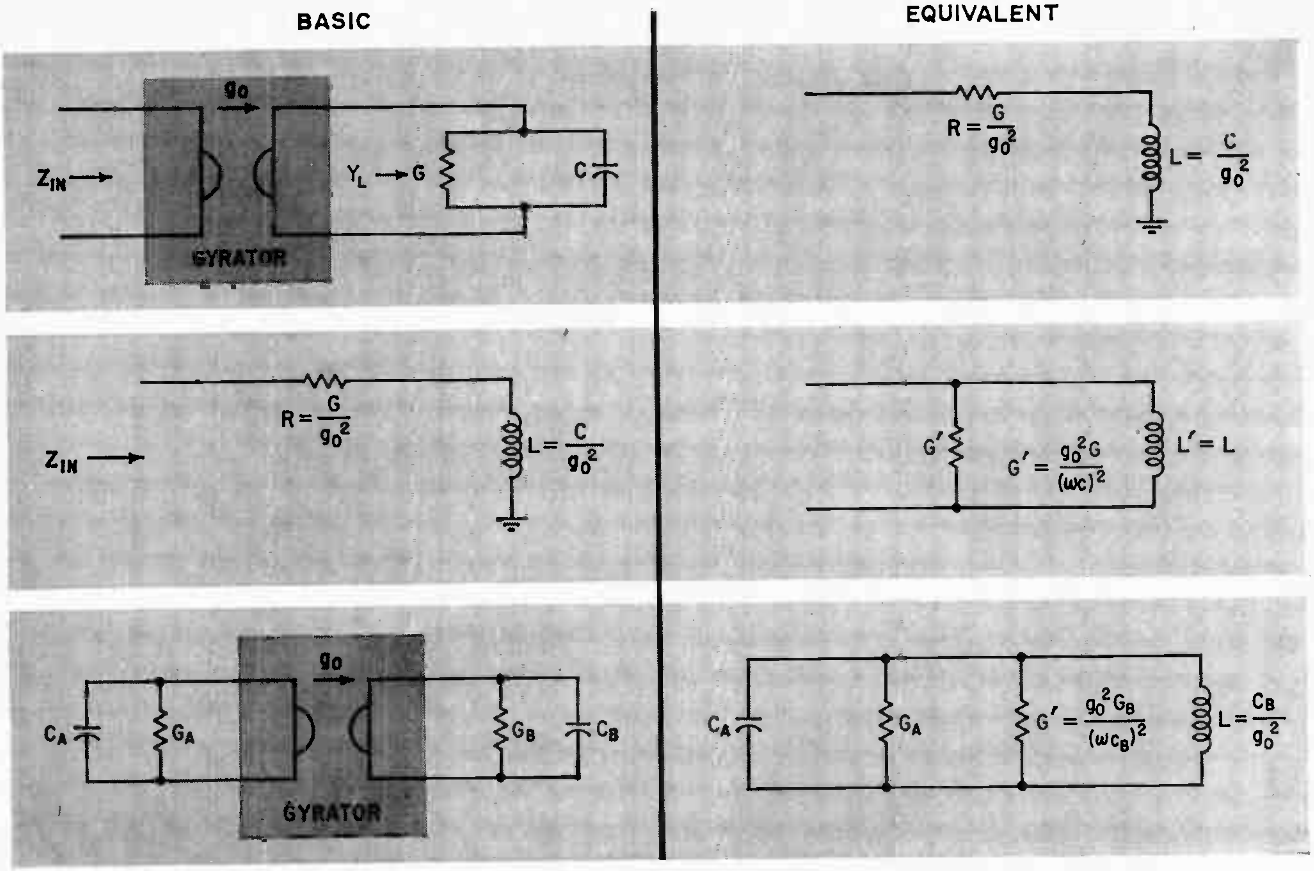
Filters designed with positive-feedback techniques are produced by cascading two-pole building blocks. This is necessitated by the pole location's sensitivity to changes in the component values. At best, the pole sensitivity is proportional to the Q of the pole-pair; a 1 percent change in a network parameter will cause at least a 10 percent change in pole location in a network whose Q = 10. If a four-pole network is synthesized with one active circuit, the sensitivity will be proportional to the product of the Q's of each conjugate pole.

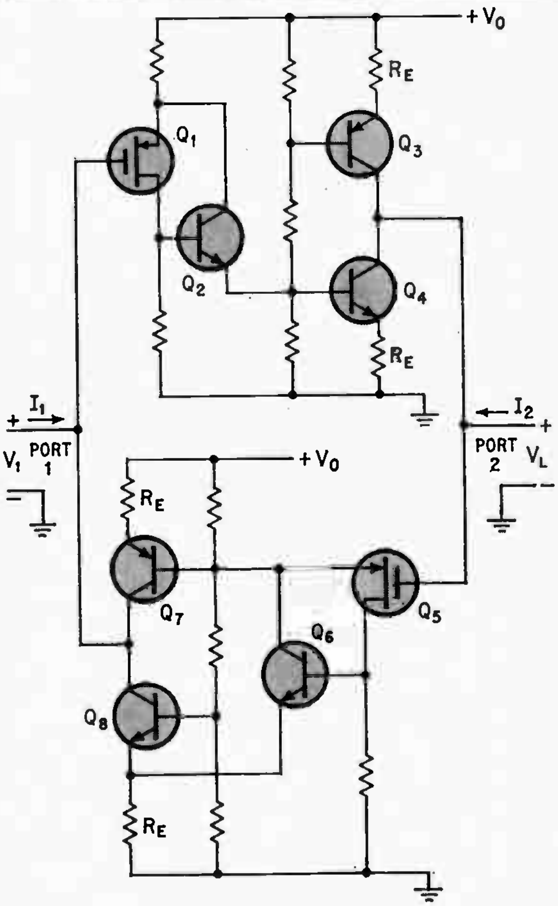
The gyrator, because of its relative insensitivity, doesn't require such cascading. It enables the designer to directly substitute synthetic inductors for passive inductors in conventional LC filter designs. Therefore, other synthesis techniques are not required. This isn't true for other methods.

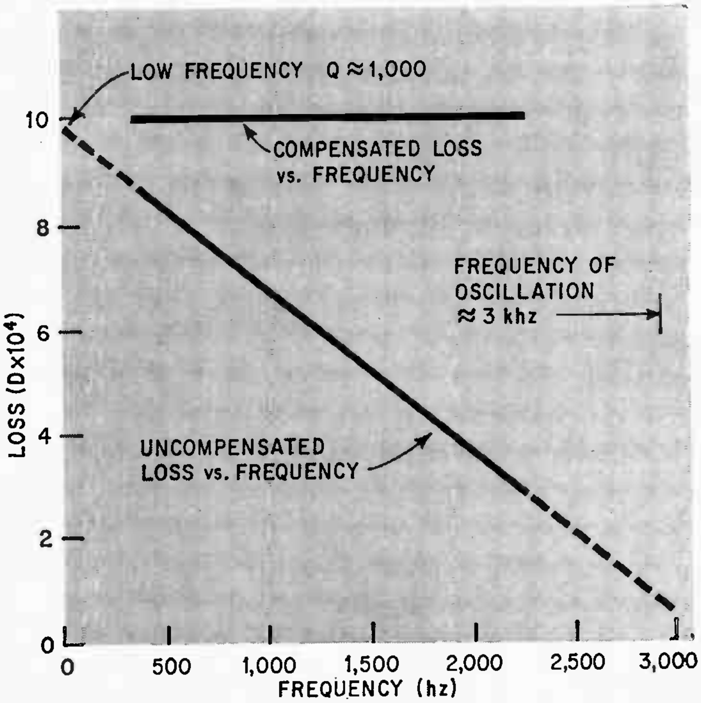
A gyrator that is terminated in a capacitor presents an inductive input impedance. Thus, it is possible to tune the synthetic inductor created in this manner with another capacitor. If ideal gyrators and capacitors are assumed, the resultant LC network would be an ideal tuned circuit. For the most part, however, gyrators are far from ideal. They have parasitic components that affect the desired high input and output impedances as well as small loop delay that can cause instability if not compensated.

Consider an ideal gyrator with a parallel RC load. The input impedance, Z_{in}, is

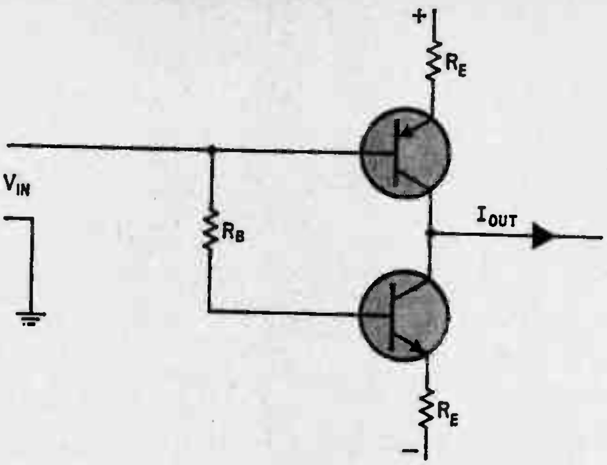
Gyrator connection







High impedance. FET's Q_1 and Q_5 with their high input impedance, enable the engineer to see only the common-collector impedances of the V-I converters Q_3-Q_4 and Q_7-Q_8 at ports 1 and 2, respectively. Plot of loss vs. frequency indicates the compensation necessary to stabilize the gyrator.



Voltage-current converter. A common-base stage, converter's collector current is proportional to base voltage. Output impedance at the common-collector terminal can be made as high as 6 megohms.

$$Z_{in} = \frac{G}{g_o^2} + \frac{j\omega C}{g_o^2} \qquad (1)$$

where g_o is the gyration conductance in mhos, represented by the series RL circuit shown in the top drawing on page 119. If the Q, $\omega L/R$, of the circuit is high it can be represented by an equivalent parallel RL circuit with the values shown in the center drawing on page 119.

Now, consider a turned gyrator-capacitor circuit as shown in the bottom left drawing on page 119 where conductances G_A and G_B represent the parasitic loading of the gyrator circuit. For the moment, the capacitors are assumed ideal, having no dissipation. The tuned circuit is also represented by the network at the bottom right drawing.

The resonant frequency of this circuit is

$$\omega_o = \frac{1}{\sqrt{LC_A}} = \frac{g_o}{\sqrt{C_A C_B}} \qquad (2)$$

where $L = \frac{C_B}{g_o^2}$

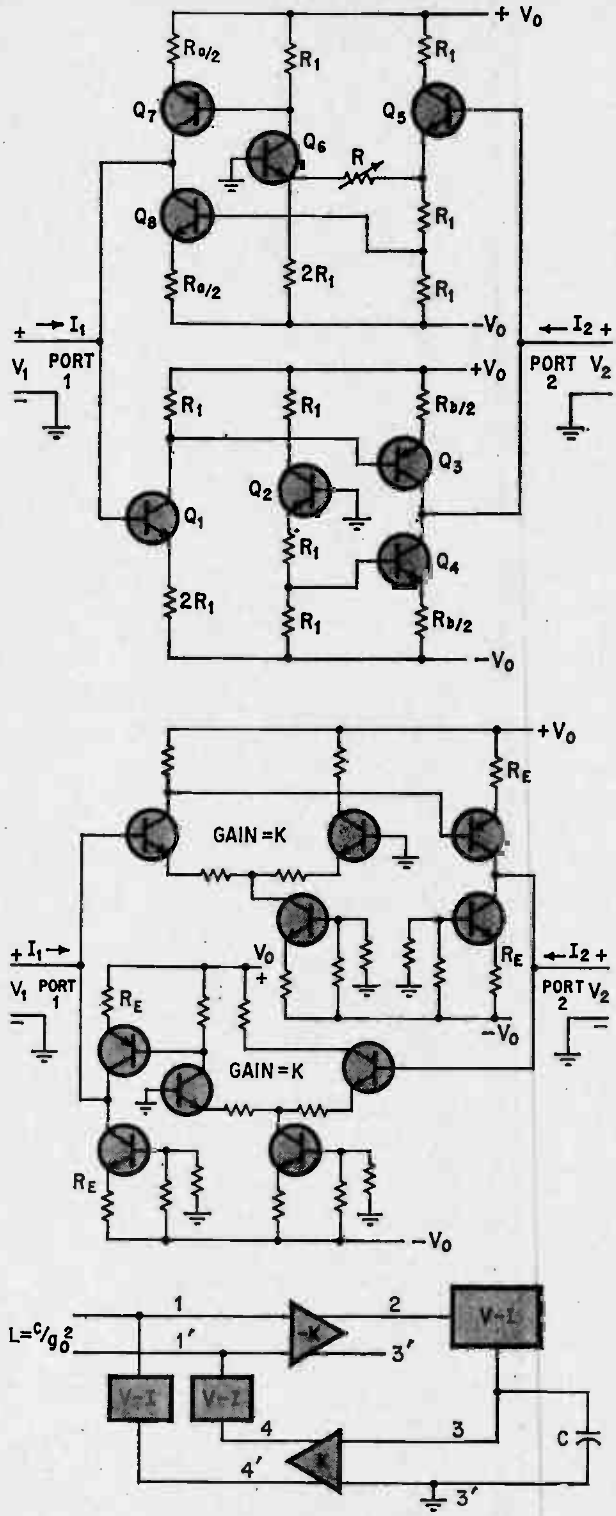
The Q—ratio of center frequency to the 3-decibel bandwidth—of the circuit is

$$Q = \frac{\omega C_A}{G_A + G'_B} = \frac{\omega C_A}{G_A + \frac{g_o^2 G_B}{(\omega C_B)^2}} \qquad (3)$$

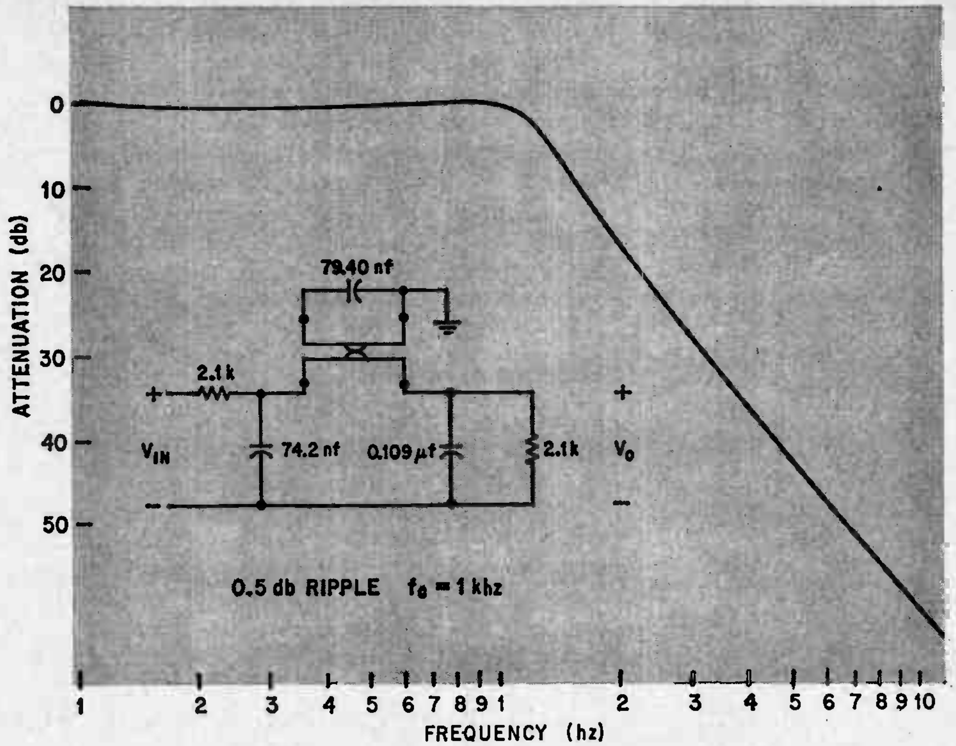
From equation 2,

$$\omega C_B = \frac{g_o^2}{\omega C_A} \qquad (4)$$

To achieve tuning at a frequency, ω, with g_o and C_A fixed, C_B is adjusted according to equation 4. By inserting equation 4 into equation 3, the designer obtains an expression for Q as a function of C_A. This is represented by



Gyrator variations. Input voltage, V_1, at top, is applied to transistor Q_1 which acts as an amplifier. Q_1 collector signal drives base of transistor Q_3, which together with transistor Q_4 form a V-I converter; Q_4 provides d-c bias to Q_3. Transistor Q_5 acts as a follower and drives V-I converter Q_7-Q_8, very high-gain negative d-c feedback loop that stabilizes the transistors' d-c operating points in center circuit, differential amplifiers are used in both the forward and reverse paths. With a third V-I converter, the circuit is changed to a balanced gyrator, shown by the solid-colored letters V-I.



Filter response. In a three-pole, Chebyschev low-pass filter, a gyrator and a capacitor are used to simulate an inductor. Response curve is identical to the theoretical characteristic.

$$Q = \frac{g_o^2\,(\omega C_A)}{g_o^2\,G_A + (\omega C_A)^2\,G_B} \qquad (5)$$

For equation 5, Q will be maximum when

$$\omega C_A = g_o \sqrt{G_A/G_B} \qquad (6$$

This maximum value of Q is given by

$$Q_{MAX} = \frac{g_o}{2}\,\frac{1}{\sqrt{G_A\,G_B}} \qquad (7)$$

The value of C_B needed to produce Q_{MAX} is

$$C_B = \frac{G_B\,C_A}{G_A} \qquad (8)$$

In most practical gyrator designs $G_A = G_B$. To achieve Q_{MAX} the designer should use $C_B = C_A$ as indicated by equation 8.

To obtain the highest Q_{MAX}, the largest value of g_o, and the smallest values of G_A and G_B are required. Parameters G_A and G_B are kept small by designing the gyrator to have high input and output impedances. However, the larger g_o is, the larger C_A must be to tune to a specified frequency, ω, according to equation 6.

Physical considerations—size, geometry, volume, and the like—usually determine the usable range of capacitance, C, which in turn, imposes restrictions on g_o for a given frequency of resonance, ω. With hybrid IC's, for example, the largest value of C is set by allotted volume; with thin-film circuits, C is determined by fabrication factors. By using the largest values of C, the highest Q can be produced. A stable value of Q, required in many designs, can be readily achieved by starting with a synthetic inductor of very high Q, for example, Q = 1,000. To achieve the design value of Q = 10, the inductor is resistively and/or capacitively damped. Damping cancels the unstable variations in the high, unloaded Q.

If capacitors C_A and C_B produce significant loss, the Q of the tuned circuit is affected. Assuming the following relationship,

$$Q_C = Q_{CA} = Q_{CB} = \frac{\omega C_A}{G_{CA}} = \frac{\omega C_B}{G_{CB}}$$

the unloaded Q of the network, Q_{UL}, is expressed in terms of Q_{UL},

$$Q_{UL} = \frac{Q_{MAX}}{1 + 2\,\dfrac{Q_{MAX}}{Q_C}} \qquad (9)$$

As the parasitic gyrator conductances approach zero, Q_{MAX} becomes large, the maximum Q_{UL} becomes $Q_C/2$. This is significant in the design of low-frequency filters in which thin-film components are to be used. Although there has been some progress toward developing low-loss, thin-film capacitors, losses of about 1 percent are still common. This means the unloaded Q is limited to about 50—much too low for some applications. Temperature-stable, ceramic-chip capacitors with dissipation factors less than 0.1 percent are available and can be used in selective-filter designs.

Perhaps the most important parasitic effect is the inherent phase shift that exists around the gyrator loop. This is caused both by delays within the transistor and by the capacitive components of the transistor reacting with the impedances of the adjacent stages. It produces negative damping that, if large enough, could lead to oscillations. The effects of phase shift are evident at low frequencies. Even in the audio range, for example, a small phase shift is readily apparent in high-Q gyrator-capacitor networks. Therefore, the low frequency model of a transistor can't be used for gyrator design at any time.

Fortunately, the designer can more often than not compensate for a phase shift or simply ignore it in his design.

Consider, for example, that the gain around the gyrator loop is represented by

$$g_1 g_2 e^{-j\theta} = g_o^2 e^{-j\theta} \quad (10)$$

where $\theta \ll 1$

If the gyrator is terminated in a capacitor, the input impedance would be

$$Z_{IN} = \frac{j\omega C}{g_o^2 e^{-j\theta}} \quad (11)$$

For a small value of θ, it can be assumed that

$$e^{-j\theta} = 1 - j\theta \quad (12)$$

so that

$$Z_{IN} = \frac{j\omega c}{g_o^2 (1 - j\theta)} = \frac{j\omega c}{g_o^2 (1 + \theta^2)} (1 + j\theta)$$

$$= \frac{-\omega C\theta}{g_o^2} + \frac{j\omega C}{g_o^2} \quad (13)$$

The second term of this equation represents the impedance-inversion property of the gyrator—an inductor, $L = C/g_o^2$; the first term represents a frequency-dependent negative resistance. The dissipation factor, D_p, of the series RL circuit is represented by

$$D_p = \frac{R}{\omega L} = \frac{-\omega C\theta}{g_o^2}\left(\frac{g_o^2}{\omega C}\right) = -\theta \quad (14)$$

Thus, the loss of a parallel-tuned circuit would be

$$D = D_{UL} - \theta \quad (15)$$

where $D_{UL} = 1/Q_{UL}$. If, for example, $Q_{UL} = 500$, then a value of only $\theta = 2$ milliradians would be sufficient to cancel circuit damping.

This becomes apparent in the plot of loss versus frequency for the gyrator on page 119. Each frequency point was obtained by adjusting $C_A = C_B = C$ so that

$$f = \frac{1}{2\pi}\frac{g_o}{C}$$

The loss is a linearly decreasing function of frequency, which means that $\theta = \omega T$,

a valid approximation when θ is small; T is the delay around the loop.

By introducing an equal but opposite shift in the gyrator loop, a designer can compensate for the loss caused by the phase shift itself. A simple RC phase-shift network can be achieved with a capacitor placed across the emitter resistance, R_E.

Although compensation for the effects of phase shift is relatively easy to achieve, there are other factors that are interrelated. Consider, for example, the effects of temperature. As temperature increases, the phase shift also increases. And since compensation applied at one temperature is unlikely to hold over a wide temperature range, there is no solution that is absolute. A partial solution, however, is better than none at all. And a designer can accommodate the effects of temperature.

From theory to reality

Early gyrator designs employed negative resistances to cancel the parasitic-damping elements of the basic transistor structure. But by so doing, the gyrators attractiveness dimmed. Despite their relatively insenistivity to changes in transconductance the gyrators were limited to noncritical filtering applications simply because of the instability problems that stemmed from the negative resistances. These gyrators, in effect, held no advantages over other active synthesis techniques.

Another drawback was the large coupling capacitors required at the gyrator ports. In some designs, internal capacitive couplings were also necessary. These were for high-frequency applications.

Within the last several years, however, a number of direct-coupled gyrator circuits have been developed that have intrinsic low-loss characteristics. Equally important, these circuits lend themselves to microelectronic fabrication.

One such gyrator configuration is the shunt-shunt feedback connection of two voltage-to-current converters with signal inversion in one path.

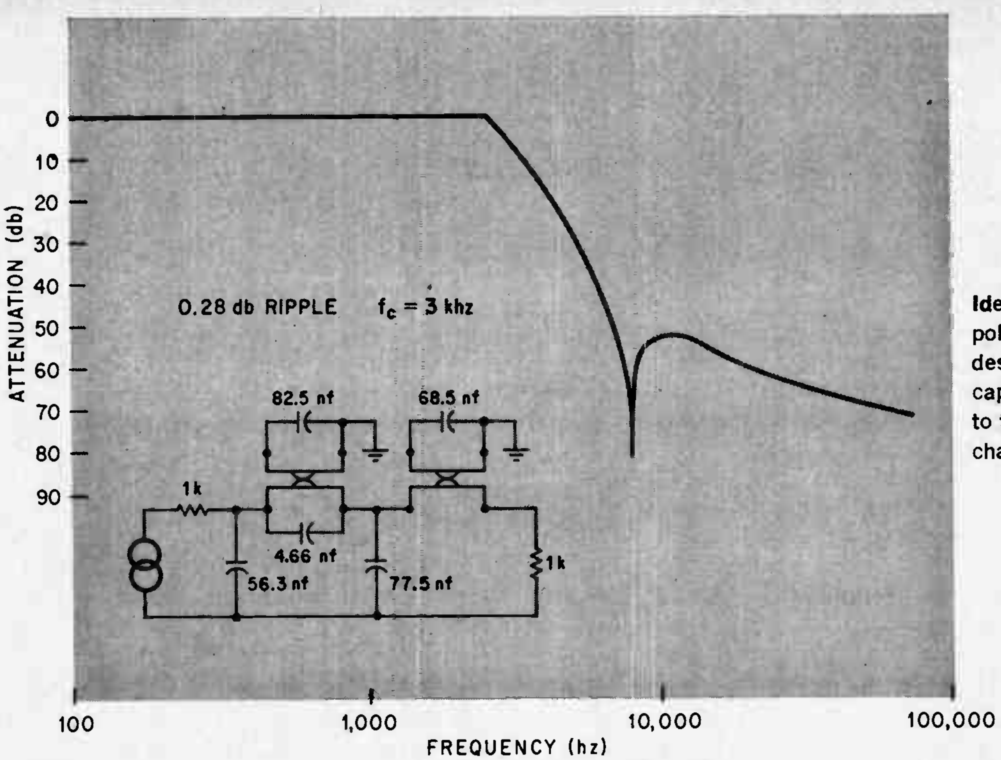
An ideal voltage-to-current converter is described by the matrix

$$Y = \begin{bmatrix} 0 & g_o \\ 0 & 0 \end{bmatrix}$$

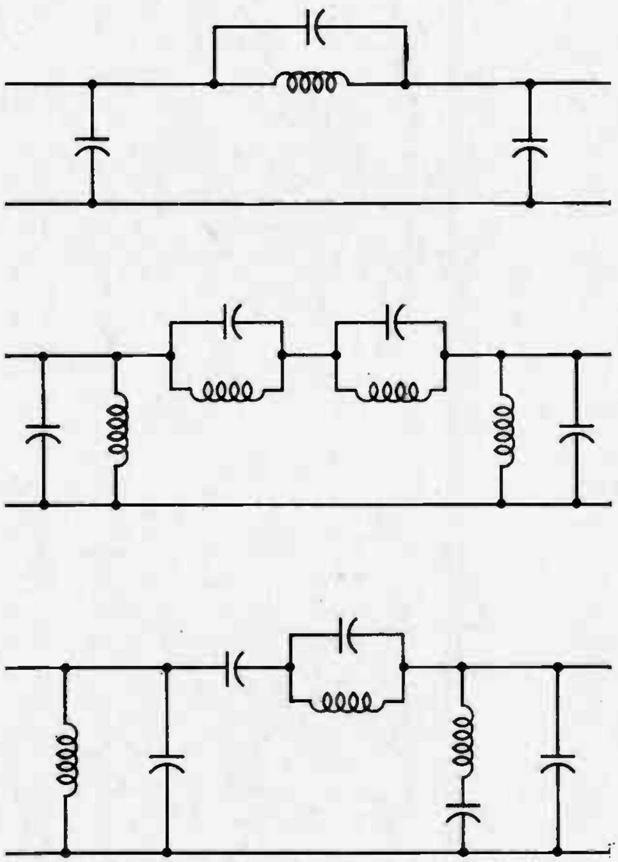
in which output current is proportional to input voltage, and input and output admittances are zero.

In a practical design g_o must be stable and the input and output impedances very high to reduce unwanted damping. Moreover, the parasitic phase shift around the loop, caused by interaction between a stage's output impedance and the adjacent input capacitances, must be minimized.

One such converter, shown at top page 120, is essentially a common-base stage in which the collector current is proportional to the base voltage; emitter resistor, R_E provides the constant. A second common-base stage, which supplier d-c power, produces a high impedance at the collector terminal. What results as an output impedance at the common-collector terminal is the collector resistances modified by the emitter and base impedances of the two transistors. With carefully selected transistors, this impedance can be several megohms—models with 6-megohm output impedances have already been achieved.



Ideal. Response of a four-pole, Cauer low-pass filter designed with two gyrator-capacitor units is identical to the theoretical response characteristics.



Transforming. With standard techniques, typical elliptic filter, top left, is transformed into a conventional law-pass-bandpass filter, right. But this results in more inductors than needed. With minimum-inductance transformation, however, the inductors do not have a d-c return path to ground, impeding implementation.

In the actual design, an amplifier—whole gain may be greater or less than unity—is inserted before the V-I converter. The net transconductance, the output (in milliamps) divided by the input (in volts), of these cascaded stages is K/R_E where K is the amplifier voltage gain, when only one transistor base is driven.

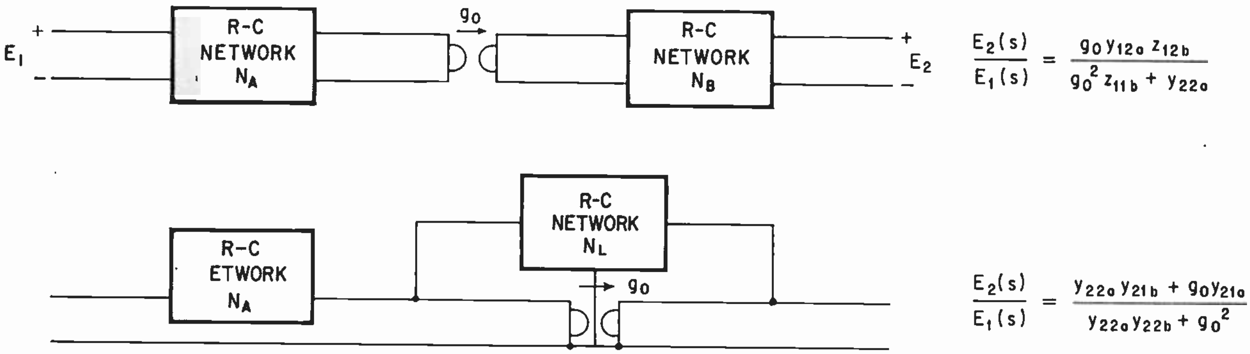
Three gyrator configurations, and their associated V-I converters are at the right of page 120. In the top schematic, there are three values that contribute to the input impedance at port 1—the input of Q_1, which is $2R_1$ multiplied by the transistor beta, and the common-collector impedances of Q_7 and Q_8. For equal-value collector resistors, r_c, of Q_7 and Q_8 connected as shown the input impedance becomes equal to

$$\frac{1}{2}\,\frac{r_c}{1+\dfrac{R_B}{R_E}} + 2\beta R_1$$

where R_E and R_B are the total emitter and base resistances, respectively. The value of this input impedance depends on the transistors used. A 300-kilohm input impedance has been reported in one IC model with the $R_1 = 680$ ohms. Some non-IC designs have had 6-megohm input impedances.

A grounded-gyrator circuit, shown at the bottom of page 120, employs differential amplifiers in both the forward and reverse paths. Here, the operation is similar. The advantage of this configuration, however, is that the gyrator can be balanced simply by having three V-I converters. With the other circuits, a balanced inductor would require two complete gyrators.

In the circuit at the bottom left of page 119, the



Variety. Several configurations are possible for coupling gyrators to R-C networks. Two possibilities are cascading with a gyrator in the center (top), and another is a parallel arrangement between the two R-C networks.

V-I converters comprise transistor Q_3, Q_4, Q_7, and Q_8. But the preceding amplifiers are composed of two boot-strapped FET follower circuits, Q_5 and Q_1; field effect transistors provide high input impedance. Because of the FET's the only impedances at ports 1 and 2 are the common-collector impedances of the V-I converters. The FET's are bootstrapped by transistors Q_2 and Q_6 which stabilize gain, regardless of the FET transconductance's temperature variations. Moreover, the emitter of Q_6 drives the emitter of Q_8, thus raising the effective transconductance of the gyrator, while at the same time, reducing the impedance seen at the emitter at Q_8. The next over-all effect is an increase in the low-frequency Q.

Gyrator-capacitor networks

The gyrator with bootstrapped FET's was tested for frequency and Q stability. The temperature coefficient of g_o^2 was found to be less than 100 ppm/°C over the range 0 to 50°C. When polystyrene capacitors were used with the gyrator to form a tuned circuit, center-frequency stabilities of less than 50 ppm/°C were measured at frequencies ranging from 0.3 to 30 kilohertz.

The effect of temperature on the tuned circuit's Q is dependent upon frequency. At low frequencies, where circuit losses are due to the V-I converters' collector impedances, Q decreases with increasing temperature. At frequencies above 3 khz, the parasitic phase shift causes the Q to increase with rising temperature.

In the plot of the phase shift for the gyrator on page 120, the loss versus frequency characteristic decreases linearly with frequency. By extrapolating the loss curve—a measure of the delay around the gyrator loop—back to d-c, the low-frequency loss due to the parasitic resistive loadings at the gyrator ports is about 0.001, or Q = 1,000. At about 3 khz, a negative Q of 1,000 is introduced by the phase shift. This results in an oscillatory condition. From the slope of the curve, a compensating phase-shifting network can be calculated. The compensated gyrator loss characteristic is represented at its low frequency value. By changing the compensation, the designer can obtain different loss characteristics as a function of frequency. In IC applications, this phase-shift damping technique is far more convenient than resistive damping.

Gyrator-capacitor networks have been developed as replacements for conventional LC filters. One such network, a three-pole Chebyschev low-pass filter is shown together with its response on page 121. The component values were obtained from standard handbook tables and scaled to the desired impedance level and cutoff frequency. A balanced gyrator and a capacitor were inserted in the circuit to achieve the desired inductor. The measured response was identical to the theoretical.

A second network is a Cauer low-pass filter having four poles. This circuit required two balanced inductors, simulated in the drawing shown at top page 123. Again, the filter's response was identical to the ideal response. Here a transmission zero is created by the parallel-resonant tank circuit. The notch was 80 decibels. Deeper notches are obtainable with further adjustment of the gyrator's Q factors.

Impedance levels are particularly important for balanced gyrators. When two grounded gyrators are connected to simulate one that floats, a low-impedance resistive path to ground must be provided for each gyrator. This path may be through other gyrators if necessary. Because of imbalances in the gyrator transconductances, impedance levels above 15 kilohms tend to produce additional resonances within the filter.

In transforming a low-pass elliptic filter to bandpass the designer usually winds up with an excess number of inductors. A better technique, called minimum inductance transformation, reduces the number of required inductors in the bandpass filter to the number of filter poles. An example is a three-pole elliptic filter in the bottom drawing on page 123.

The center filter at the bottom of page 123 can be built with two floating gyrators since there is a d-c path to ground for each. The transformed network at the bottom of page 123 does not have a ground return for the floating inductor and can't be built with the floating gyrator described.

This problem is solved by a floating power supply and a grounded gyrator. The drawback to this approach, of course, is the need for a special-purpose supply for each floating gyrator. In turn, these power supplies require large electrolytic capacitors, which precludes microelectronic techniques.

Hybrids and monolithics

The stability of g_o and the parasitic impedances are the prime problems to overcome in developing a monolithic gyrator. Gyration conductance, g_o, is dependent upon both amplifier gain and the emitter resistors of the V-I converters. Stable, low-gain monolithic amplifiers can be fabricated with the gain dependent on the ratio of resistors rather than on the absolute value. The emitter resistors of the V-I converters are critical, however. A diffused resistor, here, would result in a very temperature-sensitive device. Temperature insensitive performance can be produced by using an outboard thin-film resistor evaporated on the silicon substrate. The temperature coefficient of this resistor can then be matched with an equal but opposite temperature coefficient of a capacitor used in conjunction with the gyrator.

Relatively good matching of the temperature coefficients of thin-film tantalum components and hafnium-dioxide components has been achieved, resulting in highly stable synthetic inductors.

A second problem encountered with the monolithic gyrator is the requirement for a good pnp-npn transistor pair for the V-I converter. Good pnp transistors cannot be diffused simultaneously with the npn variety—they require additional diffusion. Lateral pnp transistors can be made at the same time, however. And when used in conjunction with an npn transistor, the result is a three-terminal device that behaves like a pnp transistor. The beta of the lateral pnp transistor is near unity. But when the transistor is connected to an npn transistor, the composite beta then behaves as that of the npn transistor.

The collector ressitance, r_c, of the pnp transistor appears as a parasitic load on the gyrator. However, the collector resistance of the lateral pnp-npn composite isn't particularly high and, as a result, significant damping results.

Better performance

A hybrid IC can provide a significantly improved version of the gyrator. But this raises the question of whether hybrid gyrators wouldn't be too good —and too costly—for most applications. Lower-priced monolithic gyrators are likely to be more than adequate. For the hybrid gyrator monolithic sub-blocks are used for the gain stages, FET's for high input impedances, and complementary transistors for the V-I converters. Such a combination of elements yields a gyrator with performance superior to the discrete version that was the model.

Thick- or thin-film resistors can be used in the hybrid version. And, the emitter resistors of the V-I converter transistors could be trimmed to achieve the desired gyration conductance. This, of course, would eliminate the need for precise gain control that is now necessary with the monolithic type of amplifiers.

Thin-film capacitors, while having desirable temperature characteristics when used with thin-film resistors, suffer from the relatively high loss, about 1 percent. Ceramic-chip capacitors fabricated with npn dielectrics are both temperature stable and have low-loss characteristics. This makes the latter-type capacitors particularly attractive for hybrid circuits, where area or volume isn't always a serious constraint.

Gyrator-created synthetic inductors are usually used as substitutes for inductors in conventional LC designs. But the application of gyrators to network design goes beyond this approach. When viewed as a nonreciprocal network, the gyrator forms the basis of many new network synthesis approaches. A number of such approaches have already been developed, using negative-impedance converters, negative-impedance inverters, nullators, norators and like components.

In the synthesis of RC active filters, gyrators have been used in conjunction with one or more RC networks in various configurations. Synthesis procedures are then developed that are based on the two-port parameters of the RC networks and the gyrator. Some examples of these procedures are shown on page 124. ■

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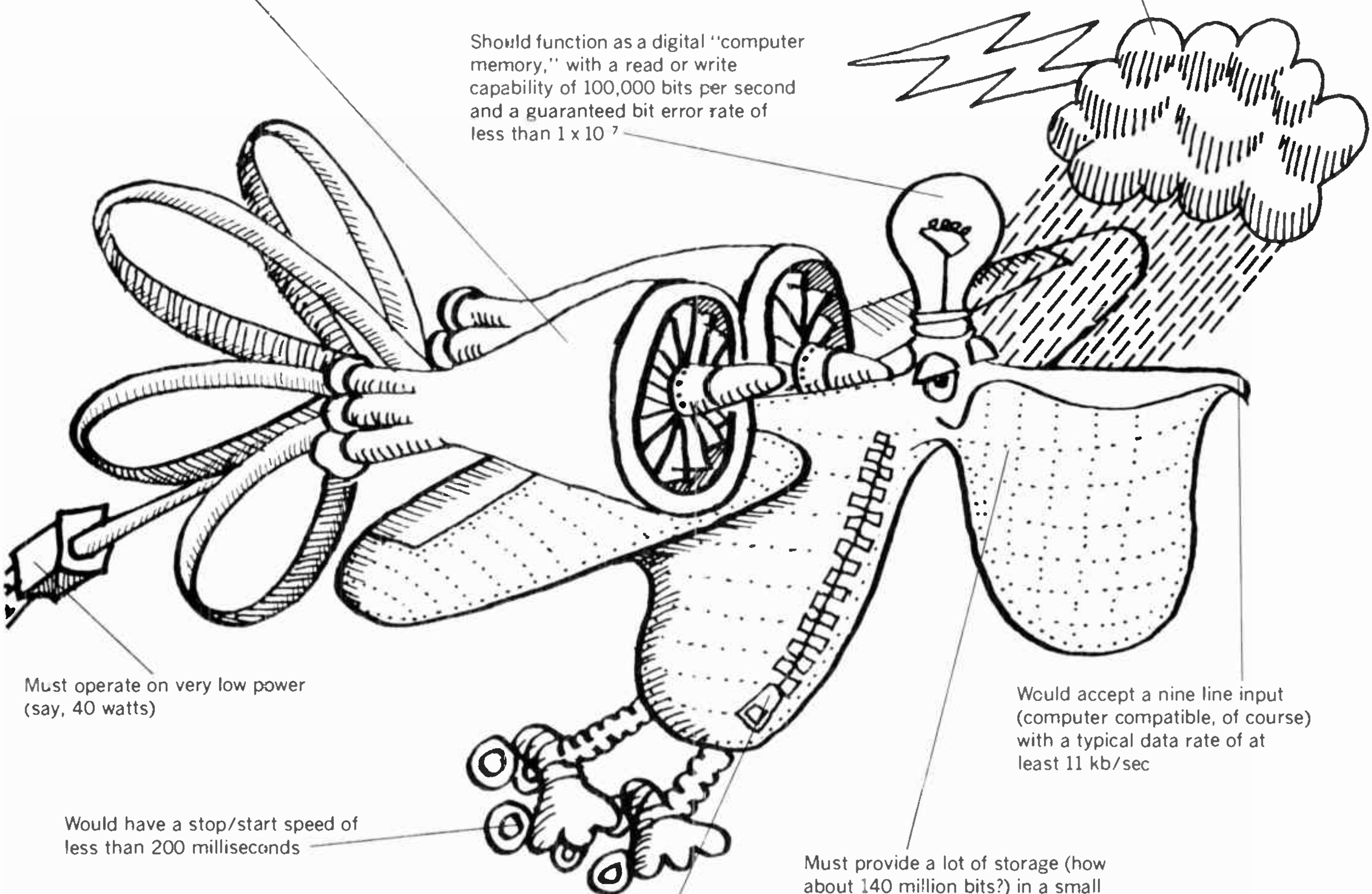

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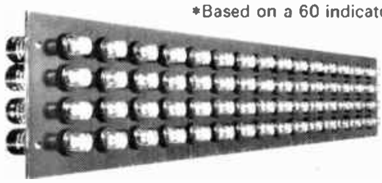

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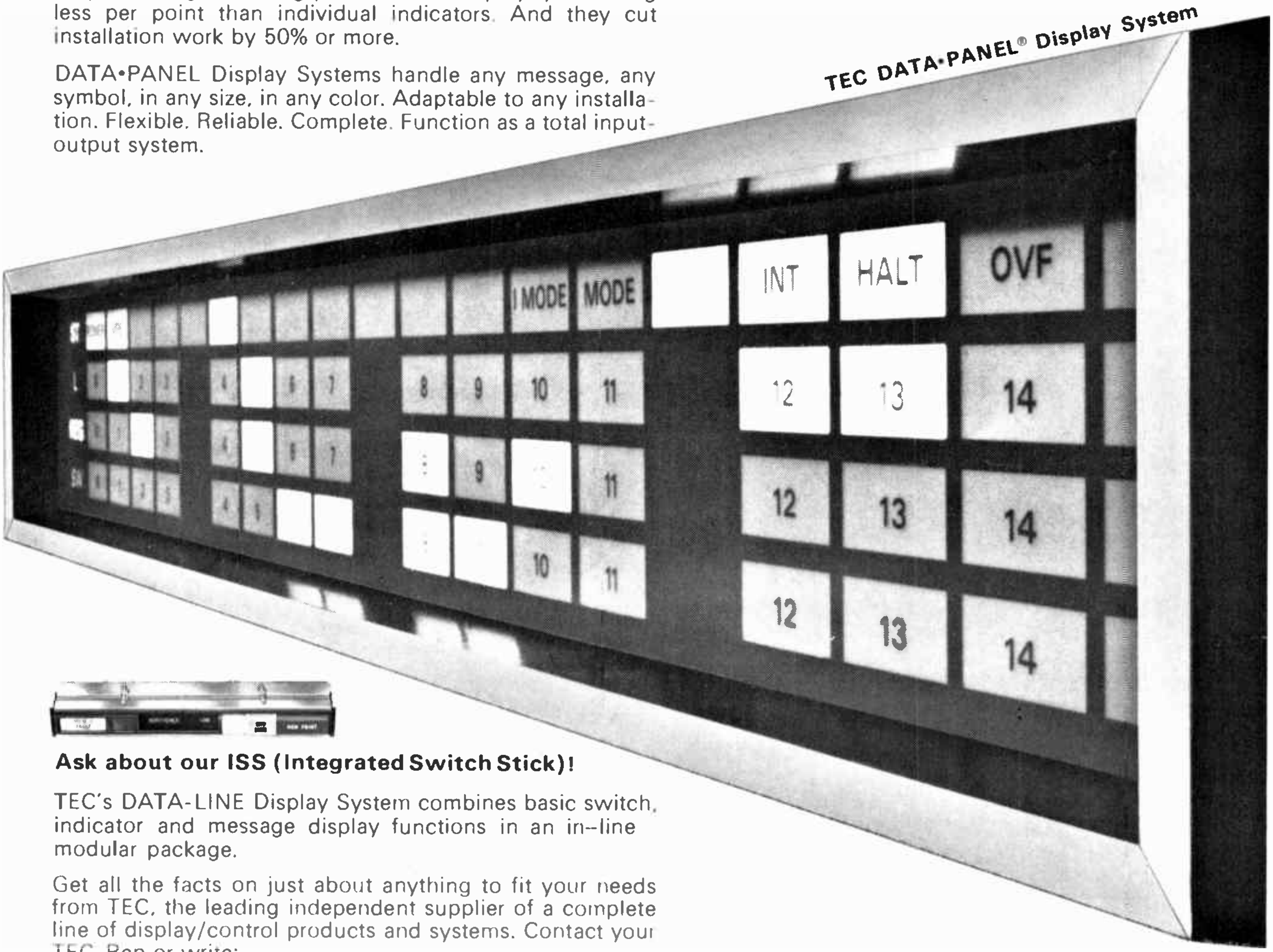

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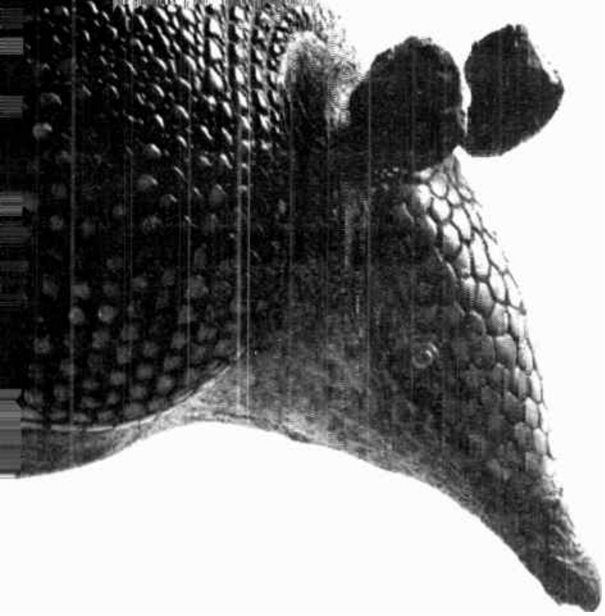

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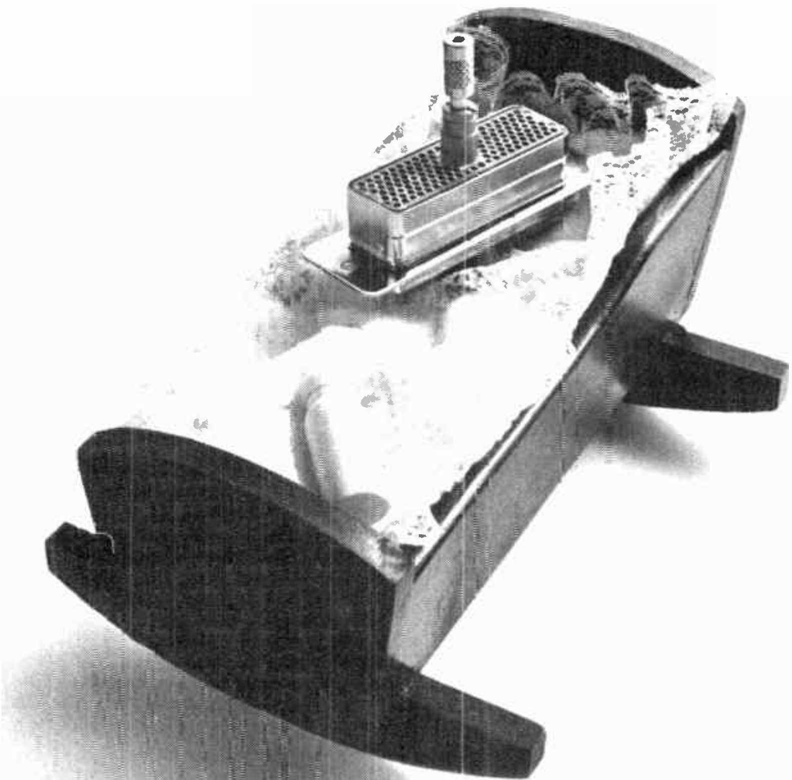

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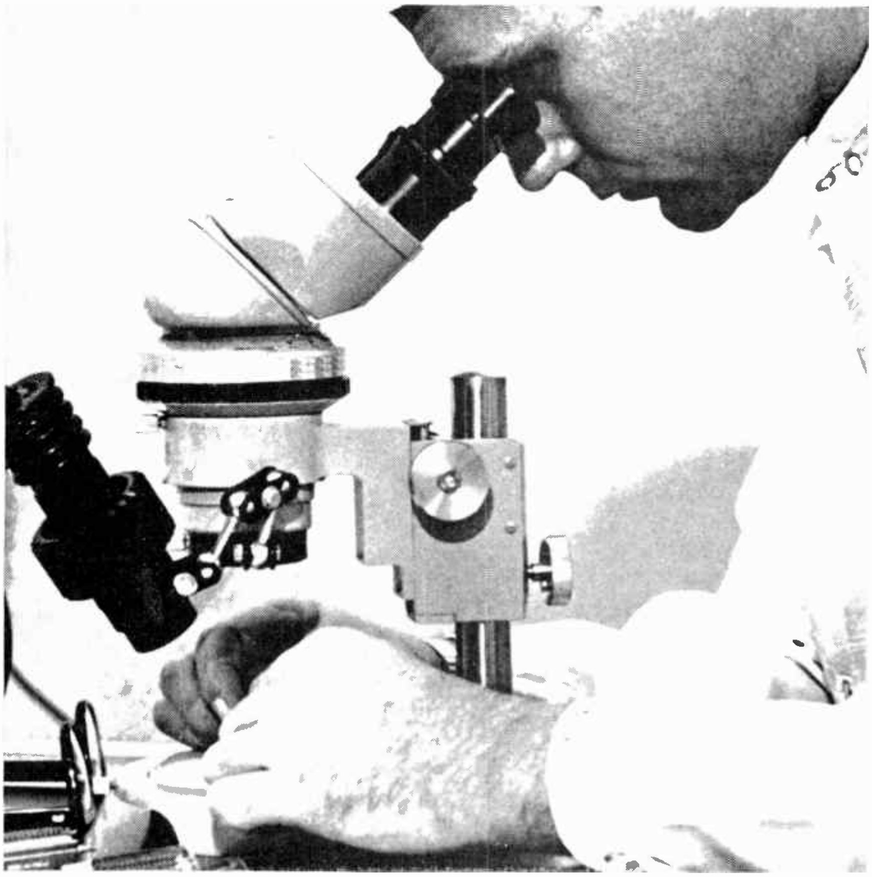

Mr. Valles inspects a cleaned part under the microscope.

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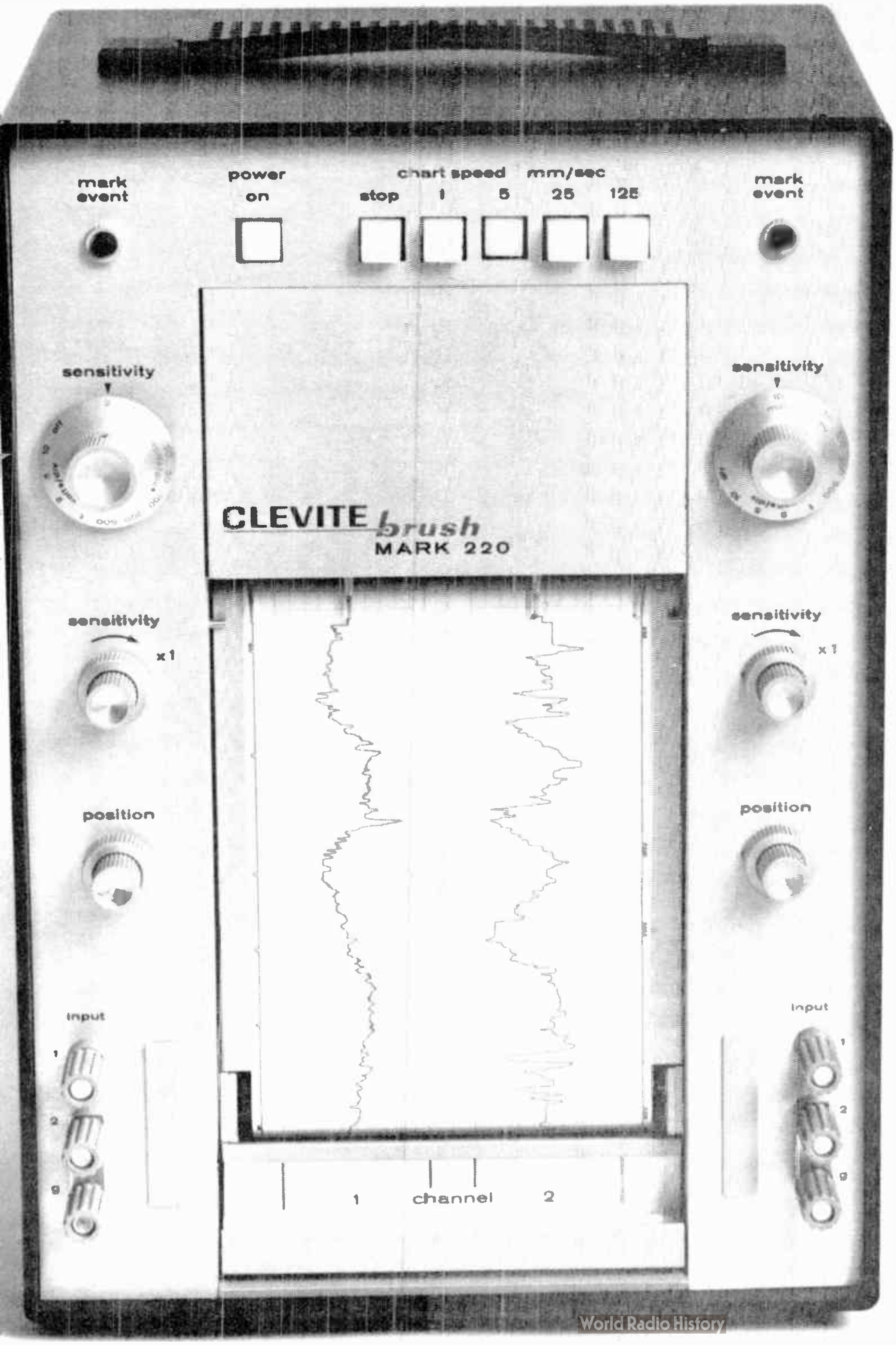

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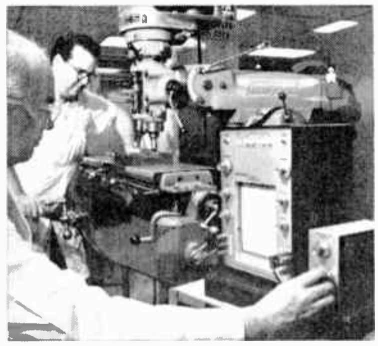

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Navy gets a new airborne watchdog

Service's success with Grumman's E-2A Hawkeye early-warning aircraft prompts development of C version with improved and more reliable avionics equipment

By Alfred Rosenblatt
Associate editor

When Task Force 71 steamed into Korean waters this spring, the big job of guarding it against surface and air attacks fell to a lumbering early-warning aircraft. Unlovely though it may be, the carrier-based, prop-driven E-2A Hawkeye performs its jobs as an airborne sentry and command and control system with such commendable competence and finesse that the Navy has ordered the next model.

The new plane and its complex avionics, to be designated the E-2C, will be built by Grumman Aerospace, Bethpage, N. Y., which delivered 59 E-2A's. The Navy's desire for a more reliable and maintainable system are among the important reasons for the new buy; the E-2A, though useful still is beginning to show signs of age since it was designed in the late 1950's with vacuum tubes and a drum-memory computer. The hope is for a three-to-one improvement in the overall mean time between failures (MTBF) with certain pieces of equipment reaching a 10-times better level, says William H. Barnard, E-2C program manager. To this end, the new system is being developed around a core-memory computer, using discrete semiconductor components and integrated circuits. In addition, of course, the plane will be able to outperform its predecessor on missions.

Perhaps the most important new feature is the system's long-range search radar, to be based on Grumman's APS-111. This unit will be able to detect aircraft flying over land, as well as over water—an important capability when the fleet is close enough to shore for enemy planes to present a threat that must be detected immediately.

Other new equipment slated for the E-2C includes perhaps the largest-capacity digital computer to be found in an aircraft and a passive detection system that can tune in to electromagnetic emissions. The latter enhances the craft's surveillance and electronic countermeasures capabilities.

The E-2C will be one of the first planes to carry the Navy's Cains (carrier aircraft inertial navigation set); it rapidly aligns the aircraft's inertial guidance system with that of the carrier via radio link. Almost all of the E-2C's electronics equipment—the major exception is the search radar—will be compatible with the Navy's versatile avionics shop test (VAST) system.

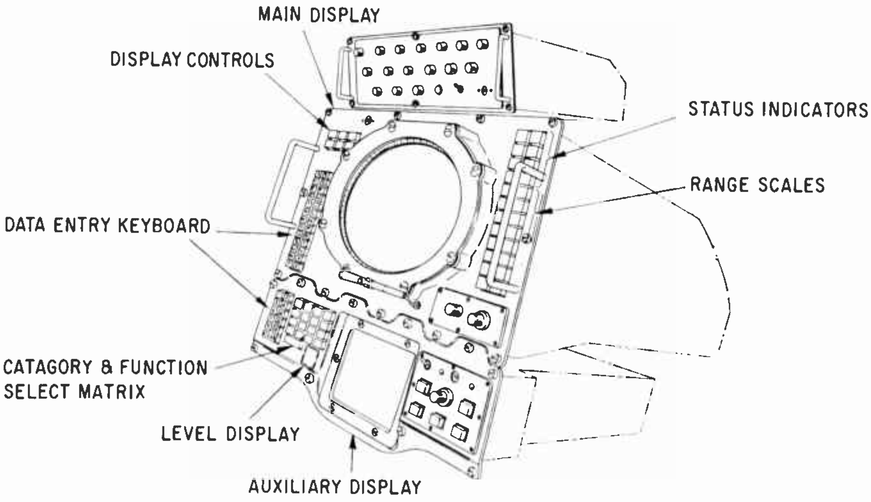
The E-2C will also be able to check how its complex avionics is operating with what Barnard describes as the most comprehensive

Going down. Carrier-based E-2A Hawkeye, long a workhorse sentry and command and control system for the Navy is slated for replacement by a C version being built by Grumman; the new plane's improved avionics will be of solid state design.

in-flight performance monitor (IFPM) flying. With the monitor, an operator can isolate a fault to a weapons replaceable assembly (WRA) while the plane is still on a mission. A radio call will ensure that a replacement is waiting when the plane returns to its carrier, and a switch can be made quickly

Grumman received the E-2C development contract a year ago. The Navy is buying the plane as a package through its Air Systems Command so it will have only an indirect say in the specific design of the avionics to be put aboard. The Navy's only concern is that the E-2C meet the performance specifications; it's up to Grumman to decide how to go about it. In the E-2A program, the Navy approved the individual performance of each of the subsystems.

First flight of a developmental E-2C is scheduled for early 1971; a production version will fly in mid-1972. The Navy may order about 28 of the systems through 1974. In the meantime, Grumman has been modifying the E-2A's left in the Navy fleet, replacing the original drum-storage computer with an L-304 digital machine from Litton Industries and making a few changes in the displays. Planes with the new digital computer, which is similar to the one intended for the E-2C, are designated E-2B's.



Two views. The probable design for the operator's console in the E-2C will feature a 12-inch main radar scope and a 5-inch auxiliary display.

Clearinghouse

Radar signals in the E-2C system are sent and received through the Rotodome antenna in a flat, round cap mounted atop the fuselage. With its disk-like housing, the antenna will have the same distinctive appearance as the one on the Hawkeye although it's been redesigned by Dalmo Victor, Belmont, Calif., to accommodate the performance requirements of the new radar. The Rotodome unit also handles transmissions for the IFF (interrogation friend or foe) gear to be furnished by the Navy.

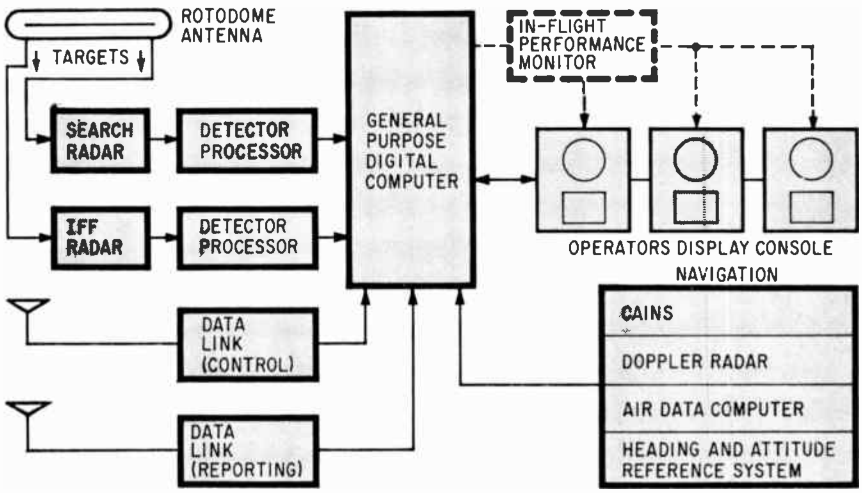
There are also associated but separate detector-processor units which tie into the general-purpose digital computer. The one for the IFF radar, built by the Hazeltine Corp., Greenlawn, N.Y., handles raw video data to produce a digital report of the range to an interrogated aircraft, as well as its location. The other for the search radar, which, along with the radar, is being supplied by General Electric's Aerospace Electronics Department, Utica, N.Y., provides real-time position coordinates for each target.

Way station

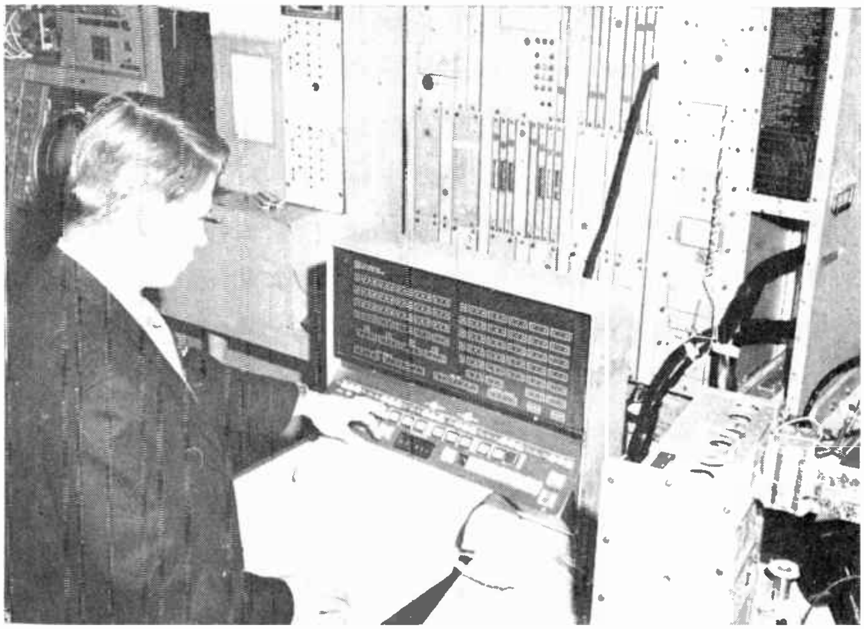
All available target information is fed to the computer, which stores it and acts as the interface for the other elements of the system. These include three separate display consoles also made by Hazeltine, as well as uhf and hf data links for getting information to the Navy's Tactical Data System and attacking aircraft. Three console operators—the same number as in the E-2A—and two pilots make up the aircraft's crew.

Aside from Cains, navigational elements aboard the E-2C include a Doppler radar, a heading and attitude reference system (HARS), and an air data computer. Navigational accuracy is extremely important on the E-2C. The problem involves more than being able to fly from point to point; the crew must always know exactly where the plane is so intercepting aircraft can be vectored accurately to the enemy. The doppler-inertial system is the principle navigator, but the E-2C can get along in either mode alone. The HARS gives redundant information which ordinarily comes from the Cains system. The Navy's Omega, navigation satellites, and Loran-C/D are not part of the E-2C system at this time.

The overland capability was added to the new search and track-



Nerve center. The E-2C's sophisticated avionics are designed around a large-capacity digital computer to be supplied by Litton Industries.



Benchmark. Engineer uses programer's console to enter the L-304 computer now being retrofitted on E-2A's; similar model will be used aboard the E-2C.

ing radar because clutter return from land is so strong that it's almost impossible for the E-2A's system to pick out a moving target. Grumman studied ways of cancelling the clutter, working from the same APS-96 that's in the E-2A, says Julius Cohen, director of E-2 programs. This radar operates in the P band. with a coherent matched filter system and a low pulse-repetition rate. Peak power, range, and detection probability are classified.

Grumman did most of the design work on the APS-111 but called in General Electric to build the system using Navy funds. This is essentially the same procedure followed on the predecessor radar, the APS-96 used aboard the E-2A aircraft. Grumman has kept the same transmitter chain in both radars. The APS-111, however, has a new receiver and clutter-cancellation features. Dalmo Victor was chosen to redesign the Rotodome antenna it devised for the E-2A. A two-year test program in which a complete APS-111 was flown in an E-2A wound up early this year. An improved version is earmarked for the E-2C.

Follow-on. In a separate program, the Naval Air Systems Command is also investigating the feasibility of fully automating the radar's ability to discriminate targets through land clutter. At present, the equipment locates and tracks targets over water automatically. But overland, an operator has to do this manually on the scope display with a strobe pencil. Contracts have been awarded to GE and Burroughs to study the problem, which centers on the design of the processor.

The overland capability of the APS-111 has attracted the Air Force's interest. The radar appears suitable for Awacs (airborne warning and control system) missions. Air Force personnel, primarily from the Awacs program office, have test-flown the gear to check out its performance. But the Awacs detection requirements — particularly range and target size—are more severe than the Navy's, says an industry source, and both Westinghouse and Hughes already hold contracts for the project.

Workhorse

With the general-purpose, programable computer, supplied by Litton, Grumman can expand considerably on the mission flexibility of the E-2C. What's more the new machine represents at least an order-of-magnitude improvement in reliability over its predecessor. Program changes can now be readily made in software as new weapons or tactics are introduced, or, when the mission profile is changed. In the case of the E-2A machine, changes are difficult to make because the logic is hard-wired. The new computer also has a built-in magnetic tape unit which can be called upon for additional tactical and diagnostic programs during a mission.

Capacity of the computer's core memory is 56,000 32-bit words, expandable to 80,000 words by plugging more memory modules into spare drawers. In addition, indirect addressing effectively doubles the capacity.

Double duty. The computer is a dual processor with shared memory banks so that it handles interlaced programs. It operates in real time, with priority interrupts. Depending on the program sequence, and with memory overlap in different banks, the computer can carry out sequential instructions at an 800-nanosecond rate. The pace slows to 2.4 microseconds if access must be to the same bank.

The capacity of the computer gives the E-2C an information display and monitoring capability vastly superior to that of the earlier system, says Lawrence H. Borts, systems engineer in Grumman's mission analysis department. Each console operator has direct access to the computer. Targets are displayed on a main 12-inch cathode-ray tube. In addition, there's a 5-inch-square crt for trouble-shooting data and details about specific misions or targets. Some auxiliary information is available on the E-2A but in more limited form since the readouts are on Nixie tubes rather than crt's. The Nixies present items like target range, bearing, or altitude.

The main display, which is completely digital and under computer control through to the final deflection plates, shows targets in a standard plan-position indicator (PPI) mode or in synthetic video. Symbols and alphanumeric characters can be traced on the scope so that an operator is able, with one or two characters, to give himself a "bookkeeping handle" on any given target, says Borts.

The auxiliary scope displays a wide range of computer-derived information. For example, if a hostile aircraft, selected by the operator on the main display with his light pen, is to be intercepted, it's possible to quickly find out such critical facts as the time it would take for an interception, the fuel remaining in the intercepting aircraft, and the track history of the target—whether it has been turning, going straight, or climbing. This information is spelled out on the 5-inch crt.

Closer watch

The big computer also makes possible expanded performance monitoring. The job of the in-flight performance monitor is not only to find out what's wrong within the avionics and pinpoint the fault to a weapons replaceable assembly but also to help the operator decide on the best possible alternate mode of operation so the mission may continue. For example, if the inertial navigation system should fail, the mission may not have to be scrubbed if it's possible to use information from the heading and attitude reference system.

When monitoring performance, the computer interrogates the various avionic subsystems within the E-2C, assesses their status, initiates subsystem tests through built-in test circuitry, and pinpoints any faults. The test routines are interleaved with the operational programs or called up from the computer's tape memory.

The bottom half of the 5-inch scope indicates, in a 4-by-4 matrix of titles, either the kind of information that can be displayed or the function that's being checked out. The operator selects a category by pressing the corresponding button on a console keyboard that's also laid out in a 4-by-4 matrix. The same button serves any purpose; all that's necessary is for the software to change the titles displayed on the scope face. The top half of the crt presents the data, as either alphanumeric readouts or an actual analog signal.

Feedback. When a fault occurs, a light comes on to alert the console operator. He then interrogates the machine using functional switches to determine what subsystem is faulty. This information is spelled out on the crt.

The operator may then troubleshoot the fault by calling up a matrix that, might, for example, list all the avionics subsystems. He selects the faulty subsystem by pushing the corresponding key on the matrix keyboard. The next display might then list all of the sections

within the subsystem, and the IFPM would check the status of each, relying on built-in test circuitry where necessary. This procedure is followed to lower and lower levels within the equipment until the fault is located exactly. There will actually be as many as 10 levels of data available through branching programs from the auxiliary display, says Borts.

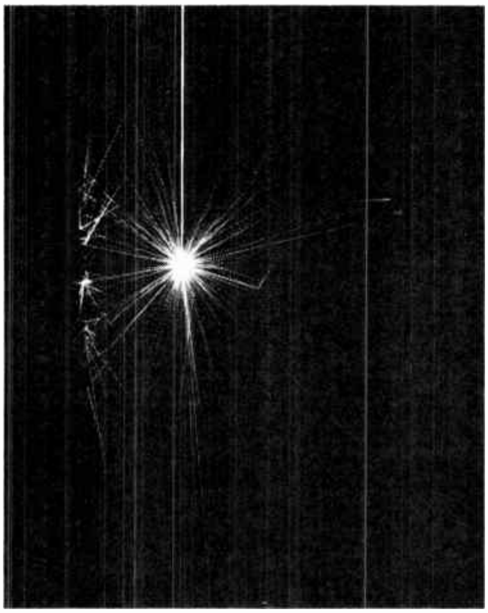
This kind of procedure is followed in the E-2A, but the operator relies on a special manual to detail the various tests. In the new system, the computer will be programed to conduct the tests automatically. The E-2C operator will also be able to look at certain critical signal points within the avionics; their waveforms will be displayed on an auxiliary test oscilloscope at the operator's console. Seeing the signal shapes and measuring their amplitude will help the operator gauge just how far performance may actually have been degraded by any particular fault.

Some 85% of the avionics in the E-2C will be fault-isolated to a WRA, using the in-flight performance monitor, thereby keeping to a minimum the yellow gear on the carrier flight deck that must be pulled up to the aircraft. Most of the WRA's will be small enough to be easily handled by one man.

Checkpoints. On the carrier, the Navy's VAST system will go to work to isolate faults down to a shop-repairable assembly, and finally to a component or group of components. As a result, a lot of special test points will be needed in the avionics. This shouldn't complicate the design too much because the points will have to meet the same sort of criteria that apply right now when special-purpose test gear is used, says Terrence J. Custer, support project engineer for the E-2C.

Grumman and its suppliers will start applying the VAST requirements as early in the development program as possible, Custer says. And VAST, rather than special factory checkout gear, will be used to ride herd on the E-2C's as they come off the production line, he adds. In effect, this will prove the VAST software—English language programs will be supplied by Grumman—before the equipment goes to the fleet.

When ordinary methods of observing and recording don't deliver



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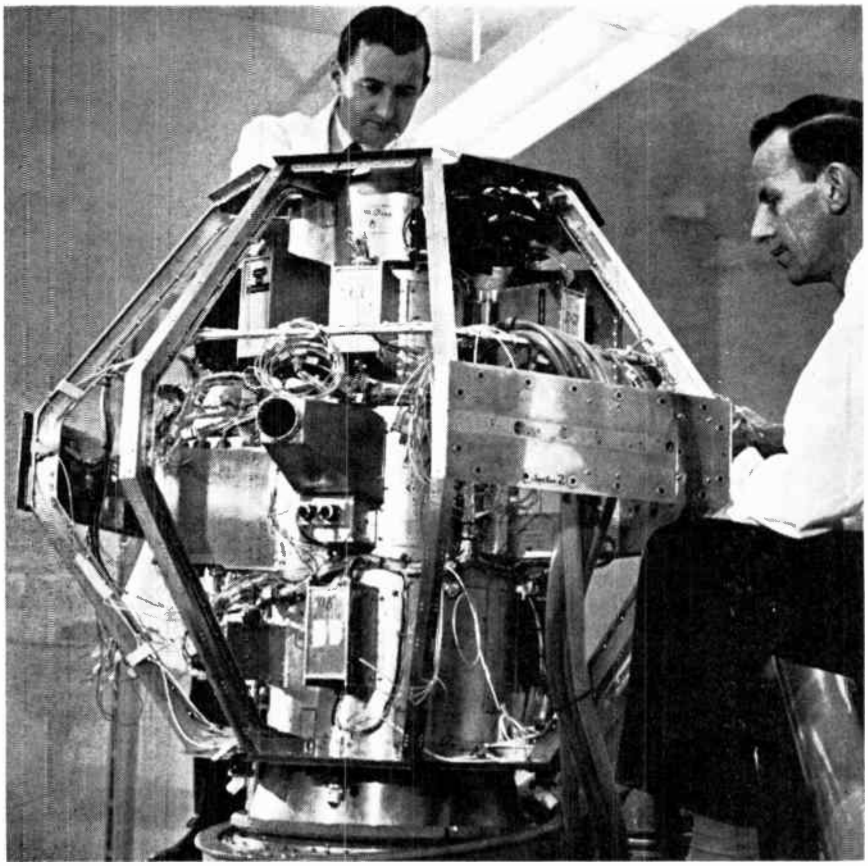
Canada's new satellite projects shake up research establishment

Military's telecommunications R&D unit is renamed and put under civilian control as government drives to put domestic systems in equatorial orbit by early 1970's

By Charles Law
Toronto News Bureau

Canada's 500-man telecommunications research organization at Shirley Bay, an Ottawa suburb, began the second quarter of 1969 with a new boss, a new name, and a new mission. Before this spring, the operation was known as the Defense Research Telecommunications Establishment. Last year, however, the Trudeau government decided to make Canada's postal department into a full-fledged ministry of communications. To this end it transferred DRTE to civilian control, renaming it the Communications Research Center.

The electronics engineers and scientists who staff the Shirley Bay complex generally welcome the chance to redirect their efforts. The two-decade association with the military, it seems, was not without frustrations. More often than not, the armed forces regarded DRTE as a quick-turnaround development shop to modify existing equipment for special requirements. And while DRTE could point to a number of achievements, it seldom had the opportunity to take on continuing programs where the organization's abilities could be fully mobilized.



New billet. Canada's Communications Research Center, long a military arm, now concentrates on civilian projects like the Isis series of research satellites.

Canada's nascent space program gave Shirley Bay a chance to get out of this rut; it became chief design architect of the Alouette-Isis series of polar-orbit satellites, sponsored jointly by Canada and NASA for ionospheric studies. Isis 1 went up this year to join Alouettes 1 and 2; a second Isis is being built.

Ottawa's decision to launch a domestic communications satellite, as well as a new government department, impelled federal officials to turn to DRTE—the only official body with the necessary skills in space technology. At the moment, there's still some concern in top scientific circles as to how well space research is coordinated.

The creation of a Department of Communications brings some order to the scene, but the Science Council of Canada continues to press for an equivalent of the U.S. National Aeronautics and Space Administration.

Lead man. The new director general of the Communications Research Center, R.C. Langille, is not particularly concerned by such worries. A veteran of defense work and one-time head of the electronics laboratory within what was then DRTE, he has been deeply involved in space telecommunications work since the earliest days of the first Alouette. Langille stepped into the top spot when his predecessor chose to stay with the Department of National Defense.

"We have to demilitarize our thinking and learn to work with the universities and intramural laboratories," he says. "CRC has much to contribute; the trick will be to find out what can be done without duplicating the efforts of larger research operations in the U.S. or elsewhere. Canada shouldn't nibble at a lot of things."

Staking a claim. Canada is determined to have a communications satellite in space. (So far, Russia has the only operative domestic system.) Long-term cost estimates are still vague and the country's common carriers are leery of government domination in the prospective corporation, Telesat Canada. But there is no questioning Ottawa's resolution to preempt at least a couple of the six orbital positions around the 95° west longitude that can cover Canada [*Electronics*, Sept. 4, 1967, p. 131].

In May 1966 when the federal government science secretariat commissioned the first comprehensive study of Canada's upper-atmosphere and space programs, J.H. Chapman, deputy chairman of the Defense Research Board, was named to head the four-man group. The so-called Chapman Report reflected the growing industry, university, and government consensus that Canada's requirements encompassed: a control organization for space activities; a domestic "telesat" system by 1970 or 1971; and, eventually, national satellite-launching capability.

Chapman was also closely associated with a task force appointed in July, 1967 to study and advise the government on the question of satellite communications. While noting that the Canadian electronics and communications industries have established competence in all phases of modern technology, the task force's report emphasized effective federal control. It also proposed full use of existing government resources for space research and development—for example those involved in the development of the Alouette and Isis satellites.

New talent. CRC chief, R.C. Langille, will help shape the role his complex is to play in Canadian space effort.

Fitting in

CRC's role as a satellite designer may well prove transitory. The government as a matter of policy wants to develop an industry presence. In the case of Alouette 1, the extent of outside participation was limited to such items as extendable tubular antennas and telemetry transmitters. But the second Alouette schedule was deliberately set up to have RCA engineers seconded to the Shirley Bay team that actually built the bird. In 1964 the prime contract for management, design, manufacture, and testing of the Isis 1 spacecraft went to RCA, with SPAR Aerospace Products tabbed to work the mechanical aspects of the design. DRTE personnel, though responsible for overall design, had to go to Montreal if they wanted to do any shoulder-leaning on the project.

Being the design authority for the Alouette-Isis series is only part of the reason the CRC has been brought in to assist in evaluating the RCA and Northern Electric proposals on Telesat 1. The Shirley Bay operation has 20 years experience in high-reliability circuitry. This background should stand it in good stead if it assumes contract management responsibilities.

Make-ready. CRC officials consider their organization more than a source of expert advice to government. A beginning must be made now on the next generation of satellites—assuming that a bird's useful life span is five years and that the subsequent versions will be able to achieve improved performance levels. Engineers at the National Space Communications Laboratory are already investigating the problems involved in, for example, direct broadcasting from satellites to private homes and dual-purpose spacecraft. Far higher power levels will be required for direct tv transmission; more modest levels would suffice if f-m radio programing were the objective. Current plans call for improving reliability in whatever systems fly by extensive use of integrated circuits and electronic scanning techniques.

Langille anticipates satellites will eventually be used for navigation or air traffic control purposes, although again the power supply is a potentially weak link. To sidestep this difficulty, he says, designs may include provisions for expandable structures to widen the array of solar cells. Despite power limitations, earlier versions work so well that they have been a source of embarrassment to the satellite-control center at Shirley Bay. Manpower is still tied up collecting data from Alouette 1 for experimenters who want long series of readings. "A pity we didn't engineer some obsolescence into that bird," says a CRC source.

Solar cells aren't the only way out of the power problem. Fuel cells and nuclear generators have been looked at though both may prove subject to technical and political difficulties. And as it happens, Shirley Bay is home base for an internationally recognized group of battery researchers working under the direction of E.J. Casey. However, this operation is still under the wing of the DRB.

Service record

Under military stewardship, Canada's Defense Research Telecommunications Establishment turned in some impressive performances on what seemed to be a five-year scheduling basis. In 1950, for example, the organization developed narrow-band, low-frequency teletypewriter service for the armed forces. A doppler navigation system for aircraft was the 1955 innovation. It features a scheme of fore-and-aft radar beams that permit display mapping of the terrain being overflown. Five years later, the Defense Research Board, DRTE's overseer, was able to offer Canada's NATO allies a meteor-trail communications system devised by its minion. The system works on a burst technique whereby a meteor's ionized trail is used to temporarily store data; tactical terminals retrieve the information with no fears about security or interception. DRTE's 1960's feat, a civilian venture, was the first Alouette, a polar-orbit craft for ionospheric studies.

D.C. Florida, the white-haired scientist who directs the space work at Shirley Bay, has his own crystal ball on the direction CRC's research will take. For instance, he doesn't favor travelling-wave tubes in a satellite.

But a new solid-state microwave device may be in the making in CRC's electronics laboratory. With its new microelectronic facility and computer-aided design know-how, researchers hope to combine power amplifiers and a low-noise front end on a single chip. Each would have a restricted output, but enough elements could be put into the system with a phased-array antenna to overcome the constraints imposed by the individual component limitations. Says Florida: "One gets graceful degradation instead of calamitous failure."

Thumbs down. Florida also disapproves of the hydrazine-powered axial and radial thrusters used to maintain the spacecraft's correct attitude in synchronous equatorial orbit. A capability for gas exhaustion is part and parcel of this design approach; in contrast, Isis I uses magnetic torquing to counter the effects of solar radiation.

Florida also worries about weight and wonders whether fuel supplies couldn't be built into the structural elements. The strength specs are designed primarily for vibration forces encountered during the launch, perhaps, says Florida; part of the structure could be sacrificed once the satellite is aloft. From an electronics standpoint, weight is indeed a critical factor. As things now stand the size of both power supply and antenna is limited because their combined weights have to be kept to a definite minimum.

Along these same lines, the configuration of the launch vehicle can dictate design parameters. Thus, a small fairing means a smaller diameter for the solar-cell cylinder and a reduction in the area of the array. Weight considerations are also behind the proposal that the number of nickel-cadmium batteries be restricted to what's needed to maintain two or three channels during eclipse.

Flight plans

Shirley Bay could provide the floor space and manpower to build upcoming satellites if need be. The two Alouettes were made there. At immediate issue are the plans for the remaining birds in the Isis series. Isis B is already in construction at RCA's Montreal space systems laboratory and a C version may be approved before the year is out.

Should Ottawa and Washington buy the Isis C proposal, which may be forwarded this summer, more than one prime contractor may enter the satellite picture. The C model, which is supposed to cap the series, is conceived as a magnetospheric satellite (reaching out at least 10 earth radii) rather than an experimental ionospheric vehicle.

Costs are escalating, but the CRC is pressing ahead to determine whether a unique program of experiments can be devised. Talks involve the French as well as the Americans; the former had satellite plans of their own until the Russians, who were to handle the launching, backed out of the deal.

Isis 1, put into a highly elliptical polar orbit, carried 11 experiments. About the same number will be on Isis B, which will become Isis 2 when injected into its circular orbit. But Isis C, also intended for a geocentric course, albeit farther out, will need a heavier booster. The alternative may be a cutback in the number of experiments.

Ambivalence. Despite CRC's optimism regarding its R&D role in satellite technology, administrators recognize that there is still considerable uncertainty. For example, no one knows yet whether contracts for Telesat birds will be awarded in a fixed-cost or incentive basis. One thing is clear, however. To have a communications satellite in operation by the winter of 1971-72 it will be necessary to use state-of-the-art technology. Therefore, the best that the Shirley Bay establishment can offer immediately is responsible advisories to assure workable coordination between government and industry in what has already been designated a joint venture.

Moreover, there must be some word from Eric Kierans, Canada's pugnacious minister of communications, on how he sees government interfacing with the telecommunications business. He's already on record about the post office's doing more than simply delivering the mail. Some observers speculate that Kierans intends to take a leaf from the British and make the department into a common carrier competing with private interests.

Meanwhile, Shirley Bay will concentrate on satellite technology. Although only 20% of its technical staff is in Florida's national space telecommunications laboratory, the two other labs, along with the two institutes on the premises, have talent that can be called into play. The radiophysics people, for example, as users of the data from research satellites, have a natural interest in the program.

Communications in Northern areas have generally occupied the attention of CRC, and it has given short courses to geologists in oil-company field parties because of its long-standing competence in the high-frequency field. Among current projects are several involving advanced modulation techniques for carrier beams to improve reception in remote northern areas of the country.

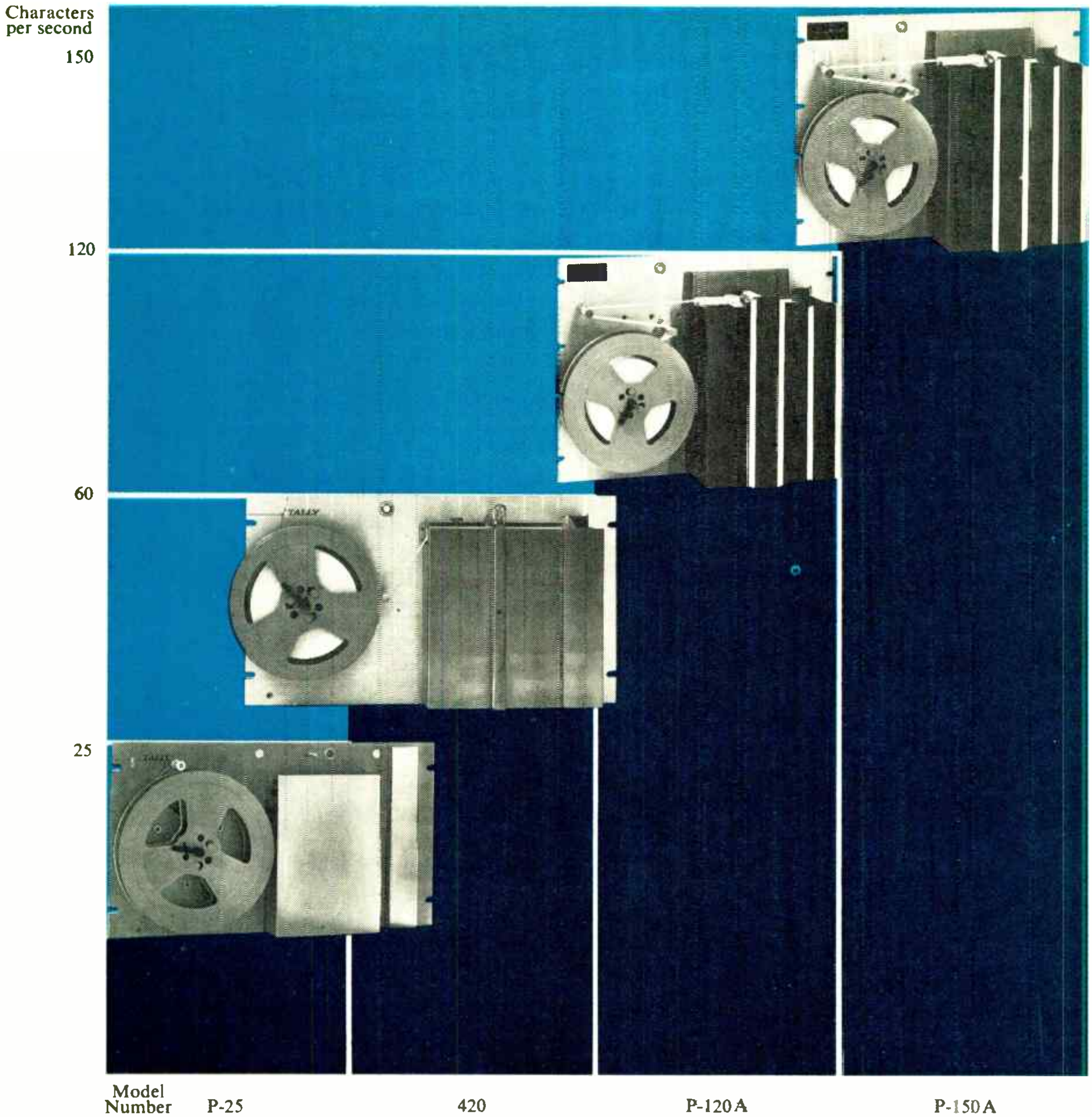
Other units at CRC are working on digital systems, coding techniques, telegraphy, and related projects, as well as building their basic knowledge of solid state physics and components. The physical chemists, for instance, hope to improve processes for making IC's. Their efforts will shortly get a boost with the completion of a "clean room" for specialized circuitry and the availability of a scanning electron microscope, which will be used, among other things, to examine crystal structures, bonding, and the intrusion of impurities. By the end of the summer experimental IC's should be coming out of the in-house microelectronics facility.

Cause and effect. The Isis program pushed Shirley Bay into microelectronics since devices had to be specified. And the only way the designers could argue from strength with the manufacturers was to know as much as possible about how to pinpoint failures. This entailed using microscopy to do proper failure analysis. CAD techniques, another recent specialty of the house, evolved as a result of the desire to shorten the development cycle of new equipment.

Though CRC will have to work its way through the administrative difficulties of switching from one department to another, it is girding itself for a faster growth pace. Langille is all for the mission approach proposed by the Science Council of Canada. Now that his organization is released from a primarily defense orientation, it should be able to devote a lot of stored energy and talent to telecommunications projects in the civilian arena.

Shirley Bay will go on with a few military projects, but hopes to avoid piecemeal work on systems that will never see production. "We never could interface," says Langille. "Occasionally there was a Mark I, but little progress towards developing more sophisticated hardware."

Time will tell whether the rechristened CRC will experience similar clashes with Kierans' department. One consolation has been that in the current period of government austerity CRC has been one agency permitted to expand its staff. But then it's new and there is no doubting Kierans' present intention of maintaining tight government control of the Telesat program. By having an in-house capability, schedules and costs should, he reasons, be well managed. ■



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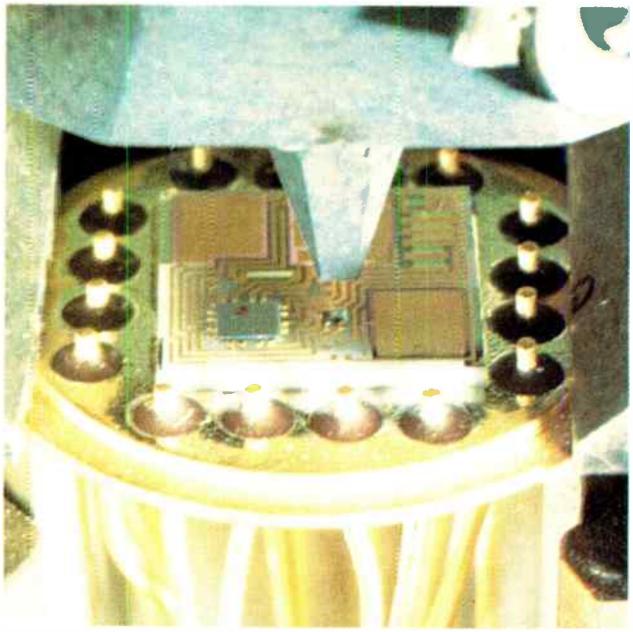
Hybrid IC lines move into production

TI starts with chip-and-wire FET preamp, but will switch to beam leads in fall; Fairchild turns to flip chip, while Motorola and RCA stay with wire bonding

By Stephen Wm. Fields
Associate Editor

First . . . Chip and wire preamplifier with FET input is TI's first product in a new line of standard hybrid IC's.



. . . and next. Future products in the line will use semiconductor chips with ultrasonically bonded beam leads.

Beam lead or flip chip: that was the question. What made it irrelevant was the semiconductor industry's realization that the production of hybrids—by whatever method available—is more important. As one industry representative put it: "With hybrids, we don't have to force a single technology to do something it wasn't meant to do. We can combine the best advantages of bipolar and MOS chips, and thick- and thin-film techniques in a single package."

Reflecting this attitude, three companies — Texas Instruments, Motorola Semiconductor and Fairchild Semiconductor—have already launched off-the-shelf hybrid lines with the introduction of their first products. TI's entry is a low-noise field effect transistor preamplifier; Motorola's first in a series of IC's for interfacing logic circuits with electromechanical devices is a dual power driver; and Fairchild started its line of memory elements with a 128-bit read-write bipolar random-access memory.

Called the HIC-023, TI's preamp is earmarked for oceanographic equipment, such as hydrophones and sonar transducers, and medical gear—primarily electrocardiographic. According to the company, the preamp has a voltage gain of 50 decibels, which is about 20 db better than that of monolithic versions. And although the gain is about the same as that of discrete preamps, the hybrid's price is about a fifth—$42 for the hybrid, compared with about $200 for discrete preamplifiers.

Something special. To some, the price alone would make the hybrid special. But, according to Bud Frye, manager of hybrid products at TI, "The FET preamp is something special in another way." Says Frye: "The first units will be manufactured with chip-and-wire techniques, but by the fall we'll be using beam-lead chips." This will be TI's first commercial hybrid beam-lead product.

"Although hybrid IC's are largely a custom market," he says, "definite requirements exists for standard functional building blocks that

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have a wide application but aren't readily adapted to monolithic approaches." The FET preamp is a good example of this. Two other products that TI is planning to introduce will also fit these requirements—a high-current, high-voltage line driver for interfacing transistor-transistor logic with coaxial signal lines, or read lines in core memories, and a high-power voltage regulator with a capability of 6 or 7 watts.

The beam-lead version of the HIC-023 will carry the same price tag as the chip-and-wire unit, but the price will eventually come down. This will be due largely to the anticipated savings in assembly and testing costs.

The HIC-023 operates on one 24-volt power supply, has a maximum output voltage of 14 volts peak-to-peak, an input impedance of 15 megohms, and an output impedance of 250 ohms. Total power dissipation with no signal applied is 90 milliwatts, and temperature drift is 0.4 db from 25° C to 125° C.

Coupler. Motorola's hybrid combines the best of each of the available technologies. The result is a device that is small, capable of controlling high power, and inexpensive. Called the MCH1002, the dual power driver interfaces high-threshold logic levels with relays and lamps.

For the logic end of the integrated circuit, Motorola engineers used an expandable dual four-input line driver from the MHTL family. To this, they added two high-current, high-voltage discrete switching transistors, and four thick-film resistors. The result is a 14-lead molded plastic plug-in package with a maximum output current of 0.5 amp, a turn-on time of 115 nanoseconds, and a turn-off time of 260 nsec. Price, in quantities of 100 units, is $7.60 each.

Also available off-the-shelf from Motorola is the MCH2005 Darlington power driver. Designed for applications requiring large current pulses for short durations, the MCH2005 converts a TTL output current of 5 milliamps into a current pulse of 5 amps. Total switching time is 800 nsec. The hybrid is housed in a TO-91, 10-lead ceramic flat package and is priced at $8.75 each in quantities of 100. In both circuits, Motorola uses chip-and-wire bonding techniques.

LSI approach. In the memory area, hybrids are being used as an approach to large-scale integration. Realizing that bipolar memories are faster than MOS memories and that small chips can be manufactured at a lower cost than large chips, Fairchild moved quickly to capitalize on its existing bipolar memory cells. Its new 128-bit read-write random access memory employs eight 16-bit $M\mu L9033$ cells bonded face down on a ceramic substrate that incorporates two layers of metalization. Called the $M\mu L4027$, the memory has an access time of 35 nsec. Its most likely application is in high-speed scratchpad and buffer memories.

Memory organization is 64 two-bit words with uncommitted collectors, which enable word or bit expansion. Eight x and eight y coincident-select address lines simplify the organization; all outputs are compatible with DTL and TTL circuitry, and both true and complement outputs are available.

Supplied in a 1-inch square hermetic plug-in package, the memory is priced at $66 each in quantities of 100 units—52 cents per bit.

Down the road. TI, Motorola, and Fairchild may be the first three firms to announce new hybrid product lines, but they won't be alone for long. By the time TI's beam-lead preamp reaches the market, at least three other semiconductor houses will be marketing either beam-lead devices or complex hybrid circuits—some of which will use beam-lead chips.

General Instrument is reportedly near production of beam-lead chips, and the first application will be in a hybrid-LSI analog-to-digital converter that is slated to be the company's first off-the-shelf hybrid product.

In August, Raytheon will have several lines of beam-lead chips that will be offered off-the-shelf. These chips will more than likely go to systems houses having hybrid capabilities.

And RCA is expanding its semiconductor operation at Mountain Top, Pa. with the intent of making thick-film hybrids. A wire-bonded hybrid product line is already in the offing. One of the first circuits from RCA will be a 100-watt audio amplifier.

Cable connectors trim out the fuss

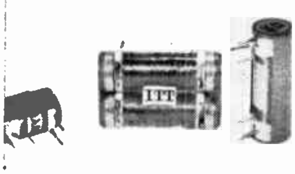
Simplified design of coaxial and multicontact units drives down price; assembly can be done by customer and requires only a few basic tools

Industrial and commercial equipment designers tend to shy away from miniature coaxial and multicontact connectors because they're expensive, and they're difficult to assemble. Four connectors manufactured by Microtech Inc. may change this, however. They cost from $1.75 to $3.75 in thousand quantities. "And the beauty of it is you can assemble them yourself," a Microtech engineer says. To assemble the coaxial connector, "you just trim your cable and thread it in," he says. For the multicontact connector, "all you need is a soldering iron and a razor blade."

This is in sharp contrast to previous connectors. Sizes comparable to Microtech's series D cost $25 each, and the manufacturer often must connect the cable for the customer because special tooling is needed to do the job.

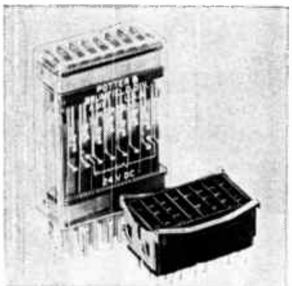
There are two coaxial series in the Microtech line. Series A has 10-32 threads with ¼ inch outside diameter; series C has 4-48 threads with ⅛ inch outside diameter. Quantity price for each is $1.75. Over-all length of the small connector is less than ¼ inch.

And there are two multicontact



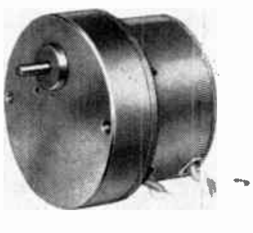
Miniature diaphragm relay JDYA features a moving contact that is a flexible diaphragm sealed in an inert atmosphere. It will interrupt up to 1 amp at 30 v d-c or a-c in either 1-, 2-, or 4-Form-A configuration. The 1-Form-A type is only 0.67 inch long. Units are available as standard coils of 6, 12, 24, or 47 v d-c. ITT Jennings, 970 McLaughlin Ave., San Jose, Calif. [341]

Dry reed relay type DRM features memory contact. Units are supplied with two coils, one to produce the make field, the other to produce the release field. Duration of energizing pulse can be between 10 μsec and steady d-c conditions. Average coil power is 250 mw for 6, 12, 24 v operation. Measuring Instrument Controls Inc., 438 Springfield Ave., Berkeley Heights, N.J. [343]

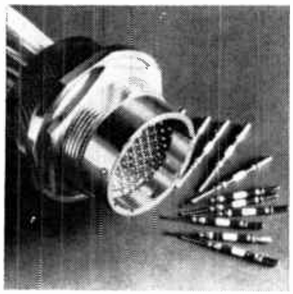


Eight-pole relay series KDP is for high-density packaging in electrical control systems. It measures 1.19 x 0.56 x 1.54 in. Available for 6 to 110 v d-c operation, the units offer a mechanical life of 10 million operations. Contacts are available in 8 Form C arrangement with a rating of 1 amp at 30 v d-c or 0.5 amp at 120 v a-c resistive. Potter & Brumfield, Princeton, Ind. [344]

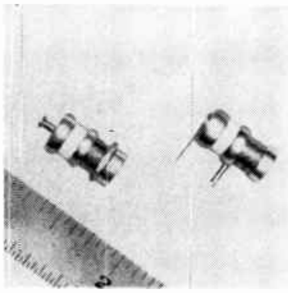
Mercury thermostats can be fixed set at any temperature between −20° and 200° F. Once calibrated, the unit will maintain the temperature to within 0.05° C over one year or 100,000 operations. It switches 2 amps a-c or d-c and comes with a plastic control housing and an aluminum or stainless steel probe. Philadelphia Scientific Controls Inc., 1135 Cedar Ave., Croydon, Pa. [345]



Heavy-duty reversible motor 81400 features high torque and compact design. It delivers an output torque of 2 oz in. at 300 rpm directly from the rotor, at an input of 3 w. Integral gearing provides speeds as low as 1 rpm; the gear train rating is 100 oz in. Rotation may be reversed by changing one connection. A. W. Haydon Co., 232 N. Elm St., Waterbury, Conn. 06720 [346]



Circular connector series 482 is designed to eliminate conducted and radiated electromagnetic interference. Units have been tested for operational reliability under vibration acceleration forces of 50 g and shock loads of 100 g at temperatures of −55° to 150° C. The device handles a voltage of 200 v d-c or rms. Amphenol Connector Division, 2801 S. 25th Ave., Broadview, Ill. [347]



All-metal, air variable capacitors series MVM meet or exceed Mil-C-14409C. They are adjustable from 0.8 pf to 10 pf. The Q factor exceeds 2,000, measured at 10 pf and 100 Mhz. Insulation resistance at 25° C and 500 v d-c is 10^6 megohms, and temperature coefficient of capacitance is 0 ±20 ppm./° C. JFD Electronics Co., 15th Ave. at 62nd St., Brooklyn, N.Y. [348]

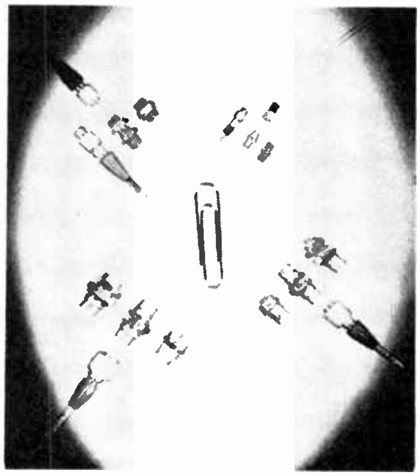
Radial-lead, power wirewound resistors designated PC-58 are available in 3-, 5-, and 8-watt sizes. By eliminating cutting, bending and forming leads, the PC-58 cuts labor costs up to 21.9% with productivity increases of 28.1%. Resistance range is 0.51 to 7,000 ohms. Price of the 3-w unit is 24 cents in lots of 500. Ohmite Mfg. Co., 3601 W. Howard St., Skokie, Ill. [342]

connectors. Series D, at $2.75, has four pins and a ¼-28 thread; series E, at $3.75, has seven pins and a 5/16-24 thread. Over-all length is less than ½ inch.

To cut the price so drastically, Microtech used a simplified design. "We've been very careful with the number of parts and how they go together," the company reports. In the D series, the pins are in a plastic insert. The cables are soldered to the pin, the insert is backed into the connector, and a snap ring retains it.

In cutting costs, the company hasn't scrimped on materials. For reliability, the bodies and pins are made of gold-plated brass, the sockets are made of gold-plated beryllium, and TFE Teflon is used as the dielectric material.

The multicontact connectors use a special cable. It's available from cable manufacturers, but since it's an unusual size, Microtech supplies it to customers.



Small economy size. Industrial connectors have outside diameters of ⅛ to 5/16 inch.

Although Microtech is directing its product to industrial and commercial markets, the company says the connectors perform well in military tests and that they are particularly good in shock and vibration.

The present line is not hermetically sealed, but Microtech will soon introduce a version with a hermetically sealed receptacle.

All series are available from stock.

Microtech Inc., 777 Henderson Blvd., Folcroft, Pa. 19032 **[349]**

Solid state switch handles 14 amps

SPST unit, priced at $20, can be controlled by d-c or a-c signals

The sound of silence is growing louder in switching circuits. Electromechanical relays along with their reassuring clicks are disappearing, and in their place are coming solid state relays, quiet but almost indestructible.

The newest of these solid state switches is the series 6 from Teledyne Relays. A single-pole-single-throw device, the series 6 switches 60-hertz signals of up to 14 amps. A wide range of inputs—3 volts a-c or d-c up to 140 volts a-c or 200 volts d-c—can control this relay. In a typical situation, a 0.3-milliamp, 3-volt signal switches a 2 kilowatt load.

The relay is compatible with transistor-transistor logic, and has a contact resistance of 100 milliohms.

In many applications, the series 6 needs no heat sink. At room temperature, for example, it'll switch 11 amps with no outside help.

Teledyne says that there's no reason why these relays, like other solid state switches, shouldn't live forever since they have no moving parts. Samples of the series 6 under test at Teledyne have passed the million-operation mark, and Teledyne is specifying the relay for 100 million operations.

Teledyne claims that the series 6 is "rugged," and is touting it for a place in industry. Some suggested applications are in level detectors, multivibrators, and transducers. The series 6 is good for controlling lights, adds Teledyne, since it can handle high inrush currents.

The price of samples is $40; in large quantities, the relay costs $20. Depending on the size of the order, delivery time ranges from stock to 10 weeks.

Teledyne Relays, 3155 West El Segundo Blvd., Hawthorne, Calif. 90250 [350]

Op amp settling time is 80 nsec for gain of 1

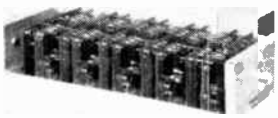
High-speed inverting device for tv and radar applications has gain-bandwidth product of 125 Mhz, output of 4 volts

Slewing rate and bandwidth, both important parameters of operational amplifiers, are usually recognized as such, but settling time frequently offers a more meaningful comparison—and this specification is often neglected.

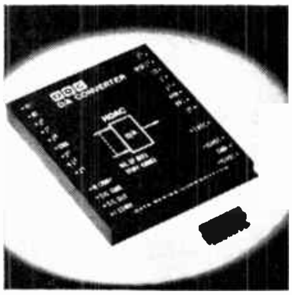
That's why Computer Labs stresses the settling-time spec of its model FS-125. For a closed-loop gain of 1, the op amp will settle to 0.1% of full scale in less than 80 nanoseconds.

The slewing rate indicates an amplifier's ability to respond to a step-function input. Fast amplifiers will slew at 100 volts per microsecond and above, but op-amp specs don't always include the limitations placed upon the user if he wishes to achieve these slew rates. If the amplifier is an inverting type, as the majority of fast-slewing op amps are, it isn't always possible to get a fast response from the op-amp configuration. This is especially so when the feed forward resistance is high. When it is, even small amounts of stray capacitance can have an adverse effect on the slew rate.

Settling time specifies the amount of time required for the

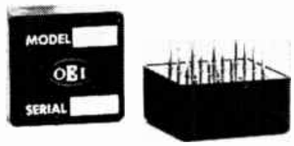


Logarithmic amplifiers series 200 convert 1-f/i-f signals to a d-c voltage that is directly proportional to the log of the input signal level. Units operate over a center frequency range of 100 to 250 khz wth a bandwidth of 8 to 24 khz. They have a dynamic range of 80 db at a logarithmic accuracy of 2 db. Aerospace Research Inc., 130 Lincoln St., Brighton, Mass. [381]

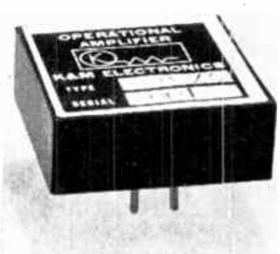


Modular d-a converters series HDAC are 8-12 bit devices that settle to 0.05% of full scale within 1 μsec maximum. Both output amplifier and reference are internal. The module measures 2.625 x 3.125 x 0.4 in. high and is intended for p-c board mounting. Price (1-9) starts at $200 each. Delivery takes 2 to 4 weeks. Data Device Corp., 100 Tec St., Hicksville, N.Y. 11801 [382]

Low-level preamplifier type NS-312 is designed for biomedical applications where the signals are in the microvolt range. It has a maximum gain of 10,500. The low and high frequency cutoff are switch selectable. Common mode rejection is greater than 10,000:1 from 0.2 to 1 khz. Price is $495. Northern Scientific Inc., 2551 West Beltline, Middleton, Wis. 53562 [383]

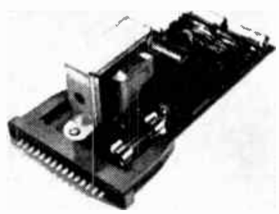


Sinusoidal function module model 5217A comes in a 0.5 cu in. package with a height of 0.5 in. It features ±1% static accuracy, ±3% dynamic error at 10 khz, and 100 khz useful bandwidth. Applications include trigonometric computers, sine and cosine generators, visual display rotation circuits, etc. Price is $43 each. Optical Electronics Inc., P.O. Box 11140, Tucson [384]

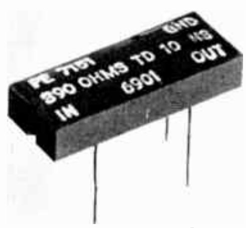


FET operational amplifier KM45 includes internal frequency compensation and short circuit protection. Features include a typical voltage offset drift of 10 μv/° C, bias current of 10 pa, voltage gain of 10^6, and input impedance of 10^{12} ohms. Unit is for instrumentation, integrator and general purpose application. K&M Electronics Corp., 408 Paulding Ave., Northvale, N.J. [385]

Dual AND model 170 is capable of resolving time coincidence of two inputs to better than 1.5 nsec at 200 Mhz with input widths 2 nsec or wider. Outputs are fast rise/fall time (1 nsec nominal) pulses with widths precisely equal to time coincidence overlap of the two inputs. The two sections are identical. Price is $350. Chronetics Inc., Mt. Vernon, N.Y. [386]



Dual power supply model 222A provides regulated ±15 v d-c at 50 ma. It also provides unregulated ±24 v d-c at 100 ma. The ±15 v units are for use with operational amplifiers and similar equipment. The ±24 v d-c output can be used to supply power output stages and as a source of unregulated relay drive voltage. California Electronic Mfg. Co, Alamo, Calif. 94507 [387]



Distributed constant delay lines are designed to be compatible with dual in-line IC packaging. Standard units are available with 100 or 390 ohm impedances and delay times of 5 to 100 nsec. Distortion is 15% maximum; temperature coefficient, approximately 200 ppm/° C. Prices are $2.05 in 1,000 lots. Pulse Engineering Inc., Robert Ave., Santa Clara, Calif. 95050 [388] output of an amplifier to reach a certain percentage of its final value in response to a step-function input. High slew rates are relatively meaningless, Computer Labs points out, if the amplifier requires an excessive amount of time to settle within 0.1% or less of its final output. This ringing can nullify the speed advantages gained with the fast slew rates. Settling time is a closed-loop parameter and depends on the circuit feedback and gain. The larger the closed-loop gain, the longer the settling time required to reach 0.1% of full scale.

Some circuit designers desire settling time accuracies to 0.01%; however, most op-amp manufacturers are reluctant to specify these accuracies. The main disagreement centers around the precision of test equipment capable of measuring settling times of less than 1.0 microsecond.

No op amp is truly general purpose—in each case, something has to be compromised to gain the specially desired benefits. In the case of the FS-125, speed was not compromised.

The model FS-125 has the following settling times for closed-loop gains of 2, 4, 8, and 16: 150, 200, 400, and 500 nsec, respectively.

With an output voltage range of 4 volts peak-to-peak, the op amp can process a television signal at 1 volt peak-to-peak across 75 ohms, or handle radar signals of 2 volts peak-to-peak across 100 ohms.

The price is $97 each in quantities 1-9.

Specifications

Gain-bandwidth product	125 Mhz
Slew rate	250 v/nsec
Voltage gain (d-c open-loop)	100,000 with 100-ohm load
Open-loop roll-off	6 db/octave
Output voltage range (± 15-v supply)	± 2v into 100 ohms, ± 3.5 v into 1,000 ohms or greater
Output voltage range (± 12 v supply)	± 1.5 v into 100 ohms, ± 2.0 v into 1,000 ohms or greater
Input-output structure	single-ended, inverting only
Input voltage offset	3 mv max (no adjustment required); vs. temperature, 10μv/°C
Input current offset	100 na max; vs. temperature, 20 na/°C
Temperature range (operating)	0 to 50°C
(storage)	−60 to +125°C
Power source	± 12 v to ± 15 v

Computer Labs, 1109 South Chapman St., Greensboro, N.C. 27403 **[389]**

New subassemblies

Readout says it big and wide

Rear-projection display has characters 2 inches high, 160° viewing angle

Jumbo characters are an additional aid to easy viewing in a rear-projection readout developed by Industrial Electronic Engineers Inc.

The single-plane display module, designated IEE series 360H, can be read easily from more than 50 feet away.

Its characters are 2 inches high, yet the 360H measures only 3 inches high by 2 inches wide by nearly 8 inches deep. The 160° viewing angle permits the display to be read from almost any position in a room.

The 360H has 12 different display positions. Anything that can be put on film, such as numbers, letters, symbols, and words, can be displayed in any combination. White is the standard color, but others are available. Brightness varies from 13 to 40 foot-lamberts depending on the lamp that is used.

Input to the 360H can be straight binary, decimal, or binary-coded decimal.

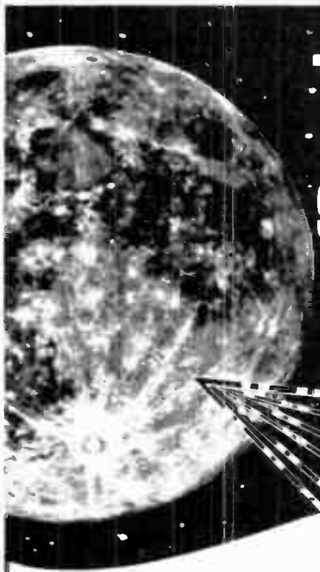
The company has several driver-decoder models that are designed to match the readout. These units accept a binary coded input, translate it into decimal, and light the proper lamp in the readout to display the desired character. The driver/decoders are available with or without memory, with negative or positive voltage, and with 8, 10, or 12 decoded outputs.

A quick-disconnect lamp assembly makes replacement easy and makes it possible to snap a different readout into position on the present lamps.

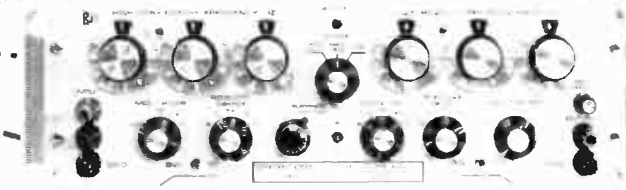
Price of the 360H is $38.50 each for 1-9 units, $27 for 1000 and more. Delivery time for standard units is 30 days.

Industrial Electronic Engineers Inc., 7720 Lemona Ave., Van Nuys, Calif. 91405 **[390]**

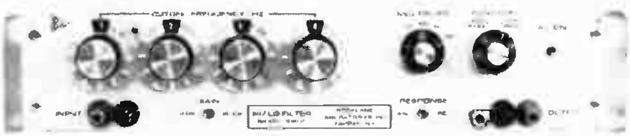
The first SEISMIC DATA from the MOON



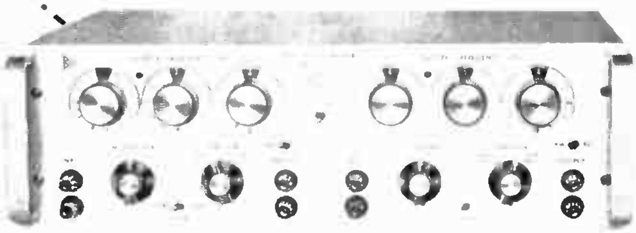
...will be analyzed by these VARIABLE FREQUENCY **ELECTRONIC FILTERS** by Rockland Laboratories



OPERATIONAL FILTER



HI/LO FILTER



DUAL HI/LO FILTER

NASA's Spacecraft Center and several university data centers will use these filters for real time processing and magnetic tape analysis of seismic data transmitted from the Apollo lunar landing site. Some reasons for choosing Rockland are listed below.

OPERATIONAL FILTER

- Functions as a variable filter or sine wave oscillator
- Tuning range: .001 Hz to 11 KHz (bandpass DC to 100 KHz)
- High pass, low pass (DC coupled), band pass and band reject responses with digital frequency selection
- Adjustable rolloffs (0, 6, 12, 24, db/octave)
- Butterworth or RC response
- Variable gain (0, 6, 20, 40 db)
- Zero suppression
- 2% frequency setting accuracy
- Silicon solid state
- AC (115/230 V) or DC operation
- Bench/rack convertible
- *Price range:* $1325.00 to $1650.00

HI/LO FILTER

- High pass or low pass (DC coupled) response with digital frequency selection
- Tuning range: .001 Hz to 111 KHz (bandpass DC to 1 MHz)
- Rolloff: 24 db/octave
- Butterworth or RC response
- Variable gain (0, 20 db)
- 10 megohm input impedance
- 2% frequency setting accuracy
- Silicon solid state
- AC (115/230 V) or DC operation
- Bench/rack convertible
- *Price range:* $695.00 to $745.00

DUAL HI/LO FILTER

- Two identical and independent filters in one chassis. Sections can be used separately or connected in series or parallel
- High pass, low pass, band pass and band reject responses with digital frequency selection
- Tuning range: .001 Hz to 111 KHz (bandwidth DC to 1 MHz)
- Rolloff: 24 or 48 db/octave per filter section
- Butterworth or RC response
- Variable gain (0, 20 db per section)
- 10 megohm input impedance
- 2% frequency setting accuracy
- Silicon solid state
- AC (115/230 V) or DC operation
- Bench/rack convertible
- *Price range:*
  $1325.00 to $1425.00 for 24 db/octave rolloff
  $1825.00 to $2025.00 for 48 db/octave rolloff

ROCKLAND LABORATORIES, INC.

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- 6 IF bandwidths: 500 kHz, 1 MHz, 2 MHz, 4 MHz, 10 MHz, 20 MHz, selectable.
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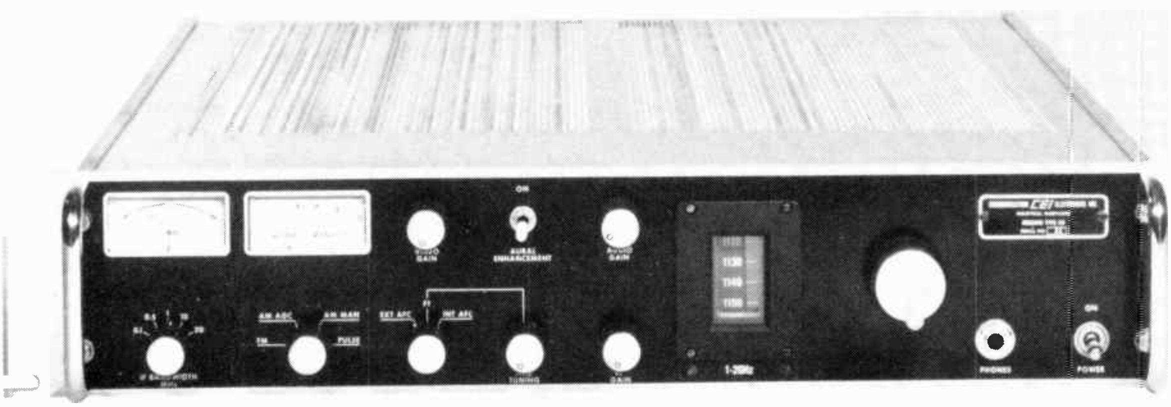


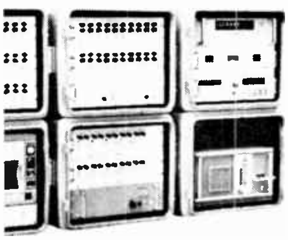
Computer aids instruments in tasks from a to d

Easy-to-operate miniprocessor for real-time data conversion can be preprogramed for process-control, scientific, medical inputs

Murphy's law says if something can go wrong, it probably will. Engineers at Beckman Instruments Inc., had this in mind when they designed the model 816 minicomputer. They reckoned that if the computer is easy to operate, chances are that it will be operated correctly. This led to the 816 having only two control switches —an off-off switch with a key to prevent unauthorized program changes and a four-position switch for load-reset-stop-run functions. Even a relatively unskilled operator can handle the machine without running the risk of fouling up the work.

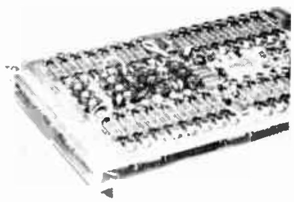
A general-purpose computer, the 816 has a memory cycle time of 5 microseconds, and add time of 45 μsec, a store command time of 32 μsec, and a skip and testing time of from 45 to 52 μsec.

This makes the 816 slower than others in its class of small general-purpose computers. But, say Beckman engineers, their machine can accept inputs from a wide range of sophisticated analog sources including scientific and medical instrumentation—as well as from process-control sensing devices

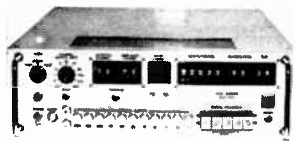


Multichannel transducer data acquisition system model SY-156(P) provides optimum portability. All system components are installed in rugged enclosures that serve as shipping containers by latching the covers in place. The system accepts inputs from strain gages, thermocouples, and can accommodate frequencies and a-c signals. B&F Instruments Inc., Cornwells Heights, Pa. [421]

Four-microsecond random access memory system FI-2 is a 1024 word by 8 bit/word ferrite core assembly built on five interconnected circuit cards and designed to slide into a card cage or mounted remotely. Access time is 600 nsec. Power required is +12 v at 3 amps. Size 8⅜ x 4⅞ x 3⅜ in. North American Philips Co., Ferroxcube Systems Div., Englewood, Colo. [422]



Core memory model 140 features 900 nsec full cycle time and 300 nsec access time. Modular design permits a wide range of word capacity/word size memory systems from this basic building block. Capacity of the module is 4,096 words x 8, 9, 10 bits. Unit measures 8⅝ x 1⅞ x 12½ in. and weighs 3.5 lbs. Micro Systems Inc., 644 E. Young St., Santa Ana, Calif. 92705. [423]

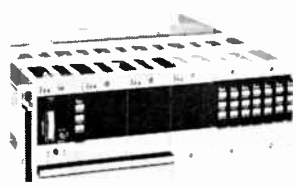


Self-contained data logging system DLS-500 will simultaneously accept and multiplex up to 20 analog and 5 digital inputs and provide outputs in IBM computer-compatible form capable of driving most incremental magnetic tape recorders. Each analog input is converted into digital data 11-bit plus sign. Applied Electro Mechanics Inc., 2350 Duke St., Alexandria, Va. 22314. [424]

Multichannel data logger model DL-2 provides for automatic and precise measuring and recording. It is designed with a digital display and a printed record of up to 100 different electrical signals. Monitoring speed is normally one signal per second and intervals between scans can be adjusted up to 5 minutes duration. P/P/M Inc., 7016 Euclid Ave., Cleveland 44103. [425]

Noiseless, high-speed display/tape system series 5700 eliminates separate verification and enables ordinary typists to prepare error-free paper tapes. It features a television-like screen which displays an exact replica of a source document and provides visual verification of all typed data before it is punched on tape. Sanders Associates Inc., Nashua, N.H. 03060. [426]

Video message generator series 44 is for communication and data systems. It converts alphanumeric data or messages in the form of standard teletypewriter codes to a visual display on a standard tv monitor or commercial tv set. Only 5¼ inches of panel space is required and power consumption is less than 35 w. Data Technology Corp., 1050 East Meadow Circle, Palo Alto, Calif. [427]



Tape data synchronizer 2755 provides coherent clocks for data processing systems where precise signal analysis or output display is required from unstable data containing record/reproduce errors. The unit tunes to all standard tape playback speeds over input reference frequencies from 3.125 to 400 khz. Interstate Electronics Corp., E. Vermont Ave., Anaheim, Calif. [428]

and numerical control equipment. They claim the 816 has a far greater analog-to-digital and digital-to-analog-conversion capacity than can be found elsewhere.

The computer digitizes incoming data immediately, thus preventing the losses in accuracy usually associated with analog input circuits, says Paul S. Mitzen, head of Beckman's systems application group. Conversation accuracy is ±0.2 percent.

Optional with the 816 are two inside-the-cabinet plug-in modules for analog scanning and conversion. One module has a 19-bit binary output plus sign, Most computers in the 816's class have 14-bit outputs and black box a-d converters outside the computer frame, according to Mitzen.

The module employs double digitizing for increased accuracy. The first 11 bits are digitized and fed to the a-d converter before the remaining eight bits are digitized and sent along. Analog signals from up to 16 channels are converted at a resolution of 1:500,000; the scan rate is 64 channels per second full scale. For faster scanning (1,000 channels per second) at a lower resolution the optional module having an 11-bit binary output plus sign, can be used.

The computer includes a 2,000-word core memory; optional is an additional 2,000-word memory. A dual d-a converter and storage card operates as two eight-bit units at ±10 volts full scale or as a single 16-bit unit. An optional universal input card, however, accepts 32 bits maximum (parallel) and operates at 5 volts. Several software packages are available so that the 816 can be completely preprogramed before delivery.

"Initial loading and testing at the factory eliminates the need for customer loading of a bootstrap program," says Mitzen.

The basic computer is priced at $8,800 and weighs 60 pounds, with the entire mainframe comprising five 8-by-10-inch printed-circuit boards that plug into a mother board. Fairchild Semiconductor's series 930 diode-transistor-logic is used.

Delivery time is 30 days.

Beckman Instruments Inc., Electronic Instruments division, 2400 Harbor Blvd., Fullerton, Calif. 92634 [429]

Data handling

Strobing signal smooths data rate

Recorder uses optics to control flow from temporary storage

The increasing number of digital data sources requires recorders with higher storage capacity, faster recording rates, uniform data packing, and mechanical simplicity and reliability. A system designed by Mobark Instruments with those requirements in mind will be available in September. The new recorder will accept random data from analog-to-digital converters, Dataphones, teletypewriters, and other business and scientific inputs.

The device, known as the syncremental digital magnetic tape recorder, uses an optical system to synchronize the flow of serial data into the magnetic head with the speed of the magnetic tape.

The synchronization technique depends on a slotted disk fixed to a capstan shaft that is driven by a stepper motor. As the disk rotates between a light source and a photocell, the resulting electrical signals govern the current flow through the recording head.

Incoming data enters a buffer, from which it is withdrawn by a strobing signal from the photocell. Because the strobe timing is established by the slotted disk, it is directly related to the instantaneous position of the tape. Thus, the data is recorded densely and uniformly on a magnetic tape with no chance of bit or character overlapping, even though the drive capstan speed may vary slightly.

The system uses standard two-track tape cassettes and can store 140,000 characters per cassette. The writing speed is up to 120 characters per second while the replay speed can be anywhere from 10 to 300 characters per second.

The price will be under $2,000.

Mobark Instruments Corporation, 1273 Terra Bella Ave., Mountain View, Calif. 94040 [430]

Dielectric isolation is design key in IC line

Radiation Inc. uses process for component separation in standard circuits; 16-channel analog multiplier heads family of industrial-control devices

There's nothing new about the use of dielectric isolation in the manufacture of radiation-hardened integrated circuits.

But Radiation Inc. has decided that the process of using a thick layer of silicon dioxide instead of a p-n junction to separate components on a chip offers advantages for standard IC's also, despite a little extra cost. The resulting circuits are simpler in construction, diverse types can interconnect with less trouble, and they can be combined into systems more effectively, the company says.

The result of this conviction, a new family of circuits, represents Radiation Inc.'s initial entry into the commercial IC field. The line, to be introduced at Wescon in San Francisco, Aug. 19-22, includes a 16-channel analog multiplier, a party-line receiver, a high-slew operational amplifier, and an op amp with both accessible bias and offset terminals for precise compensation.

Perhaps the star of the show is the 16-channel analog multiplier, the RS-1000, which accommodates bipolar analog inputs and is compatible with standard DTL and TTL circuits. It's quite flexible: its 16-

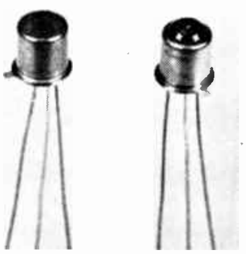
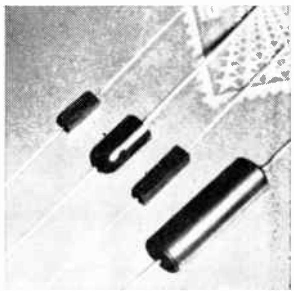
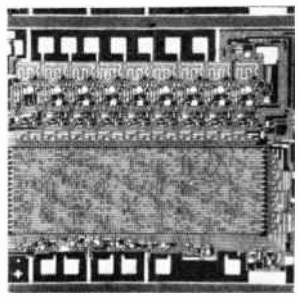


Photo scr's series PR30 and PF30 have a maximum light trigger intensity of 10 and 50 foot-candles respectively and provide high gains. Continuous current rating is 300 ma d-c; surge current, 5 amps. Operating temperature range is −65° to +125° C. Applications include tape and card readers, and optical encoders. Solid State Products, 1 Pingree St., Salem, Mass. [436]

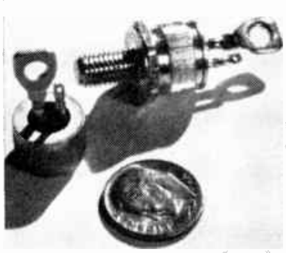
Varactors series SQ5461A, by maintaining a leakage spec of less than 4 na at the 30 v breakdown rating, can be conveniently tuned with high impedance voltage sources. The diodes are available in standard nominal capacitance values from 6.8 pf through 100 pf. Price (1-99) is $9 each; delivery, 2 weeks. MSI Electronics Inc., 34-32 57th St., Woodside, N.Y. 11377. [437]



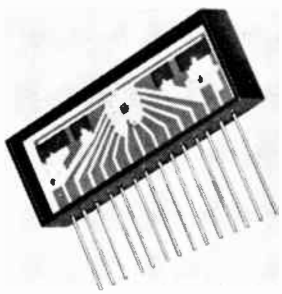
High-voltage, medium-current avalanche type silicon rectifiers offer standard and fast recovery (300 nsec). They are rated at 100 and 200 ma continuous current from 2,000 to 10,000 v. The low leakage devices are designed for commercial and industrial use where low cost and high reliability are a premium. Atlantic Semiconductor, 905 Mattison Ave., Asbury Park, N.J. 07712. [438]



Random access, read only memory EA3000 is organized as 256 words, 9 bits per word (2304 total bits). Features include low power (90 mw typical at 1 Mhz), less than 1 μsec access time over a temperature range of −55° to +85° C, variable output buffer voltage and bipolar output drive capability. Electronic Arrays, Inc., 501 Ellis St., Mountain View, Calif. 94040 [439]

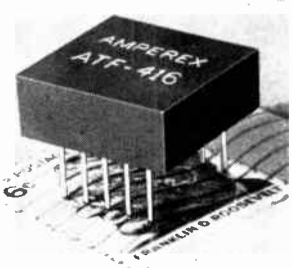


Twenty-five ampere triac thyristors SC60 (stud mounted) and SC61 (press fit package) offer a high surge current of 250 amps peak, high dv/dt and can handle up to 6 kw at 240 v. Voltage range is 200 to 500 v. D-c gate trigger current is rated at 50 ma maximum and d-c gate trigger voltage is 2.5 v maximum. General Electric Co., 1 River Road, Schenectady, N.Y. 12305 [440]



Dual power hybrid IC model MCH1002 is for interfacing high-threshold logic levels with electromechanical hardware. It features a maximum output current of 0.5 amp, a collector-emitter breakdown voltage of 40 v minimum a typical turn-on time of 115 nsec, and a typical turn-off time of 260 nsec. Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix 85036. [441]

Silicon rectifier diode DO-8 has forward current capability up to 150 amps and prv ratings to 1,000 v. Freedom from thermal fatigue is achieved by use of a hard solder construction and matched thermal coefficients. The design utilizes the Solitrode chip which features the hermetically sealed, glass passivated junction. Solitron Devices Inc., 256 Oak Tree Rd., Tappan, N.Y. [442]



Hybrid IC video amplifier ATF-416 is for industrial applications. It offers a gain of 52+3 db from d-c to 10 Mhz and has a common mode rejection ratio of at least 40 db. Bandwidth with a 1,000 ohm, 20 pf load is 8 Mhz. Unit consists of two separate amplifiers in a single package, and eliminates external "add-on" components. Amperex Electronic Corp., Cranston, R.I. 02920 [443]

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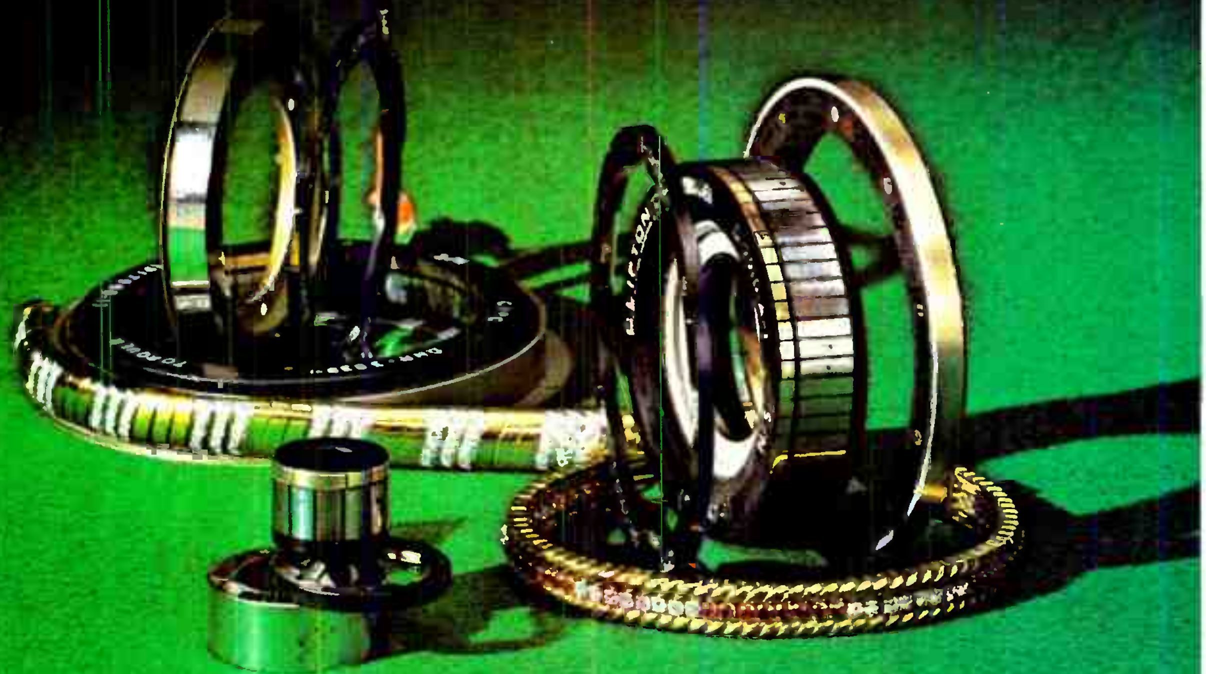

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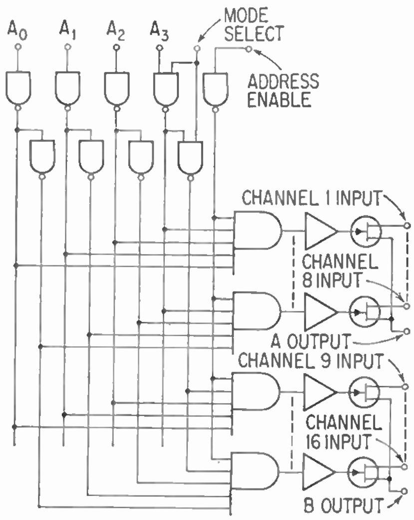

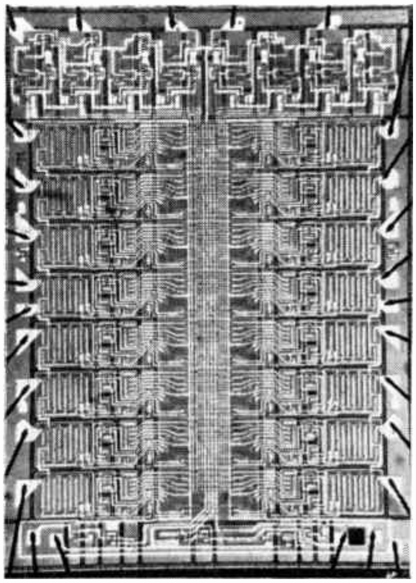

Multiplexer. Chip includes TTL gates, pnp/npn transistors, and junction FETs on single substrate.

analog inputs and 2 analog outputs can be used independently for 8-channel dual or differential operation, or bused together for 16-channel operation.

In addition to multiplexing, the circuit may also be employed as a demultiplexer where a one- or two-line input is commutated to an 8- or 16-line output. Random-access channel selection is accomplished through a 4-bit binary address input; an address-enable input can be used as an address expander for applications employing several multiplexer circuits. A mode control input is used to select either a single or a pair of channels. And an external bias control can be used for faster switching or to conserve power if the user doesn't require the full analog input voltage range of ±10 volts.

Highlights. Some of the analog switch parameters are 100 picoamperes input leakage in the "off" channel and 4 picofarads input capacitance; 500 ohms "on" resistance and an output capacitance of 40pf. And a fast access time, about 800 nanoseconds, allows for a commutation rate of 1.3 megahertz—twice that of MOS devices.

The multiplexer operates over the full military temperature range of −55° C to +125° C, and the mechanical and environmental requirements of MIL-S-883 are satisfied by packaging in a ceramic, 28-pin, 50-mil centered hermetically sealed flatpack.

The second new IC, a "party-line" triple line receiver, the RA-248, should prove to be a flexible companion to Radiation's RA-245 and RA-246 line driver/receiver. The monolithic device allows the paralleling of many receivers along transmission lines in varying lengths—a capability that's useful in multiple digital transmission systems, and in half-duplex and discrete address operations.

It enables users to fan-out into 10-line receivers from a single RA-245 transmitter. In addition, it gives the designer a choice of either terminating the line externally with the RA-248, or internally using the 100-ohm termination in the RA-246.

The new "party-line" receiver uses a current-switching operating mode that, according to the manufacturer, provides good noise immunity. The company claims that as many as 15-line pairs can be run in a single shielded cable without digital crosstalk. And to make the output look like the standard DTL logic output, 6,000-ohm pull up resistors were used between the output collectors and the positive voltage supply.

Two high speed internally compensated monolithic IC operational amplifiers feature high slew rates and wide signal bandwidths. The RA-2510 has a unity gain slew rate of +150 volts per microsecond, a large signal bandwidth of 500 kilohertz, and a voltage gain of 15,000. The RA-2500 slews at +120 volts/μsec at unity gain, has a large signal bandwidth of 200 khz and a voltage gain of 35,000.

Both amplifiers are available in either TO-86 or TO-99 package styles, and have a unity-gain small-signal bandwidth of 15 Mhz, an offset current of 20 na, offset voltage of 2 millivolts, an output impedance of 100 ohms with a +20 ma output current capability. Also, external offset and bandwidth-control points are provided in addition to the internal MOS compensation capacitor.

Two new operational amplifiers, RA-3909 and RA-3909A, have the same characteristics as the RA-2909 and RA-2909A, and include external bias and offset terminals.

The new op amps, in TO-100 packages, like the rest of the 909 family, are internally compensated for stability—particularly in the critical unity-gain configurations—and are guaranteed not to latch-up. The open loop gain is typically per octave to unity gain at 7 Mhz. The output current drive is ±20 45,000 and rolls off at 6 decibels ma, and the equivalent input noise is 3 μv/rms. At the normal operating voltage of ±15 volts, the power dissipation of the op amps is typically 52mw, and they will operate from −55°C to +125°C.

Hard line. Five new logic circuits, functionally equivalent to the conventional 54H TTL family but more resistant to degradation in a transient radiation environment, are now available. These circuits, all packaged in TO-86 flatpacks, include: a dual type flip-flop, RD-54H74R; a quad two-input NAND gate, RD-54H00R; a dual two-input and/or invert gate, RD-54H51R; a dual four-input NAND gate, RD-52H20R; and a quad two-input and/or invert gate, RD-54H54R.

The average propagation delay time of a gate is 13 nsec driving a load capacity of 150 pf; power consumption is 22 mw per gate.

Delivery from stock on all units except RA-248 and RA-548 will begin Sept. 1. The RA-248 is now available in either a TO-86 or dual in-line package, and will operate from −55°C to +125°C. The commercial version, RA-548, is now available only in the dual in-line package and will operate from 0°C to +75°C. In quantities of 100-99, the RA-248 is priced at $26.40 each and the RA-548 costs $9.90 each in similar quantities.

Radiation Inc. Melbourne, Fla., 32901
[444]

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New Books

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Microwave Semiconductor Devices and Their Circuit Applications
McGraw-Hill Book Co., 609 pp., $22.50
Edited by H.A. Watson

Unlike other books that cover only specific devices in the microwave field, this book undertakes to describe both the circuit principles and the semiconductor devices—diodes and transistors—that were used to obtain the desired performance of the microwave circuit. It was authored by 20 top engineers, all members of the technical staff at Bell Labs, and should prove an excellent reference text for engineers and scientists involved in the development of microwave solid state circuits and semiconductor devices. It provides the semiconductor devices designer with an opportunity to understand the circuit's principles, and the dependence of circuit performance on the device characteristics; the circuit designer will find set out the physical mechanisms governing the operation of specific devices, and the physical and technological limitations to achieving better performance.

The full treatment given to both device and circuit performance limitations is needed since microwave semiconductor devices and circuits perform many diverse functions. Moreover, for each of these functions, the design of both the circuit and the semiconductor component is different.

The book, divided into five basic parts, leads off with a review of semiconductor physics. The discussion centers on device behavior and structure, and the transistor techniques that have led to new microwave semiconductor devices.

The next part begins with the Schroedinger wave equation and then goes on to semiconductor crystals, electrical conduction in semiconductors, p-n junction theory, and semiconductor surfaces and ohmic contacts.

Part three, comprising several chapters, covers microwave diodes and circuits quite extensively. It includes p-n junction varactor diodes and applications; p-i-n diodes; microwave switches; limiters; phase shifters; Schottky-barrier devices and circuits; tunnel diodes and circuits; avalanche transit time microwave diodes; and bulk gallium arsenide devices. And this part also discusses the principles of snap diodes, the calculation of varactor characteristics and analyses of their performance in parametric amplifiers, harmonic generators and up-convertors, and the use of varactor at millimeter frequencies. Also covered are p-i-n diode circuits, and some circuit applications such as microwave switches, limiters, phase shifters and attenuators. Moreover, the physical design principles of Schottky-barrier varactors and their use as detectors and mixers are described. Tunnel and backward diodes are treated fully; the same is true for the rapidly evolving technology of avalanche transit time and bulk gallium arsenide devices.

The first chapter of part four is devoted exclusively to a general treatment of microwave transistors; it deals with the technological considerations, package design, and performance and characterization of these devices. The following chapter briefly considers the design principles, details, and fabrication techniques of a 4-Ghz transistor amplifier. And although the material is 4 years old, it's still worthwhile.

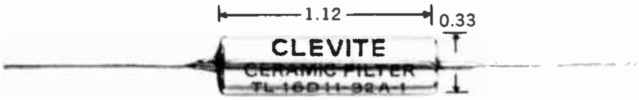
The final part discusses the present trends of microwave semiconductor devices, comparing such characteristics as noise, power output, and reliability of some of the devices and circuits previously described. And it provides well rounded view of the state of the art together with some estimates as to where the microwave semiconductor field might be heading.

Recently published

Logical Design of Switching Circuits, Douglas Lewin, American Elsevier Publishing Co., 368 pp., $10.50

This book uses an engineering approach rather than a mathematical one to cover such topics as switching algebra, sequential switching circuits, asynchronous circuits, and methods of automatic design. It is intended as a senior level text and includes many examples and problems.

60 dB Stop band rejection



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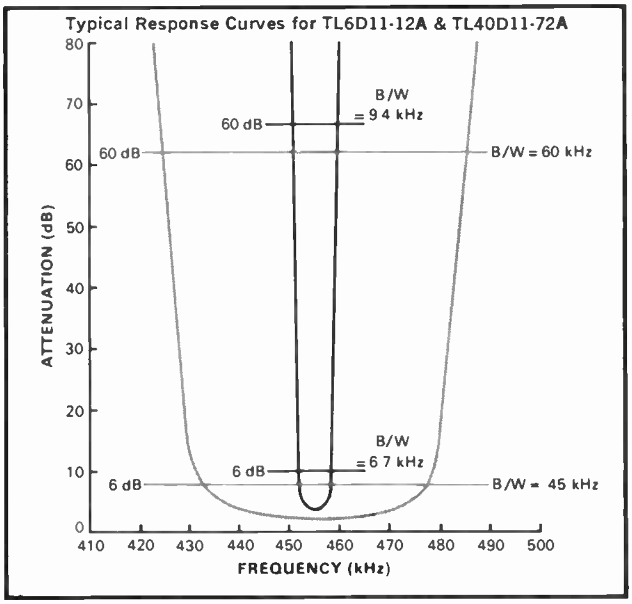

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TL20D11-38A	20 kHz	38 kHz
TL30D11-57A	30 kHz	57 kHz
TL40D11-72A	40 kHz	72 kHz

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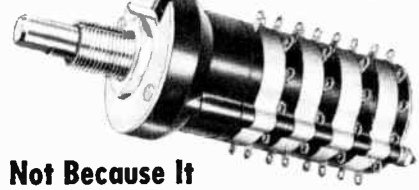

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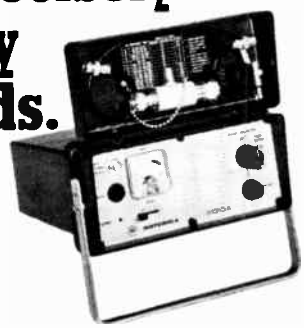

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At 4¼" high x 8" wide x 11½" deep, the unit weighs only 7 lbs. Get all the details in our Bulletin TIC 3455. Write to Motorola Communications and Electronics, Inc., Precision Instruments Products Dept., 4501 W. Augusta Blvd., Chicago, Illinois 60651.

MOTOROLA

Circle 216 on reader service card

Technical Abstracts

Five in one

A five-function IC for tv receivers
Thomas R. Mills
ITT Semiconductors
West Palm Beach, Fla.

Five circuit functions required in a television receiver—sync separator, vertical take off, horizontal oscillator, automatic frequency control, automatic phase control, and noise blanking are combined in a single monolithic chip. The integrated circuit not only does the job better than discrete circuitry, but it does so with about half the number of components. With standard fabrication techniques, 94 components are diffused onto the chip.

Besides the obvious space and power dissipation advantages inherent to all IC's, the circuit also eliminates the need for a feedback winding on the flyback transformer for both phase and horizontal control. Moreover, the oscillator requires no coils or transformers.

From the composite video signal at its input, the IC provides a correctly separated vertical sync pulse that controls the vertical oscillator, as well as a synchronized phase- and frequency-corrected horizontal pulse that controls the horizontal output driver stage. In addition to a sync noise-blanking stage, the circuit contains a switch that keeps the pull-in/hold-in range of the oscillator wide. Thus, there is no need of horizontal hold control.

An external RC circuit sends a modified sync pulse to the IC, which shapes and amplifies the pulse; its amplitude, in the range of 12 to 20 volts, is determined by an external resistor.

A transistor in series with the sync input stage makes up the noise-blanking circuit. The transistor is biased so that noise spikes above some predetermined amplitude will inhibit the sync circuit.

The horizontal oscillator, a RC-type, charges an external capacitor at a constant rate and in a predetermined time, and then discharges in half that time. The capacitor must be a 10-nanofarad, low-leakage device. Small variations in frequency and phase shift are handled by either a positive or a negative correcting voltage. This voltage, obtained from a phase detector-correction circuit, is added to the bias of the oscillator's current sources.

The pull-in/lock-in switch has a coincidence circuit that determines the synchronization of the oscillator's pulse with the horizontal sync pulse. When these pulses are out of synch, the on-off condition of the transistors in the IC is altered.

Presented at the IEEE Spring Conference on Broadcast and Television Receivers, Chicago, June 9-10.

On new terms

Use and management of the electrospace: a new concept of the radio resource
W.R. Hinchman
Institute for Telecommunication Sciences
Boulder, Colo.

A new word—electrospace—describes a way to alleviate spectrum congestion and effectively use the electromagnetic spectrum. The concept rejects the notion that the spectrum is "the radio resource," on the grounds that spectrum denotes only the dimension of frequency. The radio resource is really the electrospace, which has six dimensions: frequency, time, location, intensity, polarization, and direction of propagation. Each of these is an independent variable.

Communications channels could be vastly increased if the electrospace concept were applied to both transmission and reception, since each of the six dimensions can be varied within the state of the art. A radio receiver, for example, would distinguish between directed and nondirected radio signals by recognizing a particular combination of the six characteristics.

As it now stands, 80% of the frequency range up to 1 gigahertz is set aside for Government and television use. But a good percentage of this spectrum band is used in isolated locations and bears little benefit to, say, city dwellers.

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Presented at the International Communications Conference, Boulder, Colo., June 9-11

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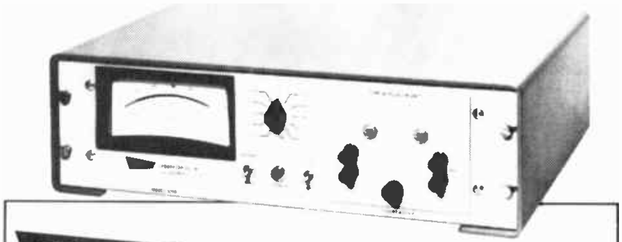

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New Literature

Deflection yokes. Syntronic Instruments Inc., 100 Industrial Rd., Addison, Ill. 60101. Technical details on four stator type high-Q deflection yokes are presented in two-page technical bulletin 69-2.
Circle **446** on reader service card.

Standard machine controller. Information Instruments Inc., 62 Enterprise Dr., Ann Arbor, Mich. 48106. A six-page brochure illustrates and describes the PDQII electronic machine and process controller, a solid state replacement for relay control panels. **[447]**

Magnetic tape recorder. Genisco Technology Corp., 18435 Susana Rd., Compton, Calif. 90221. Capabilities and applications of the model 10-110 magnetic tape recorder are described in a data sheet. **[448]**

Trimming potentiometers. Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634, offers a data sheet on the Helitrim series 66 trimming potentiometers. **[449]**

Recorder integrator. Disc Instruments Inc., 2701 S. Halladay St., Santa Ana, Calif. 92705. A four-page brochure on the series 300 integrator covers the unit's application as an integrating device with potentiometric strip chart recorders. **[450]**

Wire strippers. Eubanks Engineering Co., 225 W. Duarte Rd., Monrovia, Calif. 91016, has published a four-page quick-reference catalog of its line of automatic wire processing equipment. **[451]**

Crystal filters. Reeves-Hoffman Division, Dynamics Corp. of America, 400 W. North St., Carlisle, Pa. 17013. Two-page bulletin 930-B gives technical data and frequency-attenuation graphs for two high-fidelity crystal filters. **[452]**

Avalanche diode oscillators. OKI Electronics of America Inc., 500 S.E. 24th St., Fort Lauderdale, Fla. 33316. Low-noise, high-power avalanche diode oscillators are described in a two-page data sheet. **[453]**

Teflon bushings. Sealectro Corp., 225 Hoyt St., Mamaroneck, N.Y. 10543, has available a four-page catalog data sheet on Press-Fit Teflon bushings. **[454]**

Laser applications. Laser Nucleonics Inc., 123 Moody St., Waltham, Mass. 02154. A 16-page brochure contains more than 50 illustrations showing the innumerable applications of laser technology in action. **[455]**

Sensing devices. Pennsylvania Electronics Technology Inc., 1397 Frey Rd., Pittsburgh, Pa. 15235. Technical data 62-69 gives design parameters for ½ watt type 71T Positemp sensors. **[456]**

Directional couplers. PRD Electronics Inc., 1200 Prospect Ave., Westbury, N.Y. 11590, offers a data sheet describing microwave coaxial directional couplers. **[457]**

Pushbuttons. MicroSwitch, a division of Honeywell Inc., 11 W. Spring St., Freeport, Ill. 61032, has available a 16-page product sheet introducing a compact, oiltight line of pushbuttons. **[458]**

Active filters. Polyphase Instrument Co., E. Fourth St., Bridgeport, Pa. 19405. Bulletin AF2000 contains comprehensive computer-aided design information and performance curves on a broad new line of active filters. **[459]**

Data set. Sangamo Electric Co., P.O. Box 359, Springfield, Ill. 62705. A data set capable of operating over private lines or the DDD network is described in bulletin 5318. **[460]**

Microwave power measurements. PRD Electronics Inc., 1200 Prospect Ave., Westbury, N.Y. 11590, has published eight-page bulletin 880 describing microwave power measurements. **[461]**

Panel meters. Mura Corp., 355 Great Neck Rd., Great Neck, N.Y. 11021. A six-page illustrated catalog covers subminiature, miniature, and standard-sized panel meters. **[462]**

Television programer. Ampex Corp., 401 Broadway, Redwood City, Calif. 94063, has available bulletin V233 describing the RA-4000 random access television programer. **[463]**

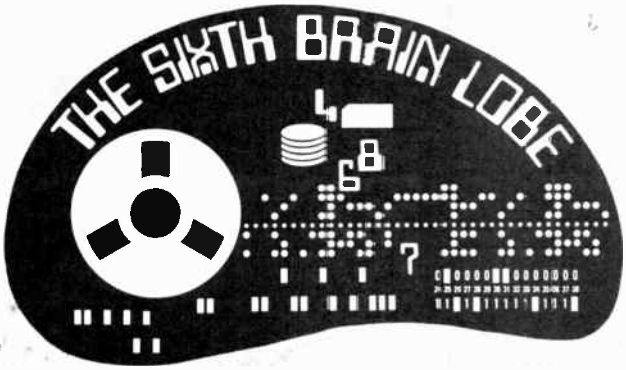
FET design ideas. Texas Instruments, Box 5012, Dallas, 75222. Twelve-page booklet CB-101 has been prepared for designers employing field-effect transistors in their circuits. **[464]**

Flexible fiber optics. The Bendix Corp., Galileo Park, Sturbridge, Mass. 01518, has released a two-page data sheet covering its line of flexible glass fiber optics. **[465]**

IC testing. Teradyne Inc., 183 Essex St., Boston, Mass. 02111. A 20-page brochure describes the J259 computer-operated IC test system. **[466]**

CCTV systems. Maryland Telecommunications, Division of KMS Industries Inc., 10534 York Rd., Cockeysville, Md. 21030. Catalog sheet SC-269-1 describes flexible, prepackaged Video Explorer CCTV systems. **[467]**

Electrical tapes. 3M Co., 3 M Center, St. Paul, Minn. 55101, has available a Scotch brand electrical tape data and sample chart. **[468]**



It is said that Leonardo Da Vinci had a special little bump on his head — a "sixth brain lobe" which permitted him to make extraordinary logical leaps into future technological ages. Thus he invented such things as a machine to wind bobbin thread evenly, centuries before the sewing machine was invented. And versions of airplanes, helicopters, the parachute, etc.

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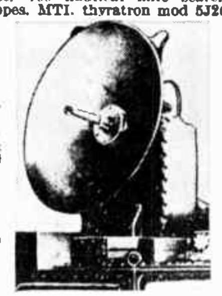

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International Newsletter

July 7, 1969

East-West trade barriers to be lifted—a little

The Commerce Dept. is quietly preparing to relax its controls over exports to Eastern European communist countries—making it easier for U.S. companies to export a range of electronic equipment, including some computers.

The Office of Export Control will soon:

- Remove a substantial batch of products from the list requiring individual export licenses for shipment to Eastern European countries and the Soviet Union.
- Relax license-granting criteria for another group of products.
- Drop other items from the lists of products requiring a license for shipment to non-communist countries, a rule that aimed at preventing trans-shipment to communist countries.
- Ease criteria for granting such licenses.
- Try to streamline its often-criticized administrative procedures to reduce the time required for processing of license applications.

Export controls are periodically reviewed so in that sense the current review can be considered routine. But this time the Export Control Office is making a special effort to ease controls on products for which the number and value of license applications indicate that there is a significant trade potential. The list of items decontrolled by the Johnson Administration in 1966 was criticized by businessmen who said it contained many items of negligible trade interest.

Details of the projected liberalization of the export control lists are being closely held. But indications are that companies producing data processing equipment, nuclear radiation testing devices and other electronic measuring equipment will benefit. It still will be necessary to obtain licenses for exports of computers, but these should be somewhat easier to get for small machines. Exports of larger data processing equipment almost certainly will continue to be banned because of its potential military uses.

Common Market eyes all-Europe computer project

The project for an advanced European computer has been pushed forward a step with a working committee request for marketing and feasibility studies. Now, it's up to the European Economic Community's Council of Ministers to okay the studies, which would cover possible contributions by countries outside the Common Market—Great Britain, in particular. Committee members and representatives of the major European electronics firms—Philips, Siemens, AEG-Telefunken, CII, Olivetti and Britain's ICL—have been discussing the project for several months. The committee also proposed that the EEC consider setting up a European Institute of Computer Science. However, recommendations on the committee's second current headache—streamlining of the European components industry—have had to be delayed, probably until October.

SGS to invade old partner's territory—the U.S. market

Watch for a move into the United States market late this year or early next by SGS, the Italian semiconductor company that broke off with Fairchild Semiconductor last fall.

The company, now wholly owned by the Italian office equipment giant Olivetti [*Electronics*, May 26, p. 181], has started to scout for an American partner for its venture. But if they have to go it alone, SGS officials say they will. SGS hopes to nail down a one percent share of the American semiconductor market.

At the outset, SGS will offer a product line of discrete devices and integrated circuits developed jointly with Fairchild. But the company will follow up fast with IC's of its own. It's now producing a line of four packages for color television sets and has another five almost ready to go. Eventually, SGS will have an entertainment IC line of 14 or 15 types. Company officials also hope to add the line of high-noise-immunity logic circuits SGS has developed for industrial controls.

To supply the U.S. market, SGS will rely mainly on the 3,000-worker plant it is readying in Singapore. The company's five European plants have booming regional markets. SGS executives see no end to the current shortage of components in Europe, predict they will continue in short supply until mid 1970 at the earliest.

Paris may offer a helping hand to software industry

France's late-starting software industry, courted by a string of U.S. suitors, may be taken under the government's wing. Government planners are working hard on a Plan Software that would complement the Plan Calcul computer development program—and keep the Americans at bay.

Details have not been worked out yet, but watch for government agencies to start farming out software development instead of doing the work themselves. The French credit the U.S. software lead to fat government contracts. Plan Calcul officials argue that a similar move would strengthen France's software industry both technically and financially, and would thus hasten the nation's computer revolution. Mergers among the two dozen or so software firms might result and closer cooperation would be a distinct possibility.

Although technical cooperation deals with U.S. firms would more than likely be encouraged, Plan Software would seek to bar takeovers by U.S. firms by giving the French firms new muscle.

The plan is to be ready for top level consideration by the end of this year. Robert Lattes, vice president of France's biggest software firm, the Sema-Metra group, says his company hasn't been approached yet on the idea. "But it sounds great," he admits.

Japan's calculators selling worldwide under other's labels

For the Japanese, the desk-top calculator has become as hot an export item as the transistor radio. Japanese firms are rapidly lining up private brand customers around the world to add to the sales they are already racking up around the world under their own brand names. The aim: shaving production costs through high volume.

In the latest deal, Canon Inc. will manufacture calculators for Litton Industries' Monroe division under a U.S. label. Deliveries in the first year alone will total 30,000 machines. Canon puts the value of the contract at about $10 million.

Other Japanese firms have pinned down similar contracts. Matsushita Communications Industrial Ltd. is supplying West Germany's Olympia [*Electronics* June 9, p. 201]. Hayakawa reportedly is supplying Facit in Sweden, Burroughs in the U.S. and Addo in Switzerland; Hitachi dealing with Friden, Omoron Tateishi with SCM, and Casio with Canada's Commodore.

Computer polices airport noise

West German system blows the whistle when landing and takeoff noise levels in residential areas near Stuttgart airport exceed acceptable values

Until something can be done about reducing the noise made by jet aircraft, there's a good business in just measuring the din. In West Germany, in fact, the government is seriously considering requiring that all big civil airports install noise level measuring and monitoring equipment. With other European governments on the same tack, a market may be opening for automatic noise monitors.

One company that is eagerly eyeing that market is Hewlett-Packard GmbH, the West German subsidiary of the American company. With only some hardware help from the parent company, engineers of the German concern have developed a computer-run noise monitoring system that has already been tapped for installation at Stuttgart's Echterdingen Airport. And, complete with seven stationary noise pick-up stations, one mobile station and an H-P computer, the system cost only about $90,000.

The system has passed its initial tests at Stuttgart and representatives of a number of other airports, in Germany, Europe, the United States, and Russia have shown interest, as have jet engine makers.

Checking the db. The heart of the Echterdingen installation is a digital computer installed in a noise evaluation center at the airport. Using the inputs from various stationary noise level pickup stations located in residential areas near the airport, the computer continuously compares airport-produced noise against levels prescribed for each station. If the acceptable levels are exceeded, both the amount and duration of excess noise in decibels, together with the date and time is printed out.

Thus, a record is produced telling authorities that a pilot has deviated from the proper approach or takeoff course and has flown too close to or too low over residential areas. The only manual function an operator has to perform is jotting down the plane's flight number.

The seven stationary noise pickup stations are located in residential areas that lie parallel to the approach and takeoff paths of the airport. The key component at each station is a condenser microphone perched on top of a cabinet that houses electronic measuring devices, a power supply, and other equipment. The microphone itself is installed in a heated and wind and weather-proof cape-like housing. To enhance reliability the equipment is automatically calibrated several times a day.

The mobile noise measuring equipment is used to take sample noise measurements at any point in the airport's vicinity. Results are either tape-recorded for later evaluation by the computer or are sent over telephone lines for immediate evaluation.

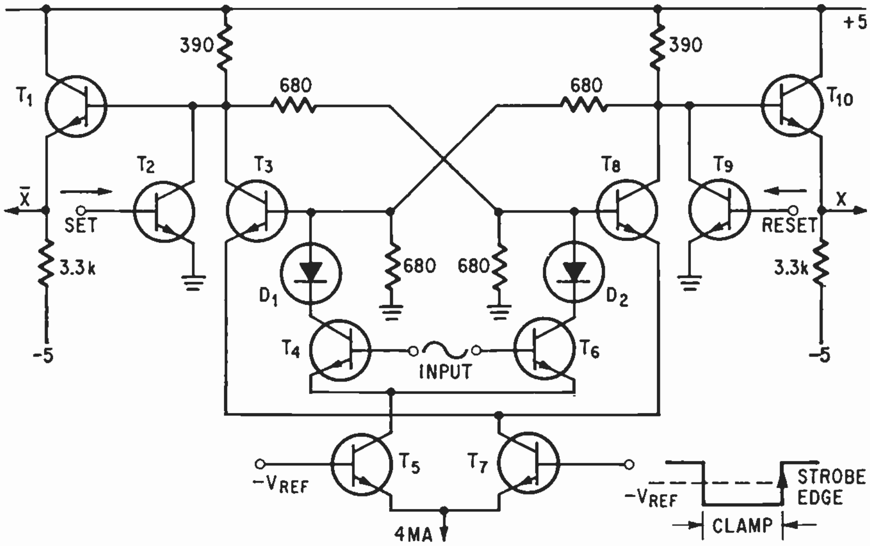
Frequency coding. Noise or sound pressure, picked up by the microphone is converted into a voltage. The db level is then determined by a pair of parallel-connected pulse-type sound level meters which measure noise levels from zero to 50 db, with a linearity of better than ±0.5 db. The dc output voltages are converted into signals whose frequency is proportional to the metered voltages. Signal frequencies vary between 900 and 3,400 hertz. In this 2,500 hz range, a frequency variation of 50 hz corresponds to a 1-db change in noise level. These "frequency-coded" noise level signals are then sent along regular phone lines to

Monitoring noise. At Stuttgart's civil airport, this automatic system samples aircraft noise, prints out details every time pre-set levels are exceeded. Teletype is used to alert authorities to high noise events.

the noise evaluation center. The H-P designers chose frequencies rather than, say, voltages, for coding to minimize distortion that might occur along the phone line.

At the noise evaluation center, a scanning and switching unit scans each outside station several times a second. This unit's scanning rate is controlled by the computer, which also alternately feeds noise level signals to a converter which produces a digital output for subsequent computer processing.

The computer, an H-P 2114 A has a basic storage capacity of 4,000 words with 16 bits each and a cycle time of one microsecond. The computer can be programmed by punched tape to accommodate any of the various noise criteria that different airport authorities or institutes already have or will establish in the future.



Stable bistable. Using carefully matched transistors pairs, British circuit design is adaptable to mass production, avoids temperature imbalance.

Great Britain

Theory and fact

So often in electronics, a theory is elegantly simple, but the development frustratingly complex. Thin film and plated wire memories offer a prime example. They store ones and zeros by opposite polarities, which holds out the tantilizing possibility of using a switched bistable circuit as a combined amplifier, discriminator, and register. The ordinary ferrite store, on the other hand, has a readout signal of large amplitude for ones, and small amplitude for zeros. That means that before the output can be used to set a register, it has to be separately amplified and discriminated.

In theory, a switched bistable circuit can do all that at once. All it takes is a regenerative circuit consisting of two cross-coupled transistors. The circuit is held in an unstable state, with both transistors on or both transistors off, and is released to find one of the two stable states—either transistor on with the other off—at the same time as the signal arrives from the store. If all circuit parameters are in balance and random noise is low, the slight artificial imbalance provided by the signal, amplified by the inherent high loop gain during the transition phase immediately after release, will determine which of the two states the bistable chooses.

But it turns out to be another matter to actually get the idea to work—let alone get it into production. For one thing, it's difficult to reduce differential temperature effects below the level where they affect device reliability by unbalancing circuit parameters. For instance, in the computer store application, a sequence of repeated ones means that one transistor is on for a relatively long time while the other is off, and the heat differential generated may alter the transistor characteristics enough to render the device unable to discriminate the small signal inputs, probably about two millivolts.

For another thing, the obvious method of operation is to clamp the circuit unstable by disconnecting the power line, apply the input signal to unbalance the cross-coupled network, and reconnect the power. At this point, the circuit goes straight into stability according to the direction of unbalance. However, power switching is not easily compatible with speed, and high speed is always incompatible with the decoupling necessary to prevent crosstalk.

Solution. Now it looks as if Roy Berry of Britain's Royal Radar Establishment has found the answer. Berry believes that monolithic integrated circuitry and careful matching of transistors will reduce temperature differentials to unimportant levels, and that power switching can be replaced by switching the tail current, at half volt or so, in a long-tailed transistor pair.

Market. And because plated wire and thin film computer stores should soon be in use on a large scale, Berry foresees a market large enough to justify a monolithic IC bistable. He reported on his work at a computer technology conference at Manchester University last week.

Berry has devised a circuit he considers basically satisfactory and has constructed a hybrid model, using commercially available dual transistor pairs, two transistors diffused into the same chip. This experimental circuit has an offset of approximately one millivolt which Berry has cancelled out with an external balancing resistor so that he can check the ultimate sensitivity of the circuit.

Berry believes that production monolithic circuits could be made economically with about the same offset but without the need for external balancing since plated wire and thin film signals are typically in excess of two mv so that circuit offset would not affect bistable decision. Berry found that the experimental circuit could detect 10 nanosecond pulses of ±0.5 mv, when a 60 nsec clamping period was used to enable the circuit to forget its previous state before being asked to make a decision about the next. With common mode noise of 0.5 volts present, which Berry says would most likely correspond to a realistic situation, 20 nsec pulses at ±1 mv could be detected with 60 nsec clamping period, equivalent to sensing at 10 megahertz repetition rate.

Tailing. In Berry's circuit (see diagram), the cross-coupled transistor (T_3 and T_8) are a long-tailed pair. The tail current is fed through transistors T_4 and T_5 to clamp the circuit in the unstable state, when T_3 and T_8 are non-conducting. When the input signal appears between the bases of transistors T_4 and T_6, it is amplified using this current and applied as a differential bias signal to the bases of the bistable transistors. At the instant of release from clamping, which is arranged to coincide with the peak of the input signal, the tail current is switched by transistors T_5 and T_7 to the bistable. The high regenerative loop gain of the bistable quickly grasps the input signal and switches the bistable according to input polarity.

In the hybrid experimental circuit, matched dual transistors are used for the bistable pair, the input pair, the switching pair, the output emitter follower pair (T_1 and T_{10}) and a pair of isolating diodes included to insulate the bistable from write-in digit disturb noise.

France

Cartel blanche

Imagine an RCA and a General Electric deciding to divide up their markets, one company to get all the electronics business, the other to get all the higher power business. In the United States, anyway, the first result of such an agreement would be angry howls from government trustbusters. But in France, the government, eager to strengthen the country's industrial base, is solidly behind just such a move being made by the two big French electrical/electronics companies. The Thomson-Brandt group, already France's major electronics firm, will increase its dominance in this field. Compagnie Générale d'Electricité (CGE) will become undisputed leader in its specialty, heavy electrical equipment. Both will continue making radio and tv sets and other consumer products, but they'll cooperate in marketing.

Give and take. A key provision of the agreement is that Thomson-Brandt, through its Thomson-CSF subsidiary, will take over management of the state-subsized computer company, Compagnie Internationale pour l'Informatique (CII). Thomson-CSF and CGE each own one-third of CII, while the big steel and heavy equipment maker, Schneider S.A. holds slightly less than a third—a situation which has made for "collegial management, with too many long discussions of detail taking place at the top level," says Edouard Guigonis, commercial director of Thomson-CSF.

In exchange, Thomson-Brandt is giving CGE similar management control over Societe Alsthom, a firm with whom CGE jointly owns its heavy electrical equipment subsidiaries but in which Thomson-Brandt is the major shareholder with 23%. CGE will now integrate the subsidiaries into Alsthom and then take 40% of Alsthom's stock.

CGE will turn over some of its radio equipment business to Thomson-Brandt, and the two companies plan to form a joint subsidiary to build telephone data processing equipment. Other cooperative accords may come later.

Laying cable to rest

France has laid its last long-distance telephone cable. It's not that the French are throwing up their hands in despair over their severely overtaxed phone system. They're going to build microwave relays—lots of them—in an effort to come to grips with what has become a very hot political potato. In fact, France's new president George Pompidou and all the other presidential candidates promised during the campaign to solve the telephone mess.

The state-run telephone system —the PTT—admits most of its trunk lines have an "efficiency rate" of 40% or less, meaning an average call must be placed three times before it finds a clear circuit.

The PTT blames lack of funds, and that's where the microwave relays come in. The cost of such links in France has dropped by half over the past decade, estimates Yves Fargette, microwave chief of the PTT. For new installations, microwave is now cheaper than coaxial cables. And since total transistorization became the rule in France a year or so ago, upkeep costs have fallen, too.

Modernizing. All this means microwave will give the PTT more circuits for its money and the PTT is launching an ambitious construction program that will quadruple its microwave system over the next two and a half years.

Microwaves now account for 2.7 million kilometer-circuits, only 15% of the total phone system. By the end of 1971 microwaves will total 10.7 million kilometer-circuits, or 30% of the whole. Cable circuits will be doubled by adding new modulation equipment to take advantage of existing cable capacity.

Most of the new microwave systems will be built between provincial cities, where traffic jams are the worst because of past concentration on hookups to Paris.

The cost. This new microwave construction will mean a bonanza for electronics companies of some $13 million next year and a still greater amount in 1971. This year's microwave expenditures will total around $7.6 million.

PTT's contract award system is in for a modernizing, too. To streamline red-tape and cut costs further, the PTT plans to abandon its present policy of negotiating contracts whenever a microwave system is to be built, which necessitates 20 or 30 contract sessions a year. Instead, it will award contracts at the beginning of each year for all the work to be done that year. The PTT thinks this will help suppliers plan longer production runs and reduce costs. The PTT will also try awarding "turnkey" contracts that will give one firm responsibility for entire systems, from electronics to power supply to building construction.

Australia

Fare Enough

From Times Square to the Ginza, the lot of the taxi rider is not a happy one. Besides traffic jams, there's the din of two-way radios crashing out messages. Even the squelching jangles. Then there's the problem of reading the fare, which is often indicated in tiny numbers. And when rates change, the numbers on the meter may just kick off a search through printed sheets showing the new charges, leaving the rider feeling he's the victim of some con game.

In Sydney, however, the harried traveler is due for a couple of electronic assists. One is an electronic taximeter. The other is a selective two-way radio system. The two work together part of the time.

The electronic taximeter, a development of Standard Telephones and Cables Australia Ltd., has a wired-in memory containing the fare structure. Every time the speedometer cable revolves, a sensor sends an impulse to the taximeter; here the impulses are counted and compared with fare-structure information. The computed fare is continuously displayed using large cold-cathode readout tubes, a boon for the late night cab rider.

Taxiing. Fast changes in fare rates, easy reading featured in new taximeter.

Modular. The taximeter plugs into a cab's dashboard rather like a portable car radio. When fare changes are made the meter can be removed to adjust the memory wiring—a job that takes an hour at most. And that's an important consideration in Australia where the cab fares, fixed by government authority, change frequently due to changes in driver wage scales, the price of gasoline, and maintenance costs. With mechanical meters, the whole taxi is down.

Through a connection with the cab's two way radio, the meter can also be directed by the taxi radio room to add a surcharge for relaying a customer's address to the driver. In Sydney, there's a 15 cent fee for calling a cab by phone. Selective commanding is made possible by a new communications system between base stations and cab fleet that turns on the receiver output only in the particular car called. Developed by the Plessey Pacific Control Research Laboratory in Melbourne, the system uses silicon IC's to decode a taxi's call number and turn on the output when the right call number is sent.

Japan

New from old

A Japanese company, competing for an automatic train control job, has pulled some new tricks from a bag of old technologies. What has emerged is an induction radio system using a novel transmission line and antenna loop couplers. The system holds down induced noises and unwanted radiation in the transmission line and antenna loops, beating by a noise-suppression factor of 40 decibels the conventional system of parallel lines coupled with single-loop antenna.

Designed for the bustling Japanese National Railway, the communication system features a transmission line with conductor sandwiched helically between two polyethylene cylinders for protection against rain and snow. The line is laid out beside the tracks to move control signals between train station, wayside station, and train.

Confident. Under development by Sumitomo Electric Industries of Osaka, the network is one of three competing systems contracted by the Japanese National Railways for automatic train control. The first uses a leaky coaxial cable; the second, a leaky waveguide. The radio induction system is the cheapest of the three. Sumitomo engineers modestly estimate that their system, nearing test completion, has more than a 50% chance of being selected by the government for production.

Copper tape was chosen for the conductor in the line (which operates from 50 kilohertz to over 1 megahertz) because its width is easily altered to change the characteristic impedance. Reduction of the impedance is the key to minimizing coupling loss between train station and wayside stations strung along the tracks.

Pairs of tapes are twisted helically around the polyethylene core at constant pitch. At the transmitting and receiving points, the antenna loops are a fraction of pitch apart. For example, in Sumitomo's quadruplet line (two pairs of tapes), the loops are set a half pitch apart; they are connected so that their coupled signals are superposed. A signal to or from the transmission line goes through a phase shifter in which a signal in a conductor pair is phase-shifted.

Even. In this way, phase and amplitude of noise are uniformly distributed over several pitches along the line. Therefore, noises inducted at two points on the line at a distance of a half pitch have a phase difference of pi and cancel each other. The unwanted radiation from a line is also suppressed since the radiation from a half-pitch section gets canceled by that from the adjacent half-pitch section.

Signals transmitted to the line from the antenna will not radiate into space—since the loops are arranged at intervals of odd multiples of a half twist pitch and are inversely connected.

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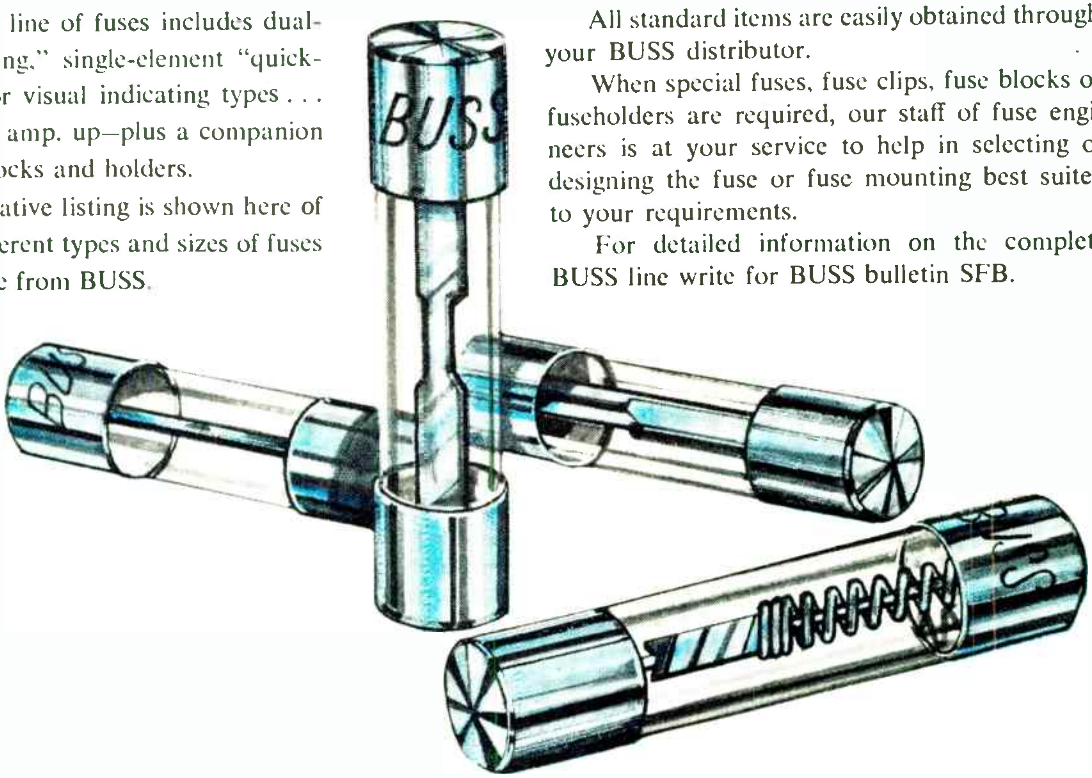

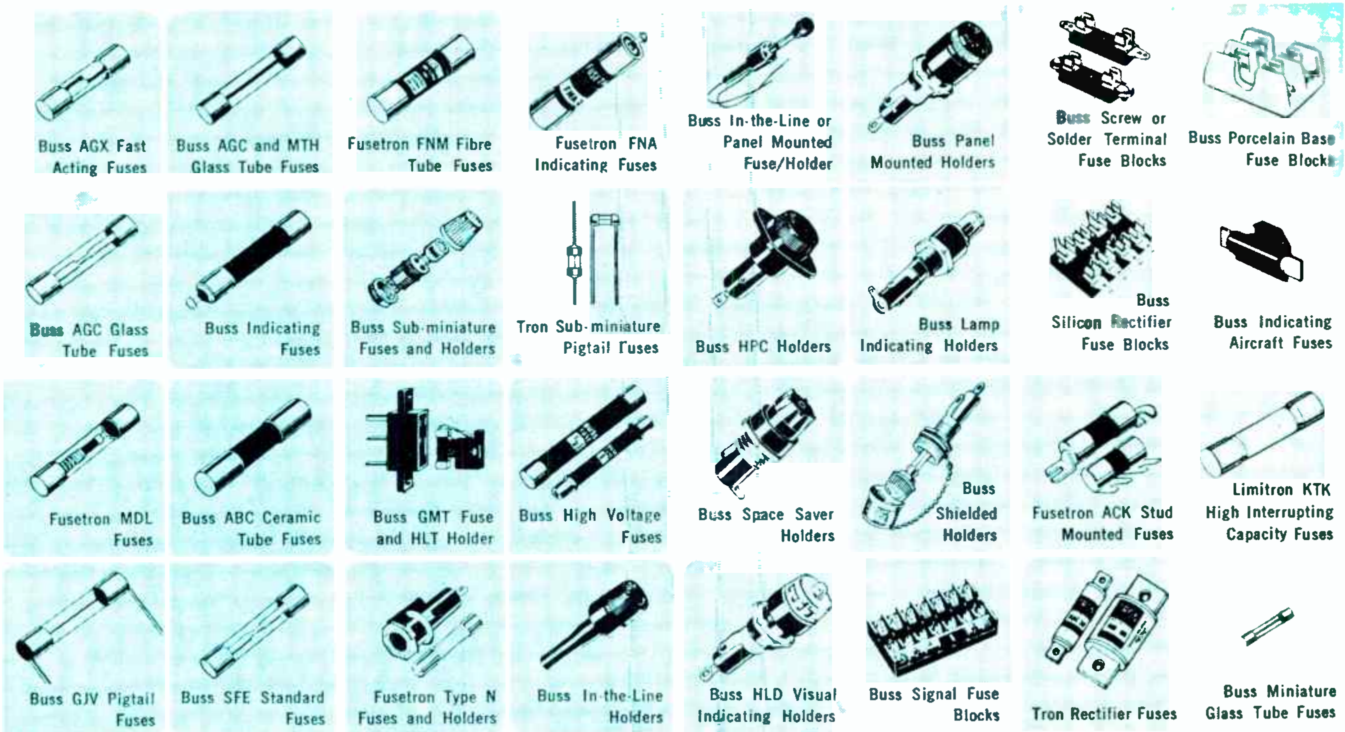

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