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1972 annual U.S. electronics markets forecast 77

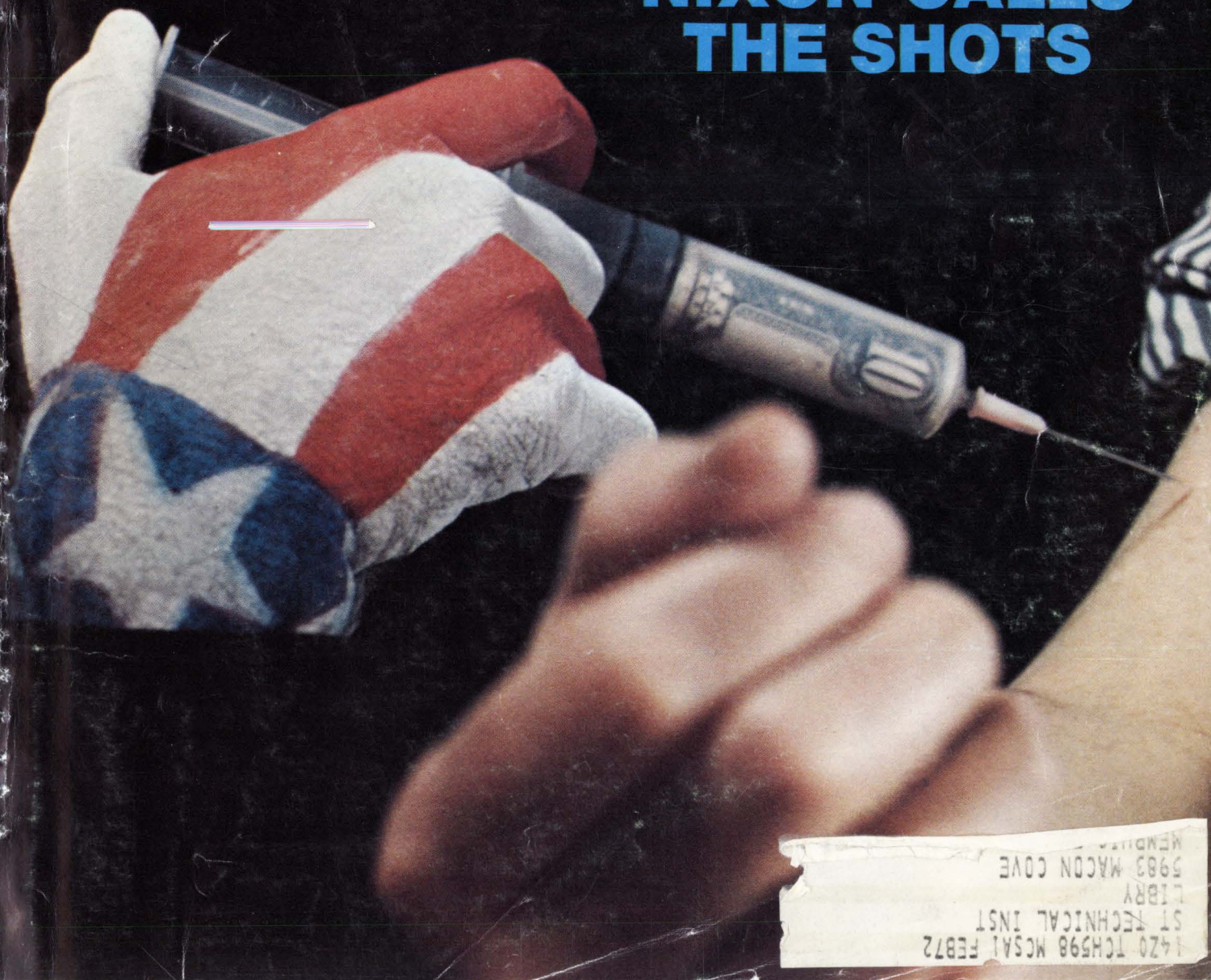
A new self-aligning MOS process 89

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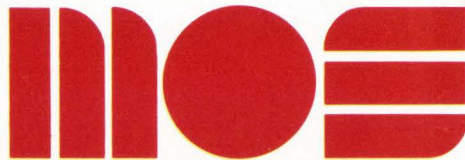
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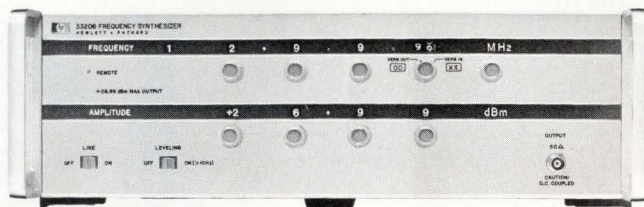
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Publisher's letter

The third and last of our yearly special reports on the major electronics markets of the world is also the most extensive, covering as it does the entire U. S. market (see page 53). This year we've stuffed more data than ever before into 24 pages of text and four pages of tables.

For example, the tables that start on page 77 have final figures for 1970, estimates for 1971, and forecasts for both 1972 and 1975. We've included 1970's results both to help you compare subsequent developments and because we've made additions and changes in many of the categories.

This year, for the first time, we handled the gathering of the numbers the same way we go after a news story. Instead of relying only on questionnaires sent to the knowledgeable men in all segments of the electronics industries, we sent our entire editorial staff out into action.

From both personal interviews and telephone calls, the best estimates of between 500 and 600 top leaders were gathered by *Electronics* staffers in New York and around the country. These inputs were analyzed and, if unreasonable discrepancies turned up, rechecked company-by-company.

And, of course, our reporters and editors used the personal contacts advantageously, gathering some of the details for the main report at the same time.

And our new approach to putting our market report together led to an interesting qualitative improvement. We mentioned earlier that some of the categories were revised. Every year we do change a few of the labels on the tables as the indus-

try segments themselves change. This year, though, because of our direct contact with industry leaders, we had direct feedback on which categories were becoming obsolete, which were growing so fast that they should be broken out as separate entries. And all that feedback came in while there was still time to react, time to get back and get the correct questions answered.

We want to extend a very hearty "thank you" to all of you who contributed your time and knowledge to our survey. Your participation has made this year's market report the most authoritative ever.

To your left is our masthead. We would like to call particular attention to the entry "Managing Editors" and to the name "Robert Henkel" because this issue is the last to list his name. Bob is leaving *Electronics* after nearly five years as managing editor to join Business Week as technology editor. His strong news sense and determination to put out the best possible news section issue after issue will be hard to beat.

But if any one can do that it's Larry Curran. Once assistant managing editor on Technology Week magazine, Larry has been in charge of our Los Angeles coverage since 1967, and as the New Year rolls around Larry will move in from the West Coast to take over as managing editor, news.



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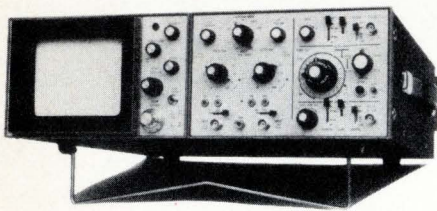
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Readers comment

Information GaP

To the Editor: The comparison between GaP and GaAsP devices is difficult to make, especially as the easier technology of GaAsP has meant the earlier arrival of its products in the market place. However, George Smith uses some distinctly outdated data on GaP in his article in your October 25th issue, and this leads to some doubtful conclusions about the prospects for GaP. Some of the important facts are:

- GaP crystal diameters are not limited to ½ inch. Substrates up to 1 in. in diameter are now being sold, by my own company among others.

- Red-emitting GaP diodes with efficiencies up to 3% are sold by several firms, again including my own. These emit up to four times more light than the best available GaAsP diodes, at drive currents of 10–20 milliamperes, and the comparison is still more favorable for GaP at 1–2-mA drive levels.

- Mr. Smith makes the reflector technique sound a disadvantage. Yet it can save in semiconductor costs and in the number of bonds needed to make an array.

- The present advantages of GaAsP are the somewhat lower material costs, the higher brightnesses available for special applications, and the ability to make monolithic diffused arrays. However, there is no doubt that GaP will be challenging in all these areas.

P.B. Hart

The Plessey Co. Ltd.

Caswell Towcester, Northants.,

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■ *Mr. Smith replies: 15 mm is the average diameter of GaP slices, only a few of which attain 25-mm diameters—and these cost \$144 per square inch. Moreover, they seem not to be available in production quantities. In contrast, GaAsP slices are typically 1½ to 2 in.², and—as Mr. Hart says—cost less, at \$20/in.² The reflector technique admittedly reduces costs, but at the sacrifice of luminance and off-axis performance. Finally, GaAsP chips are as likely to improve as are GaP chips.*

To the Editor: A recent article by George E. Smith on light-emitting

diodes [*Electronics*, Oct. 25, 1971] contains a statement that gallium phosphide wafers are only about ½ in. in diameter and are not commercially available. This statement is completely incorrect, since we at Metals Research have been supplying 1-in. wafers for the last 18 months on a world basis and can now supply up to 1½-in. wafers.

A. J. Fletcher

Metals Research Ltd.

Melbourn Royston, Herts., England

Bucket brigade vs CCD

To the Editor: In a recent report on a bucket brigade self-scanned area imager under development at RCA [*Electronics*, Nov. 8, 1971, p. 32], the statement is made that the bucket brigade has "the salient advantage of not experiencing the charge transfer loss at high scanning rates that's one problem with charge-coupled devices."

Not only is this statement untrue (the voltage dependence of the transconductance of the MOS transistor gives rise to the same charge transfer behavior for both), but additional blurring effects can occur in the bucket brigade due to variations in clock pulse amplitude that do not occur in the CCD system.

The report is also misleading in its discussion of the merits of charge transfer readout as compared to X-Y addressing. Apparently this comparison was made in the context of a specific X-Y addressed photodiode imager. The conclusions, however, are framed as general problems of X-Y addressed systems, and in this context they are not correct.

Jerome J. Tiemann

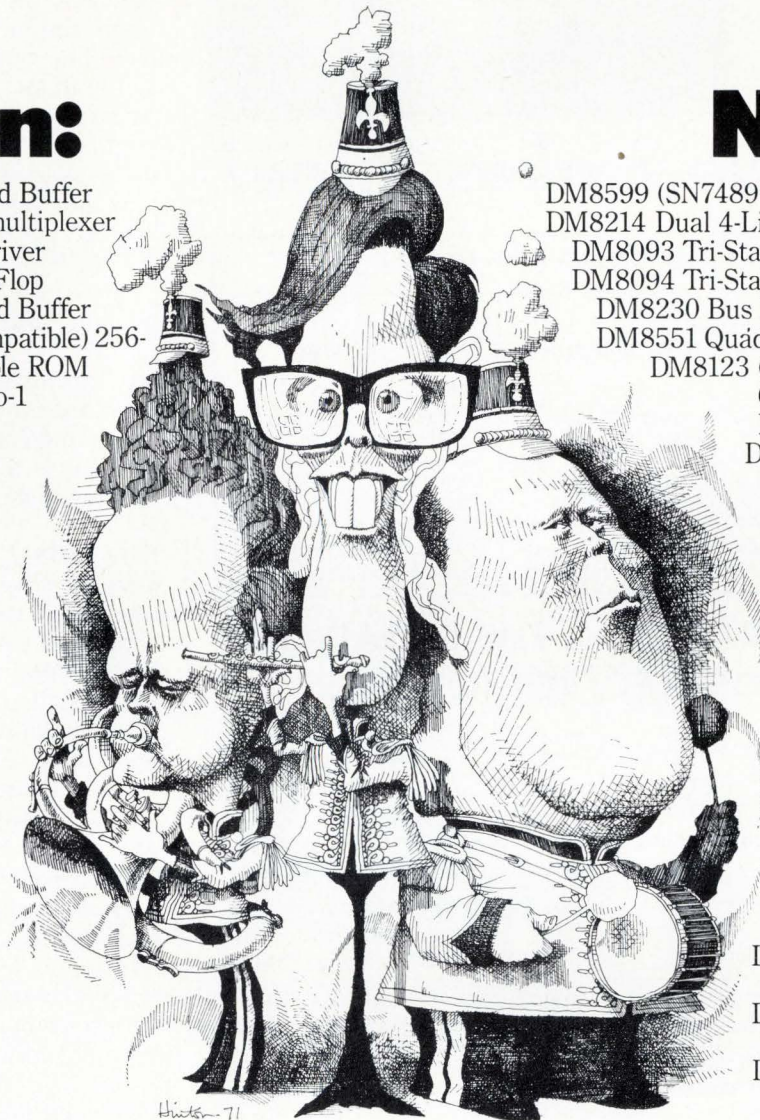
General Electric Co., R&D Center
Schenectady, N.Y.

■ *Early versions of CCDs showed some charge transfer efficiency problems at high transfer rates, leading some observers to wonder if these devices would be suitable for memories. But recent advances have assured researchers that rates as high as 20 MHz to 1 GHz will be attainable. The X-Y addressing referred to in the report alluded to that used in today's vidicons—a prime replacement target for much surface charge transport development effort.*

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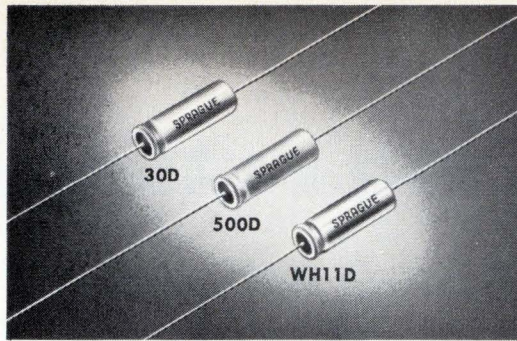
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Good operating life characteristics, including stability, ESR, leakage current. Will withstand 1000 hr. life test at 85°C. Ideal for radio, TV, and other entertainment applications. Write for Engineering Bulletin 3149 or;

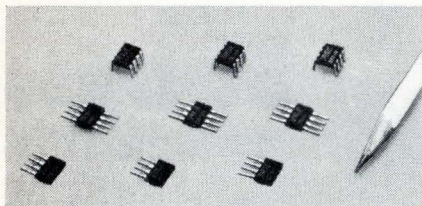
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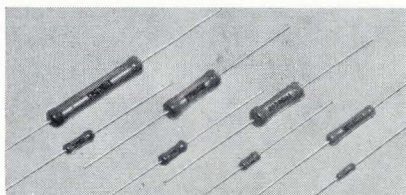
U.L. LISTED FILTERS. Series JX5000 for EDP equipment and general-purpose use. Rated 125/250 VAC, 0-60 Hz, 1 thru 50 amps. 60 db @ 150 kHz, 80 db from .5 MHz thru 1 GHz. Special designs and rectangular multi-circuit units also available. Write for Engineering Bulletin 8210 or;

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TECHNICAL LITERATURE SERVICE, SPRAGUE ELECTRIC CO., 35 MARSHALL ST., NORTH ADAMS, MASS. 01247

49-1117

40 years ago

From the pages of *Electronics*, January 1932

The editors of *Electronics* have sketched the picture of the electronic and radio arts as they exist today. The outlook we find encouraging. In fact, if an accountant were to summarize the situation, he might, somewhat as follows, draw up "the electronic balance sheet."

Liabilities: Radio overproduction, engineering unemployment, financing delays, idle factory capacity.

Assets: New inventions, lower manufacturing costs, new tube uses for 200,000 plants; a million places for "electric eyes," increasing public-address demand, a 300,000-car auto-radio market, and new opportunities for radio, home-talkies, television, etc. in 19,000,000 homes.

Early in 1932, television signals on a 4-meter wavelength will be broadcast over the densely populated New York City area from the tip of the airship mooring mast of the world's tallest structure, the Empire State Building. It is expected to serve only an area within 15 to 25 miles of the tower, as the waves are limited to visible distances, but even so, a ready-made audience of ten millions will be reached.

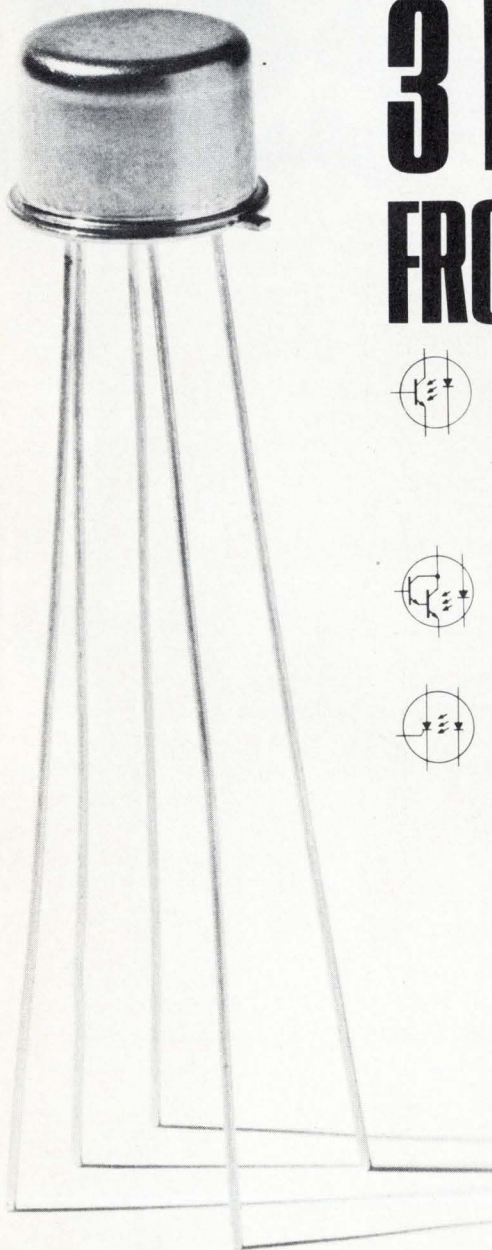
Great secrecy has been maintained concerning the new television transmitter, but it is understood that the 2.5 kw television unit will be of the arc-scanning type, covering 120 lines and 24 frames per second.

Television does anything but stand still. Interest centers around what is happening in the Empire State Building in New York, in the RCA-Victor laboratories in Camden, in the Philco Laboratories in Chicago where Majestic engineers are reported to be burning midnight oil, and in California where deForest is said to have a new system.

Dealers or radio manufacturers who look to television to pull them out of the red in 1932 had better look elsewhere for their profits, according to those close to what is actually going on. The Federal Radio Commission, admitting that progress has been made in 1931, does not seem inclined to open the television bands.

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We're the second one. And we have lots of all the numbers listed here in stock at Hamilton/Avnet.

We make most of their linears except three. (We even make the regulator named LM105.) And, of course, they make everything we make. But, what the hell, we're paying for this ad.

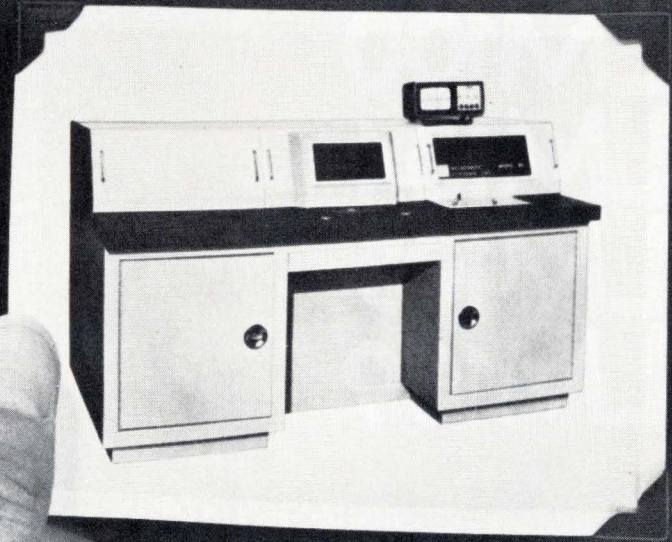
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LM108A
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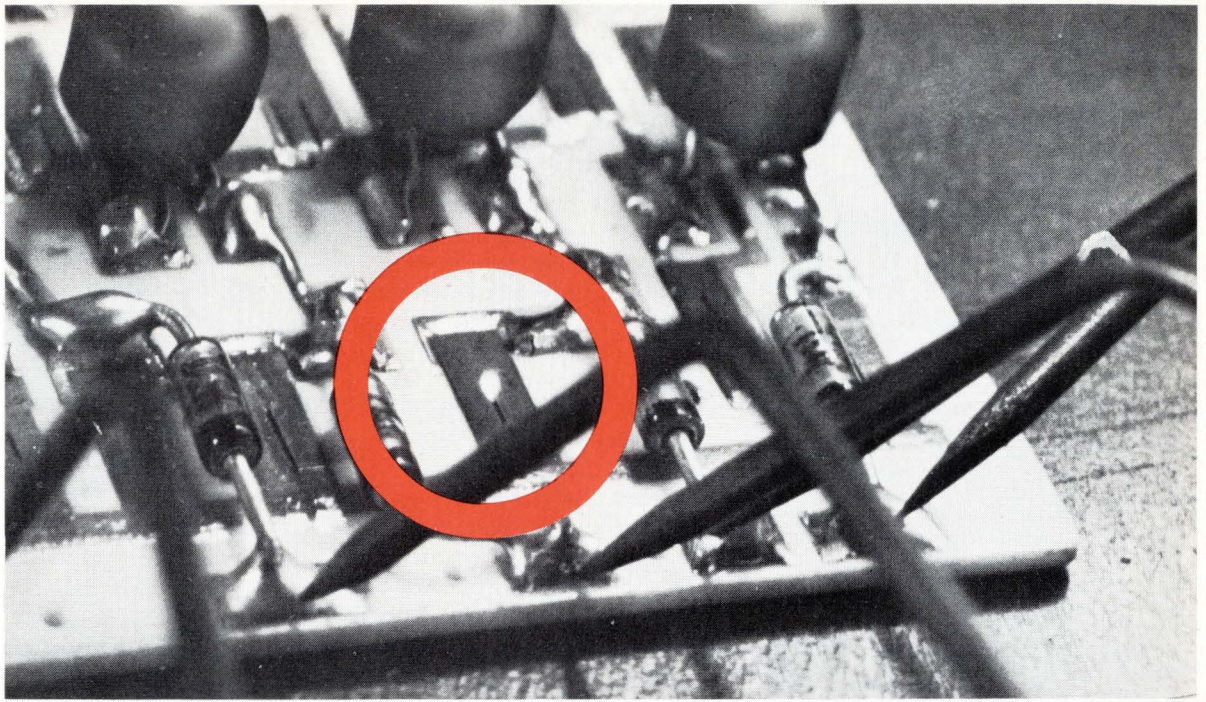
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Total systems capability from General Radio



Functional Laser Trim

Resistance Trimming is only the beginning... complete functional trimming is now a reality

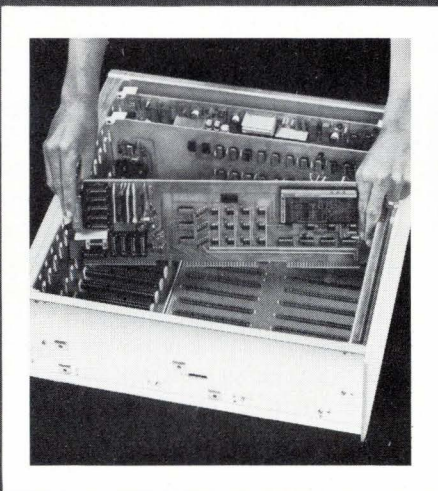
Resistance trimming at speeds to 10,000 trims per hour and accuracies to $\pm 0.1\%$ is only the beginning with Micronetic's new Model 80 Laser Trim System. Now you can select the specific functional trimming capabilities you need to trim your fully assembled hybrid circuits.

Functional trimming is fast and economical

Trimming assembled hybrid circuits to a functional specification can compensate for active device variations through the adjustment of only a few resistors. Throughput increases, yield improves, and the need for a separate final test operation is eliminated. In addition, because the Model 80 can functionally trim to compensate for wide fluctuations in active device parameters, specifications on these active devices can be relaxed for substantial added cost savings.

General Radio instrumentation makes it possible

Micronetic Systems has joined forces with General Radio Company to provide a complete functional



trimming system. The Model 80 measurement system is built by General Radio in modular plug-in form. The basic module is the Resistance Measurement Unit, standard on the Model 80. Separate plug-in modules to measure ac and dc voltage and current, frequency, and capacitance are available as options to provide complete functional trimming capabilities.

Functional software included

Micronetic's exclusive Resistor Trimming Language (RTL) software package allows complete flexibility by controlling all parameters of the laser trim system with simple English language statements. Instructions to control all the GR plug-in modules are included in the RTL software supplied with every Model 80.

Lowest capital investment

The standard system, complete with the basic resistance measurement module and RTL software, costs only \$59,000, net FOB Watertown, Mass. Modular expansion capability means you pay only for the capability you need.

General Radio service

The complete Model 80 System carries a full one-year warranty. Service, if required, is performed by General Radio's worldwide service organization.

Write or call Micronetic Systems or your local GR sales engineer for information on how you can save money with the Model 80. Resistance trimming is only the beginning . . .



Micronetic Systems, Inc.

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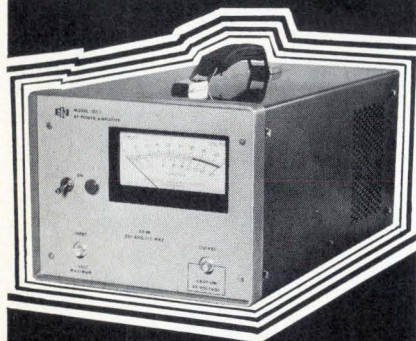
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EN ELECTRONIC NAVIGATION INDUSTRIES

People

Cooper says Litronix is over the hump

"When I first looked at Litronix," recalls Irving Cooper, the new director of sales at the Cupertino, Calif., light-emitting-diode product company, "I saw a group of people, expert in the fields of materials technology, device fabrication, and display assembly techniques, but they lacked a good sales program—which I thought I could give them." Cooper now has his chance.

"Litronix is over the hump," as Cooper puts it, "because it has survived its first year or so of operation and has picked up a significant share [10%] of the LED market. And since we have a good customer base, the question is how fast can we grow."

Cooper points out that the LED business "is a component business like ICS, and so sales and distribution play a big role in the company's growth." Cooper has had 11 years of experience selling electronics components. With a BSME degree from the Newark College of Engineering in New Jersey, he joined the sales section in the electronic components department of Corning Glass Works in 1960. There he helped establish Corning as a major supplier of high-quality resistors and capacitors. In 1965, he was transferred to Signetics Corp., a Corning subsidiary, where he held various sales and marketing jobs, the last one before joining Litronix being general sales manager for all IC products.

From his new post, Cooper sees things somewhat the way they were when he first entered the IC business



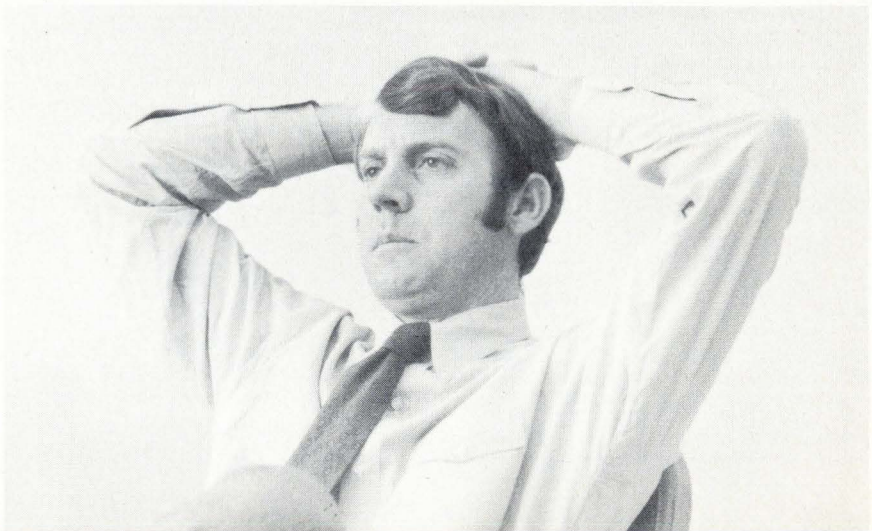
Cooper: "Lacked good sales program."

seven years ago. There are a few major LED suppliers and a lot of people looking to get into the business. For example, Cooper says, "I think that both National Semiconductor Corp. and Signetics will eventually be in the LED business, and so Litronix will do battle the same way Signetics did seven years ago. The difference is we started at Signetics with nothing."

Crowley sees IC business putting emphasis on service

Meanwhile, back at Signetics, Irving Cooper's replacement as general sales manager, Jerry Crowley, says that he is seeing significant changes in the IC business. "For one thing," he says, "I see an element of maturity, which hasn't existed for some 11 years." Part of this, he believes, is due to the tight business conditions that prevailed in 1971. "The economy has caused a weeding out of some IC companies, while others are

Crowley: Significant changes in the IC business—including "an element of maturity."



Fluke's new low cost synthesizer with lower phase noise, low spurious content, high stability and high reliability means

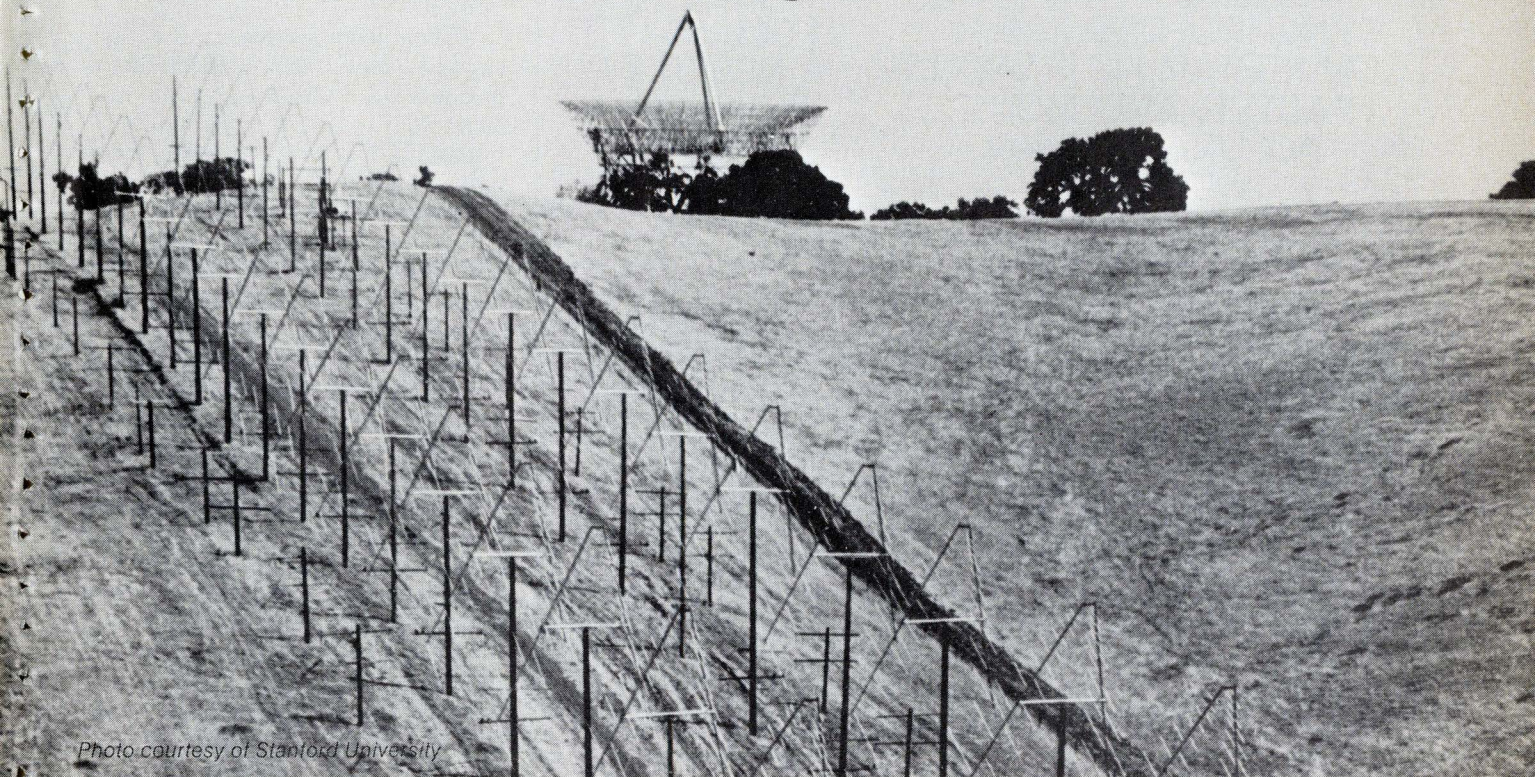


Photo courtesy of Stanford University

improved performance in all signal generation and measurement uses

- Low cost, \$4995 base price
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realigning their priorities." The result, he says, is "a new emphasis on service."

Adding some service. In the past, Crowley feels, the semiconductor business was "all gleam, shine, and technology, but now it's more distribution and service with the technology held off for only those occasions when it's needed."

Crowley, 33, worked for Motorola and Westinghouse before joining Signetics in 1963 as a device development engineer.

He says that "the IC business is now split into three distinct categories, and we are organizing to better serve them. There is the commodity or supermarket business which our distributors serve, the second-tier customer who will be served by reps; and the guy who has to be sold with applications support and needs a direct link to the factory. He will have to be served by our direct sales force."

The new sales manager feels qualified to run this new setup at Signetics because he has been on all sides of the fence. He has designed circuits, set up marketing plans for them, and sold them—his previous job at Signetics was MOS product manager.

Into the fire. Crowley, a West Coast native who received his BSEE in 1961 from San Diego State College, recalls his entry into the sales business as not being the most pleasant. "It was mid-July, and when I got off the plane at Newark Airport the temperature was 95 and so was the humidity.

"I no sooner got to the office, when my boss, Irving Cooper, told me he was leaving the East Coast to take a position at the home office in California. I asked him where do I start; he pointed toward Philadelphia and said 'go sell.'"

Now that he's got Cooper's old job as general sales manager, he is finding the job is not just to sell ICs. "We must differentiate what we are selling each customer so we can better serve them in the future. It's as they teach in sales and marketing classes, if you worry about service first, then market share and profit will follow."

18-MONTH LASER WARRANTY backed by a 1/2 million hour life test

When you buy a laser, you want it to last as long as possible. But even with a year warranty, you can't know how long it will last before you buy—unless the manufacturer has conducted extensive reliability tests.

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Spectra-Physics has proven the reliability of their He-Ne lasers with over 1/2 million hours of life test data logged to date. This extensive reliability data indicates a projected MTTF of over 26,000 hours. And the actual average life of the tested lasers is over 14,000 hours; as the test continues, this average will rise toward the projected MTTF.

Everyone offers One Year Warranties—

But, because our reliability tests have proven that our lasers will last over a year and a half (8,736 hours in a year), we can offer you an 18 month warranty even if you operate the laser continuously. And this warranty will mean the most to you because our reliability tests prove you will seldom need it.

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And 4 years ago we began using cold aluminum cathodes—our customers have been buying increased reliability ever since.

But while these features all are important for long life, they would be useless without the right manufacturing technique. We have been perfecting our technique in the production of over 25,000 plasma tubes, more than anyone else in the world.

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And now about the particular laser you need. Our most popular models are summarized below; we have even added a few new models and increased the power spec on another (with no price increase) so you'll likely find what you need. All have guaranteed output stability usually found only in more expensive models, and all are covered by our new life-test proven 18-month warranty.

Please send me more information on the following proven He-Ne lasers. I understand that all are backed by your life test proven 18-month warranty.

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	Model	Price*	Model	Price*
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2.0 mW	132	\$280	133	\$330
3.0 mW	134-3	\$365	135-3	\$415
4.0 mW	134-4	\$465	135-4	\$515
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Spectra-Physics

DIRECTIONS MOS

Reflections on Custom LSI

Mutual Self-Interest Dictates Close User-Vendor Interaction

Practical, proven, implemented, and growing fast? Yes. Custom MOS-LSI can also be a gamble.

Many features have been forwarded as potential advantages of custom LSI over standard products. Smaller size and weight, very low power consumption, greater reliability, improved performance, are some of these and they are important considerations for some equipments. So is the marketing advantage achieved through proprietary designs. But the overriding impetus for MOS/LSI is cost — lower cost — and if the LSI design does not result in lower cost than an equivalent system of less complex components, chances are it will lose out in the final analysis.

Decisions To Make

MOS/LSI is not necessarily a panacea. Lower costs are not automatically obtained. Achievement of desirable results from custom LSI is predicated on the following choices:

Choose the right volume level product — If the end equipment is manufactured in very small quantities so that the total number of LSI circuits is small, custom design could turn out to be indigestibly expensive.

Choose a competent supplier with

Design know-how — The cost-effectiveness of the LSI part depends critically on the ability of the semiconductor supplier to advise the potential user on how to achieve the most performance per dollar.

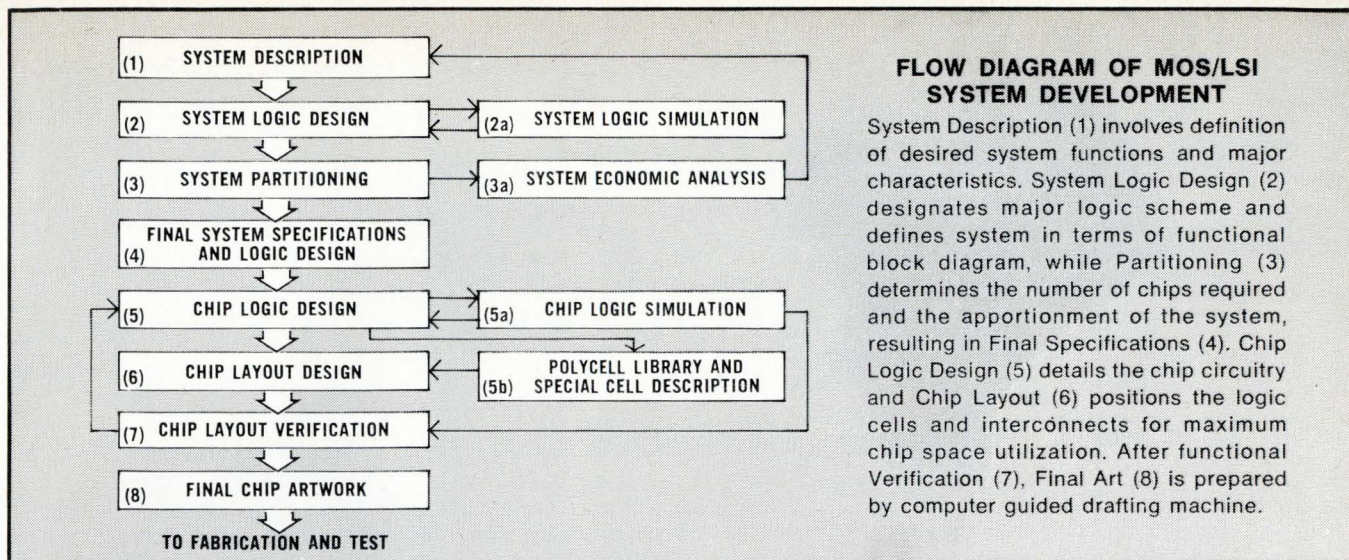
Technology know-how — If the system concept clearly points to a particular technology, it is important that the semiconductor supplier be well-versed in this manufacturing technique.

Adequate manufacturing capacity — Product introduction dates are usually critical, development time is usually short, and rapid high volume manufacturing buildup may spell the difference between hitting or missing the peak of the market for the new equipment.

Under many circumstances, custom MOS/LSI makes a great deal of sense. With a hundred or more gate-circuit equivalents on a small chip of silicon (in some state-of-the-art circuits over 6000 devices are being fabricated on a single chip) system manufacturing costs are substantially decreased. Fewer circuits per system means lower packaging cost, smaller board assembly labor costs and reduced inventories.

Mutual Risks and Joint Rewards

It is clear that the advent of MOS/LSI has perturbed the customary relationships between IC user and IC maker. First and foremost, the user may have to relin-



FLOW DIAGRAM OF MOS/LSI SYSTEM DEVELOPMENT

System Description (1) involves definition of desired system functions and major characteristics. System Logic Design (2) designates major logic scheme and defines system in terms of functional block diagram, while Partitioning (3) determines the number of chips required and the apportionment of the system, resulting in Final Specifications (4). Chip Logic Design (5) details the chip circuitry and Chip Layout (6) positions the logic cells and interconnects for maximum chip space utilization. After functional Verification (7), Final Art (8) is prepared by computer guided drafting machine.

quish his prerogative to sole and exclusive control over his equipment design. Frequently he finds the LSI supplier deeply involved in his system definition and design problems, and if his own MOS experience is limited he may find himself largely dependent on the semiconductor manufacturer for development of a new LSI logic system. Strange as this position may be, it is a natural accompaniment of a technology where processing know-how, circuit design, and system design are so intimately and critically entwined in the success of the project.

For his part, the LSI supplier may find that he has committed large portions of his engineering talent to the design of a set of custom chips for a single customer. Since the components manufacturer's profit comes almost exclusively from the sale of the semiconductor parts, failure to go into production, for whatever the cause, results in an irretrievable loss of engineering effort. Even if the parts work fine, but the customer has misjudged the market for his new equipment, the results are equally damaging to the IC maker. For this reason the LSI maker has a strong motivation to do everything he can to help the customer develop the most cost effective LSI system that can be produced.

With the success of the project spurred by such strong self interests on the part of both parties, the design responsibilities must be accepted jointly. At the start, the definition of the system — its intended functions, features and capabilities — are for the equipment manufacturer to determine. At the end, the processing of the LSI chips should be left to the supplier.

Creating A Design

The process begins with the generation of a system description by the equipment manufacturer and ends with the fabrication of the prototype circuit by the supplier. The intermediate steps, the system design phase, usually involve a joint effort, requiring close communications between the user and his supplier.

Two major milestones mark the path of system design. The first is the determination of the specifications and logic of the final system. The second is the

generation of the final artwork from which the circuits are fabricated. Numerous feedback loops among the various design blocks are necessary to accommodate the complexity of design procedures.

Experience has shown that valuable interactive dialogue can take place as early as the System Description stage. At the very least, the components manufacturers should be called upon for an economic analysis, since cost is so strongly dependent on chip size, on manufacturing processes, and on yield.

Other Considerations

Behind the optimism generated by skyrocketing LSI sales figures is the sobering realization that LSI, so far, has been the tool of a few sophisticated manufacturers. These companies have paid the tuition. The systems in use so far are early milestones toward a 1976 MOS/LSI market in the \$300 to \$600 million range that will be generated by many companies. Most of this growth will be in new applications which are not economically feasible with present discrete or bipolar IC designs. Much of the new MOS/LSI will replace electromechanical or magnetic types of equipment. Fortunately for today's newcomers to the field, they no longer need to climb the learning curve from the bottom rung. Enough design and manufacturing experience has been accumulated by semiconductor manufacturers so that many of the false starts and other pitfalls can be circumvented.

This is the third in a series designed to present a realistic, objective analysis of MOS technology in a dynamic, competitive industry. For a more complete view of the fundamental concepts evolved from Motorola's experience in major custom MOS/LSI projects, and of the broad scope of Motorola's total MOS involvement, circle the reader service number or write to Motorola Semiconductor Products Inc., P. O. Box 20912, Phoenix, AZ 85036.



Coming Next: "PUTTING MOS TO WORK"

Circle 19 on reader service card



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Only HP Offers You All This For The Low Price Of \$2975

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The unique, modular/plug-in architecture of the Model 10 lets you “design” your own problem-solving system. You can expand the memory, add peripherals, or change the keyboard of your existing Model 10, at any time.

Only HP Gives You A Fully Expandable Dual Memory

The Model 10 has a unique dual memory system—one memory for programs and one for data. You can expand from the basic 500 program steps *and* 51 data registers to 2036 program steps *and* 111 data registers.

Beware of simple number comparisons with other calculators. The refinements in the memory design and the keyboard make the Model 10 so efficient that in most cases it requires *fewer steps to execute a given problem.*

Only HP Lets You Design Your Own Keyboard

Interchangeable keyboard plug-in blocks give you a choice of powerful *Statistics* or *Mathematics* functions, complete with their own memories, under single keystroke command. Another option, the *User Definable Function* plug-in, lets *you* customize individual keys with operations uniquely important to *you*.

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Only HP Gives You A Wide Choice of Sophisticated Peripherals

The I/O bus of the Model 10 lets you plug-in a Marked Card Reader, Paper Tape Reader, Digitizer, Typewriter, Tape Cassette, or the *exclusive X-Y Plotter* that plots linear, log-log, semi-log, or polar plots, and writes alphanumerics.

Only HP Offers You A Totally New System

The Series 9800 is no paper tiger. It's available now to free you from the drudgery of problem-solving so you can get on with your job of innovative thinking and designing. For more information or a “hands-on demonstration” at your desk, write: Hewlett-Packard, P.O. Box 301, Loveland, Colorado 80537. In Europe: 1217 Meyrin-Geneva Switzerland.

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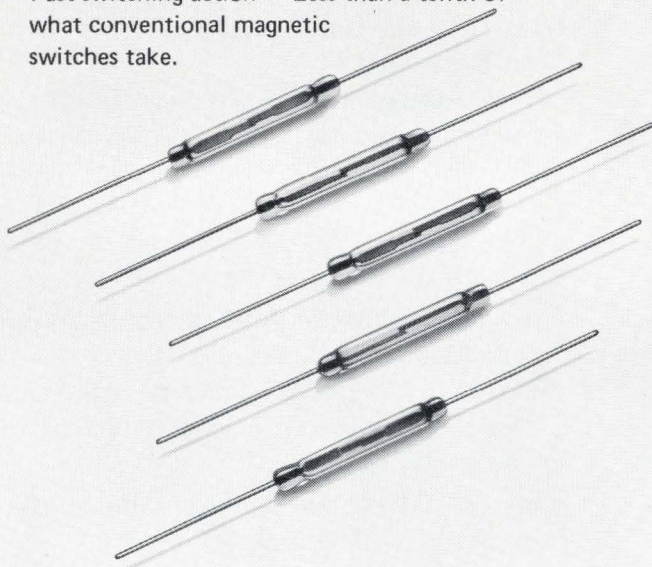
HEWLETT  PACKARD

CALCULATOR PRODUCTS

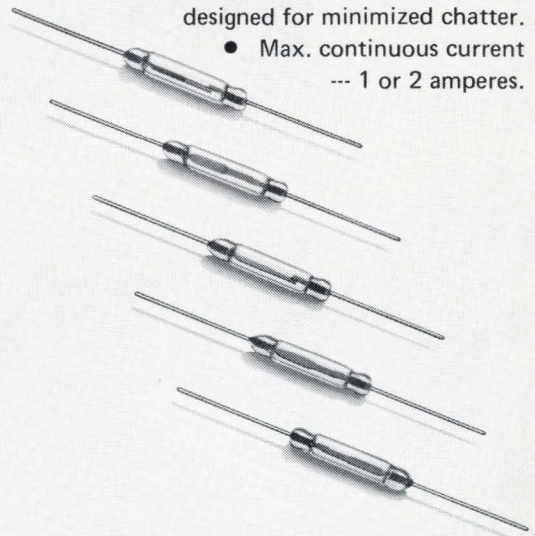
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			2 A		11~25 min.		100 μ s max.				
FDR-4	A (make) Offset gap		1 A	20~52	8 min.		50 μ s max.		350 V DC minimum		
FDR-7			11 min.								

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Aerospace & Electronics Systems Winter Convention (WINCON): IEEE, Biltmore, Los Angeles, Feb. 8-10.

International Solid State Circuits Conference: IEEE, Sheraton Hotel, University of Pennsylvania, Philadelphia, Feb. 6-18.

International Convention & Exhibition: IEEE, Coliseum and N.Y. Hilton, New York, March 20-23.

International Geoscience Electronics Symposium: IEEE, Marriott Twin Bridges Motor Hotel, Washington, D.C., April 9-14.

International Conference on Magnetism (INTERMAG): IEE, Kyoto International Conference Hall, Kyoto, Japan, April 19-21.

Southwestern IEEE Conference & Exhibition (SWIEEEO): IEEE, Baker Hotel & Dallas Mem. Aud., Dallas, Texas, April 19-21.

Off-Shore Technology Conference: IEEE, Astrohall, Houston, Texas, April 30-May 3.

Spring Joint Computer Conference: IEEE, Convention Center, Atlantic City, N.J. May 15-18.

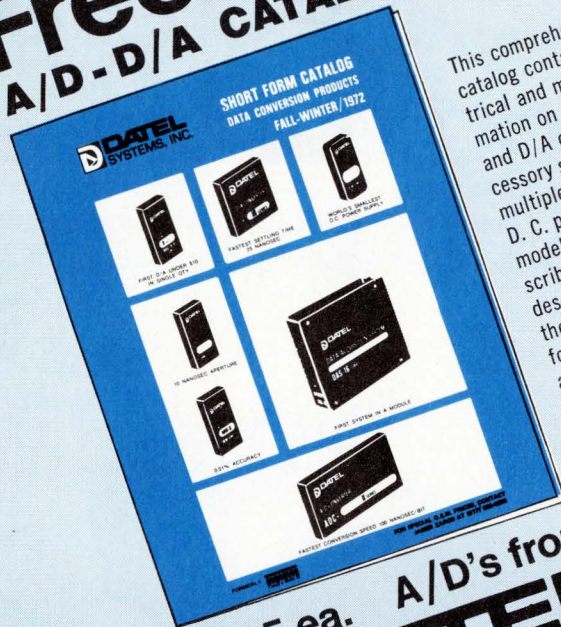
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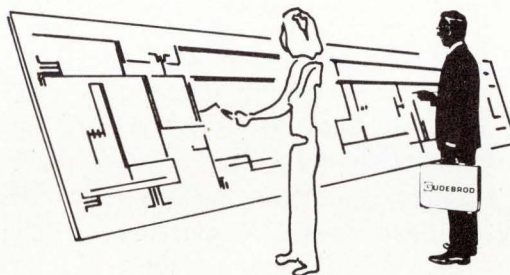
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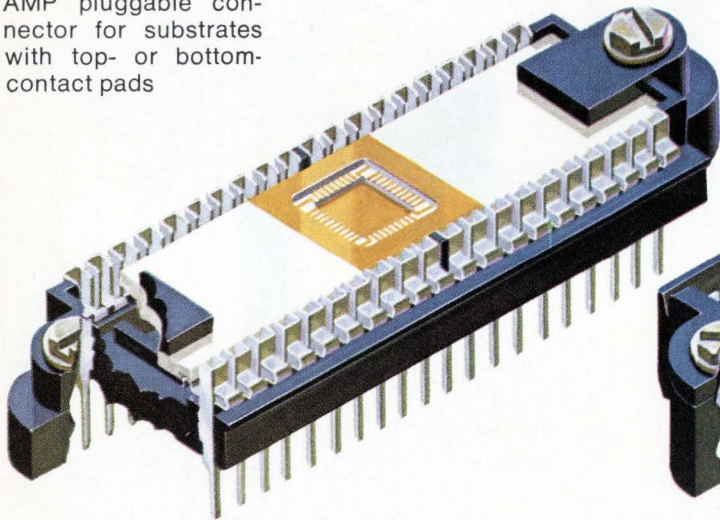
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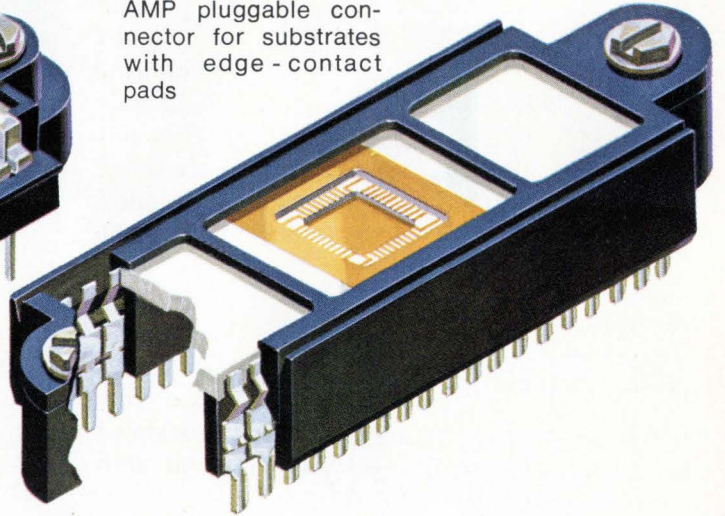
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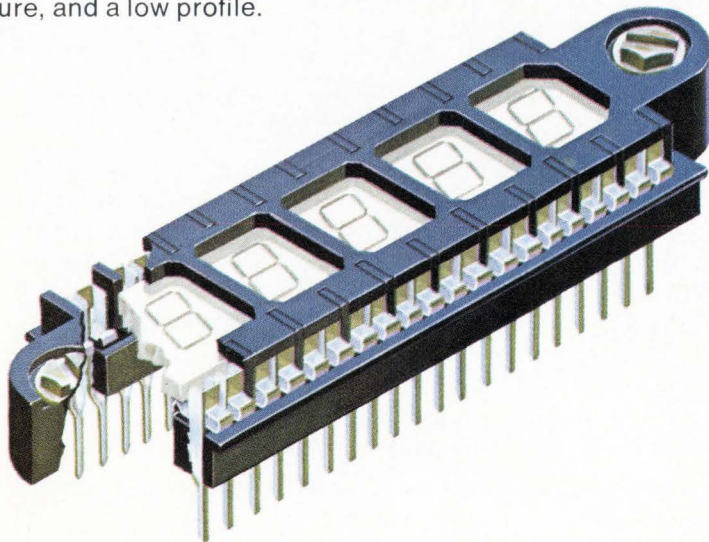


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Electronics Newsletter

January 3, 1972

Mostek 2-chip set includes memory, printing capability

Following its single-chip circuit for small calculators [*Electronics*, Feb. 1, 1971, p. 19], Mostek Corp. of Dallas will announce a two-chip C/MOS circuit for larger machines. **The device points up a trend toward more complex functions on fewer chips—in fact, it's the first standard C/MOS two-chip set to contain memory and printing capability as well as all the logic and operation functions.**

Like the one-chip predecessor, the new pair is ion implanted and performs addition, subtraction, multiplication, and division. It is in a standard 40-pin dual in-line package.

The set will provide: automatic round-off; floating decimal on intermediate multiply and divide; selectable fixed point on any of 12 places on final result; indicators for overflow and memory usage; and a minus sign giving credit balance.

Also featured is power clearing of all registers including memory—a feature usually found only in multichip sets—automatic constant storage, and fully decoded seven- or eight-segment outputs with full multiplex circuitry. The chip sets will be available in 30 days, says Mostek.

Lockheed sells plated wire line to Motorola

Lockheed Electronics Co. is the latest in a growing line of firms to get out of the plated-wire memory business, following Electronic Memories & Magnetics Corp., Xerox Data Systems, and the Librascope Group of Singer Corp. Lockheed has sold its complete plated wire manufacturing and development activity to the Government Electronics division of Motorola.

A Lockheed Electronics spokesman says the firm "couldn't envision a broad-based commercial business for plated wire," but Motorola's plated-wire systems have gone mainly into high-reliability military-aerospace hardware. The military still is an eager customer for plated wire (see p. 31).

The Motorola division has been making plated-wire stacks and systems in Scottsdale, Ariz., for some time, and had been buying wire from Lockheed. The cash transaction adds significantly to Motorola's in-house capabilities, and gives the firm Lockheed's business backlog. Motorola has not disclosed if it will sell to outside customers or was mainly interested in expanding its ability to supply its own system needs.

New IEEE board must respond to amendment vote

Engineers who want the IEEE to become more of a force in promoting the economic well being of members will have to be prepared to see their dues raised. That's the underlying dilemma facing the society's new board at its first meeting Jan. 12 as it takes up the issue of how to react to sentiment among the membership favoring a more militant stance.

The problem came to a head over a near-deadlock vote on a constitutional amendment that would have given the organization more flexibility to push engineering jobs as well as provide its traditional services. **The membership's vote—23,266 for adoption, 23,633 against, with two-thirds needed for passage—is the spur to board action.** But the hooker is that EEs can't expect to get the added service without paying more dues.

The next move for the board will be to find out just how much more the members are willing to pay and how far into the new territory the institute can go.

3½-digit display is built into multimeter probe

Light-emitting diodes are continuing to find their way into more and more applications. Keithley Instruments Inc. of Cleveland will announce this month a digital multimeter that incorporates a 3½-digit LED display in the unit's hand-held probe. The battery-operated, portable ac-dc multimeter, **which will sell for \$325, has automatic ranging and polarity** and can be used as a bench-type instrument with the probe stored in the front panel.

Motorola to push n-channel MOS

Motorola Semiconductor plans heavy emphasis on n-channel as well as complementary MOS. James Nord, MOS marketing manager, says he's **planning to introduce two n-channel 8,000-bit ROMs and a static shift register**, all of which have silicon gates. Nord looks for all these parts to reach "significant" volume production in 1973, after a year's design-in time, **for 1974's data-processing products.**

At the same time, some 30% of the division's total investment expense is already going for C/MOS parts, **with about half that effort for the timepiece market**, says John Ekiss, MOS operations manager. Eight parts in Motorola's series 14,000 C/MOS are already on the market, and the division plans to introduce 10 C/MOS products in each quarter of 1972. Most of them will use MSI technology, and less than half will be RCA parts that Motorola is second sourcing.

Voice prints okayed by Federal, high state courts

Voice print technology, which positively identifies a speaker from his sound spectrogram, is well on the way to becoming a common forensic tool. In a mid-December pretrial hearing, a U.S. district court judge **ruled that the voice print of a defendant was admissible as evidence against him**—the first such sound spectrogram to be accepted in a Federal court. Dr. Oscar I. Tosi of Michigan State University's Department of Audiology and Speech Sciences, who recently completed a study of speaker identification for the Law Enforcement Assistance Administration [*Electronics*, Oct. 11, 1971, p. 52], testified that **a person's voice print is as unique as his fingerprint.**

In addition, in a November landmark decision, the Minnesota Supreme Court held that the issuance of a warrant for arrest and a search warrant was justified by the voice print technique, and that sound spectrograms should be admissible "at least for the purpose of corroborating opinions as to identification by ear alone," and for the purpose of impeachment of a witness.

More semiconductor memories passing tests, says Mow

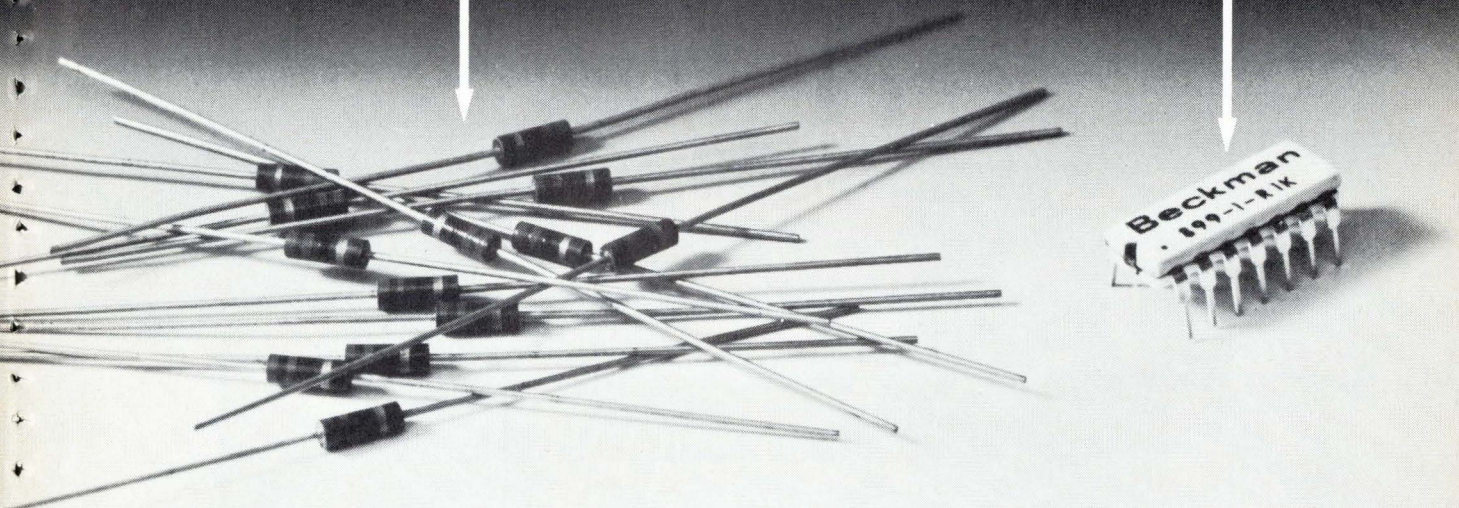
Most semiconductor memory manufacturers are now making parts that pass tests, says a major LSI test-system maker, **a condition that didn't exist a year ago.** The results, according to William C. W. Mow, president of Macrodata Co., is that **1972 could be the year for such memories to take off.**

Mow bases his bullishness in part on the fact that the company shipped more than 60 of its low-priced MD-100 memory testers last year and has orders for several of the more sophisticated MD-150 systems.

Another good indicator is Mow's prediction of an **80% increase in sales** for his Chatsworth, Calif., company, primarily in semiconductor memory testers. That would put Macrodata close to the \$5 million mark in sales by year's end.

13 STANDARD RESISTORS

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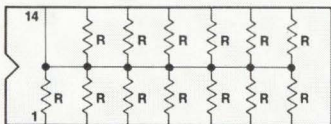
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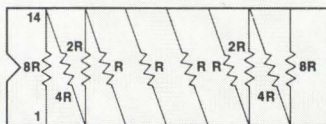
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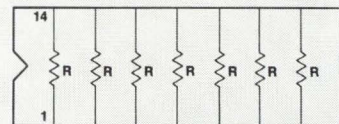
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Is RCA turning away from technology?

Company officials claim their cutbacks in electronics operations are merely timely "belt-tightening"

The effects of RCA's \$250 million writeoff of its computer operation are beginning to be felt throughout the corporation. While an official spokesman says that what is going on is merely an overall "belt-tightening," with no special squeeze on science and technology, other company sources disagree.

Not only are RCA's bankers pressing cost-cutting measures, those sources say, but they also want a better return on the investment dollar. The corporation may do this by expanding into new nonelectronic areas.

"We are de-emphasizing science and technology," flatly states one insider. "Our goal now seems to be to become a low-technology, high-profit-margin conglomerate," he says, pointing to some of RCA's acquisitions. Among them are auto renter Hertz Corp., publisher Random House, and, more recently, industrial-real-estate manager Cushman and Wakefield, and frozen-food producer Banquet Foods. The opinions of these companies are reported to carry considerable weight around RCA.

Changes in Jersey. The RCA watcher can find evidence to back the contention that a shift from high-technology areas may already have begun. For one, changes have been going on in the Solid State division in Somerville, N.J., long understood to be a money-losing oper-

ation. Last November, it discontinued development of gallium arsenide light-emitting diodes and semiconductor lasers. Only a handful of the people originally involved in the work were relocated to RCA's tube plant in Lancaster.

Regardless of the official position, others say that RCA's liquid crystal effort has been largely eviscerated. Only about a half dozen people out of what was once as many as 30 may remain. The company now says it's concentrating on applying the liquid crystals to digital readouts for minicalculators and instruments. It has abandoned last summer's idea of using them in ad displays.

Perhaps the mood of RCA's management is best summed up by one engineer still at the Solid State division: "They're laying off the best people, the flexible ones they used to depend on for growth, and locking into people satisfied to do specific tasks. They want to get a profit on the areas they're committed to, and don't mind cutting back on the technologies whose payoff is in the future."

Employment in Solid State is at 1,750 after 126 layoffs in the last two

months of 1971. But a division spokesman blames the generally depressed state of the economy and retrenchment, adding: "The computer division's demise had very limited impact on our decision to cut staff. Sales to that division were less than 4% in 1970 and 1971."

Despite that outlook, other things have happened to dim the overall picture. The latest is that the management of the division's Technology Center in Somerville is being taken over, beginning this month, by the David Sarnoff Research Center down the road in Princeton, N.J. The official reason given for the transfer, involving as many as 400 people, is that the Technology Center's activities are really more closely related to what the Princeton laboratories are doing, making managerial economies possible.

Center layoffs. The Sarnoff Research Center itself recently laid off 68 of its 1,350 people, about one-third of them high-level technical personnel. This cutback was attributed to the fact that the center was no longer supporting the efforts of the computer division. But among the casualties were two men who re-

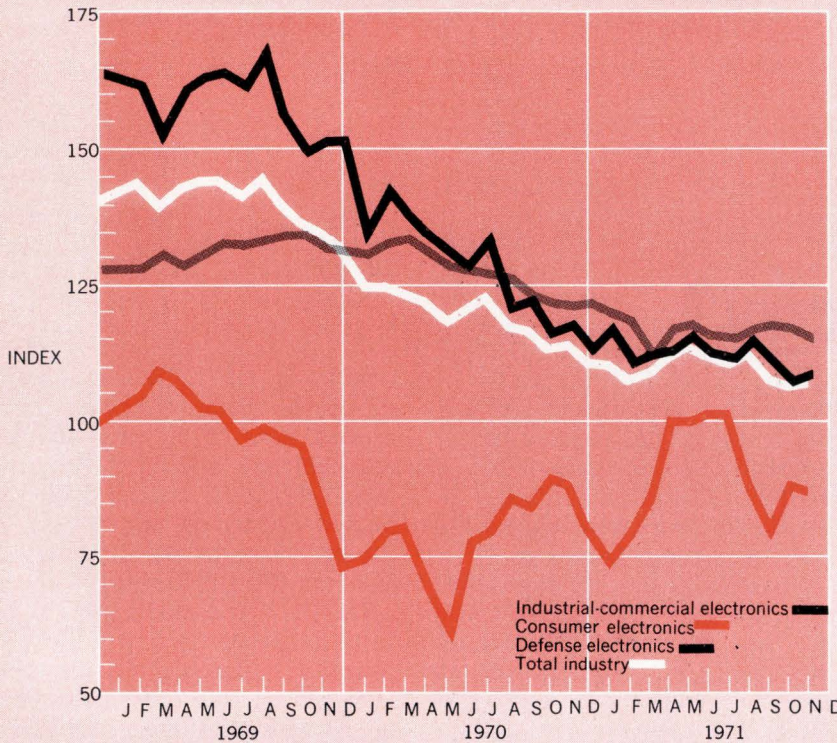
Meanwhile, at CBS . . .

Cutback in long-term technical commitment in favor of short-term cash position has also hit CBS' EVR operations. The company's official position at year-end was that the Electronics Video Recording program would be "restructured." After months of rumor, CBS says it's stopping production of players and cartidges in the U. S. because of cost.

CBS enjoyed a headstart in the commercial and education market for its video player, but had costly bugs in production, requiring continued attention from CBS Laboratories, which developed the playback-only system. According to reports, EVR partners in England, Imperial Chemical Industries and CIBA, will take over production.

Electronics Index of Activity

Jan. 3, 1972



The total production index rose in November 1971 for the third straight month. However, while increasing 0.4% over October, it was still 5% below its year-ago figure.

The monthly increase was accomplished even though only one component of the index moved upward. The 1.7% gain by defense was enough to do the job, though that sector was still 7% behind its November 1970 total.

Consumer electronics was down 1.3%, leaving it 1.6% off from 1970. Industrial-commercial dipped 0.1% to lag a full 5% behind the comparable month in 1970.

Segment of Industry	Nov. '71	Oct. '71*	Nov. '70
Consumer electronics	86.8	87.9	88.4
Defense electronics	110.0	108.2	118.1
Industrial-commercial electronics	116.6	117.7	122.8
Total industry	108.1	107.7	114.1

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.

signed: Fred Rosi, staff vice president for materials and device research, and Leonard Weisberg, who headed the semiconductor device research laboratory. They left, says an RCA spokesman, because their "personal philosophy for research differed from RCA's management with respect to meeting the requirements of the company's [product] divisions."

RCA's corporate staff is also reported to be cutting back, by as much as 30% in some departments. And last month, the company announced it was transferring the SelectaVision business development function to the RCA Consumer Electronics division in Indianapolis. Other cost-cutting steps included phasing out its magnetic products business, which included computer tapes, disk packs, and audio and video recording tapes, and closing the ServiceAmerica operation. ServiceAmerica was supposed to ser-

vice all makes of television sets and other home entertainment products. Although annual volume had reached \$1.5 million, the operation was apparently still not profitable.

And RCA has folded its quarterly, *Electronic Age*.

Companies

Motorola opening MOS design center in Boston

MOS manufacturers have been wondering for the last few years how best to interface with their custom chip buyers at the design stage. Most of the major MOS houses either invite the customer to their facility, or send design teams to him. Collins Radio Co. has even tried—with little success—to offer remote data entry into a central Collins computer complex [*Electronics*,

Nov. 23, 1970, p. 32]. Now, Motorola's Semiconductor Products division has decided to take complete design centers, and the people to staff them, to the customer. John Ekiss, operations manager for MOS, believes this is the first attempt to take the total design capability to the customer.

The first remote MOS design site in Boston is scheduled to be online by September 1 and will be known as the Eastern Design Center. It will be equipped with Control Data Corp. 1700 and Digital Equipment Corp. PDP-11 computers, both driving a variety of peripheral devices required for MOS/LSI design.

More to come. Robert Diamond, who has been named manager of remote design centers, will head the eastern facility and Al Sheng will be its technical director. As the first in what Motorola hopes is a series of remote sites, the center will be capable of duplicating the MOS cell li-

brary and all the processes that exist in Phoenix and Mesa, Ariz. The staff and equipment will be capable of doing everything, from system partitioning through logic simulation to artwork generation.

Togetherness. Diamond says the intent is to work closely with the customer very early in the design, and eventually to make him so conversant with Motorola's systems and processes that he can do his own design, with Motorola engineering acting as consultants.

Confirming the division's commitment to the remote design center concept, Jack C. Haenichen, vice president and director of MOS operations, says that the budget for the eastern center's first year is \$200,000, on which he expects no return, even though customer discussions have begun. Further, the center is already funded for a year.

"I can't envision this costing us more than a couple million dollars before we know if it will pay off," the outspoken Haenichen says. If it's a success, "we'll have several other centers up and running by 1973," he continues, pointing out that the initial software outlays will be a one-time cost.

Haenichen and Diamond agree that Motorola's objective is to make the customer a key member of the design team—to have him design LSI chips instead of circuit boards. "We want to teach him how to design, give him the gear to do it, and then produce the chips for him," Haenichen asserts.

Memories

SEMI delivers bipolar system to RCA for Aegis

Semiconductor memories still seem to be more promise than production reality, but the military has a chance to evaluate thoroughly a large, fast system now that Semiconductor Electronic Memories Inc. of Phoenix, Ariz., has delivered one to RCA. Significantly, the mass memories are bipolar units, as were the first semiconductor memories to go into pro-

duction computers in the IBM 370 series.

The SEMI system will be used in the multifunction array radar of the Navy's Project Aegis fleet defense system [*Electronics*, Dec. 7, 1970, p. 25] to store the location of multiple targets. RCA is prime contractor.

Donald Winstead, SEMI's vice president and director of marketing, characterizes the delivered system as "the first high-density, high-speed, militarized semiconductor read-write random-access memory system ever produced." It has a capacity of 344,064 bits which can be boosted by paralleling.

He says the system could be made with dynamic MOS shift registers, but with a different organization that would also increase the system power consumption beyond that of the bipolar arrays. Further, the paralleled and individually clocked MOS devices could not provide true random access, which the bipolar units do. SEMI's basic storage module is made up of two chips, each containing 64 words by two bits, totaling 236 bits of storage. SEMI uses a solder bump technique to bond the dice to a ceramic substrate [*Electronics*, Feb. 2, 1970, p. 40], patterning its process after the IBM approach.

Up to now, military semiconductor memory systems have been built up from 16- or 64-bit chips, and used primarily in buffer and scratchpad applications, Winstead points out. The SEMI unit, a prototype, is the only memory that will meet the Aegis performance specs, in Winstead's opinion, putting the company in an advantageous position for any future procurement.

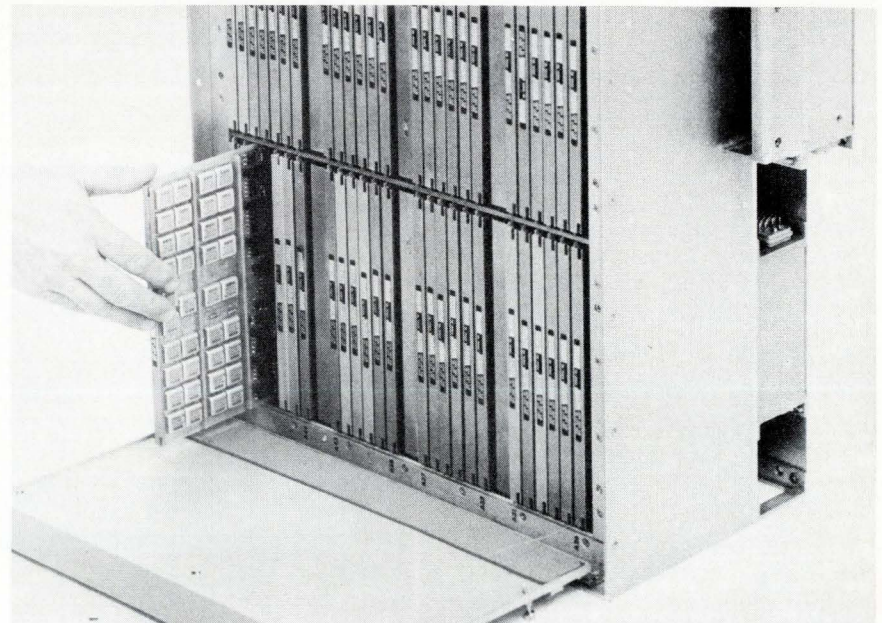
Money pinch. SEMI, however, is fighting for survival, after having had its financial pins knocked from under it by former backer Electronic Memories & Magnetics Corp. of Los Angeles [*Electronics*, Dec. 6, 1971, p. 25].

Nevertheless, Winstead says, the memory unit built for RCA could be further enhanced by upgrading to a 512-bit module (two 256-bit chips) that's to be ready in May.

Plated wire's shiny future boosted by Nemonic deal

Although the glamor and excitement of memory technology seems to lie in the continuing battle between tried-and-true ferrite cores and upstart semiconductor arrays, there's still a lot of plated-wire ac-

Store's open. SEMI's bipolar memory system for Navy's Project Aegis. It will serve in the multifunction array radar to store locations of a variety of targets at long ranges.



tion in the background. It's making money for companies such as Memory Systems Inc. of Hawthorne, Calif., and Nemonic Data Systems Inc., of Denver, Colo.

Plated wire is no longer a serious contender for general-purpose computer memories—although Univac and a few overseas firms would dispute that. But Bruce Kaufman, president of Memory Systems, says his company is doing very well in the industrial-control market, and feels that plated wire has an excellent future in military and aerospace applications as well, thanks to its nonvolatility [see p.54].

However, the most recent optimistic indicator is an agreement between Nemonic Data Systems and SCI Electronics Inc. of Huntsville, Ala. Nemonic supplies plated-wire stacks around which SCI builds memory systems.

Sole source. SCI's principal business since its founding in 1961 has been contracts for data management and control subsystems in various aerospace projects—notably the experiments package in the Apollo 15 service module. Many of these subsystems required memories, and in many of them SCI used plated wire, which it bought from various sources, principally Honeywell. Now SCI is building stand-alone plated-wire systems and its agreement calls for Nemonic to be the sole source for the plated-wire stacks.

For SCI, Nemonic is supplying a variety of stacks, ranging from a wee 20-bit-by-16-word buffer to a respectable 8,192-word-by-24-bit array, with prospects of even larger capacities to come—all built to military specifications. In the few months that SCI has been building such systems, it has sold several to customers such as the University of Colorado, for a computer aboard the Orbiting Solar Observatory, and the Jet Propulsion Laboratory for the Viking orbiter.

By and large, Nemonic's business has been about 40% military and 60% commercial, says Robert A. Fillingham, president. The commercial memories are going largely for industrial control systems, as are

Kaufman's products. Fillingham's two-year-old firm [*Electronics*, Mar. 30, 1970, p.47] turned a profit for the first time in September, shipping an average of \$90,000 worth of wire per month and a healthy \$122,000 total in December—out of an \$800,000 backlog.

Components

Battery offers high voltage, 10-year shelf life

A pilot plant to produce the first solid state battery intended for the commercial market has been set up by the Mallory Battery Co. The power source, which could find its way into pacemakers, ordnance fuzes, and other high-voltage, low-drain circuits, already has been provided in prototype form to several selected potential customers.

Main features of the solid state battery, says Don G. Wilson, vice president for research, engineering, and environmental affairs for the parent P.R. Mallory & Co. Inc., Indianapolis, are a variety of voltage and current drain ratings, high voltages in small space, a projected shelf life of at least 10 years, operation at over 100°C, no gas or corrosion, and hermetic sealing.

The basic cell in the battery con-

sists of a lithium anode, solid lithium iodide as the electrolyte, and a heavy-metal halide as the cathode. The open circuit voltage is 1.9 volts, and the cell's current density is 50 microamperes per square centimeter. Higher voltages are attained by stacking additional cells. Since only the complete battery must be enclosed, there's less case material to take up space. The energy density ranges from 1.0 to 3.5 watts per cubic inch, depending on the voltage and capacity of the solid state battery.

One model of the solid state cell delivers 50 v with a capacity of 10 milliampere-hours and will last 1,000 hours at a drain rate of 10 microamperes. The cell fits into a package 0.65 inch in diameter by 0.80 in. long. Other units can deliver from 7.4 v to 200 v.

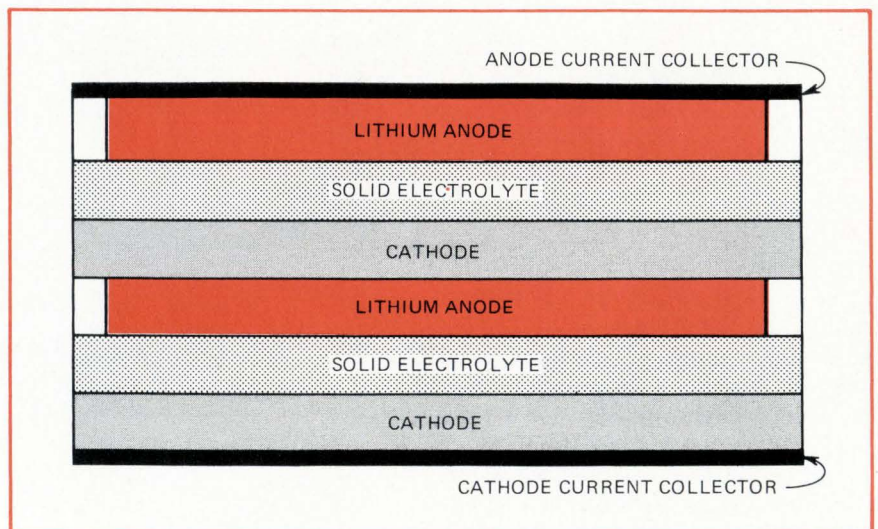
Until field tests provide some clue to potential production volumes, Mallory won't quote prices.

Communications

Comsat speeds logic in digital circuits

By using ingenuity plus some standard Fairchild and Motorola emitter-coupled-logic devices, engineers at Communications Satellite Corp.'s

Power pile. Higher voltages may be gained with Mallory's solid state battery by stacking additional cells. Diagram shows two cells. New battery has projected shelf life of 10 years.



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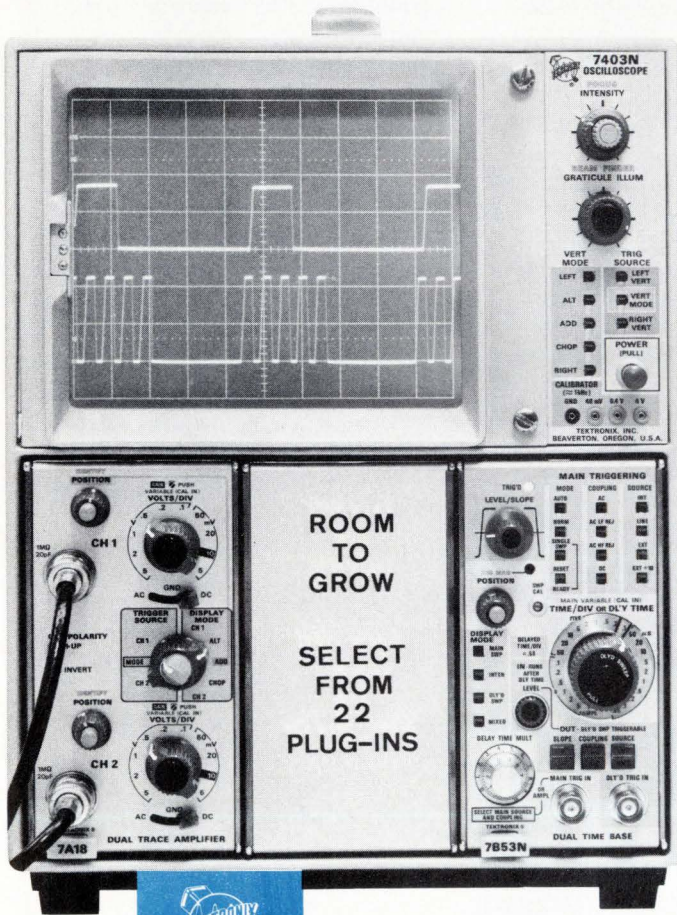
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laboratories are developing digital logic functions on circuit cards with speeds up to 350 megabits per second. That's 10 to 15 times faster than anything else available.

While researchers elsewhere have attained such speed on the bench, Pradman Kaul, engineer in the switching and multiplexing techniques branch, says that Comsat Labs is already using 50-to-150 megabit circuits in systems and is readying the 350-megabit devices for use while trying to achieve even higher digital speeds.

Filling a need. The Maryland lab began developing high-speed function cards for in-house use when it found that, although individual high-speed devices were available, there were no functional circuits obtainable for its specialized communications work. The lab now has a library of 70 circuit cards in the 70-to-150-megabit range with such functions as 512-bit memories, decade counters, and shift registers "available off-the-shelf to anyone at Comsat," says Kaul.

The way to get 350-megabit speeds is the essence of simplicity: place uncased integrated circuits on the periphery of a chip, and reduce the real estate and interconnections in the middle, says Kaul. A decoder decade counter, for example, uses resistor chips of tantalum nitride on silicon. There are 12 resistors on a 50-by-50-mil chip and the whole functional area is an inch square.

But besides the use of nonsaturating ECL elements, says O. Gene Babbard, who developed the high-speed line for Comsat, there are several other factors which permit high speeds: the use of the largest possible ground plane on one side of each card, the building of a "ground screen" into each card chassis before the signal interconnects are added, the use of microstrip transmission lines for the on-card distribution of clock, strobe signals and the like, and the building of completely functional networks on a card.

In a decade counter with integral binary-to-decimal decoding, for example, the ground plane, which covers about 75% of the board, establishes a stable ground reference for

the ECL circuits. It also provides a backup plane for the microstrip transmission lines and reduces the impedance of most of the interconnections to about 50 ohms.

Eight-layer board. The 50-megabit circuits are packaged in eight-layer hybrid ceramic boards, which gives three interconnect layers and one layer on each side to shield the power supply. Single-wire-wrap techniques are used for interconnections up to 6 inches, Kaul says.

The transmission mode is via four-phased phase-shift key modems but the laboratories are building eight- and 16-phase versions.

Besides digital communications, the logic cards show promise for radar signal processing, digital filters, and audio and video bandwidth compression.

Materials

Ampex controls ferrite to double head life

After two and a half years of work with the material, Ampex Corp., Redwood City, Calif., has developed ferrite record and reproduce heads for instrumentation recorders that have a useful lifetime at least double that of present metal heads.

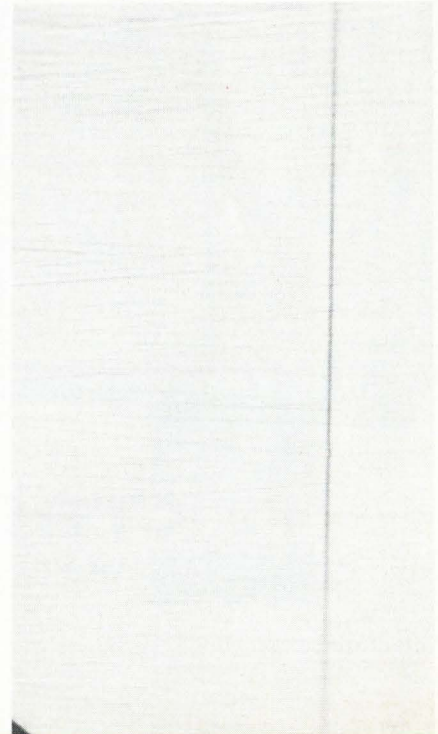
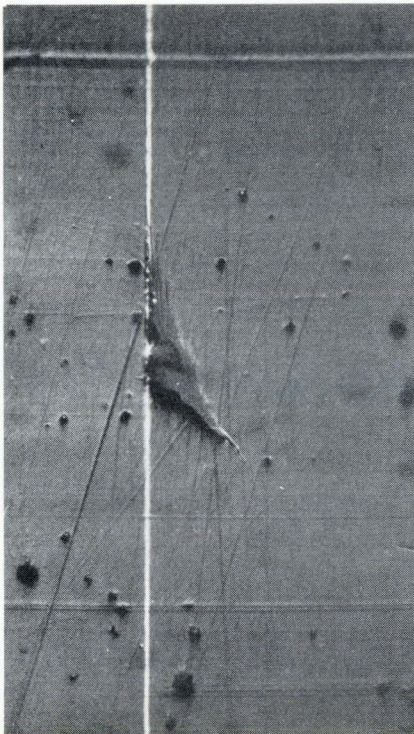
Avner Levy, section manager of the Magnetic Head Design Engineering department, says: "Normal permalloy heads are guaranteed for 1,000 hours, but we are guaranteeing our new ferrite heads for 2,000 hours and we will prorate them up to 4,000 hours."

Levy adds that existing ferrite heads are for recording only. "This is easier to make," he says, "because the record head gap is only 250 microns; the problem is with the reproduce head—its gap is only 25 μ in. and, until now, these couldn't be made with a reasonable life expectancy."

Avoiding gaps. The problem was in the basic ferrite material. To make an extremely small gap that will hold its width after thousands of hours, a very uniform and compact ferrite material is needed. Ferrite, because it is a ceramic-like material, has better wearing properties than metal; but because it is made up of pressed powder, it is granular and contains voids. When the voids are adjacent to the head gap, they effectively increase the gap width, destroying the head's properties.

"We had to go back to basic R&D," says Levy, "and develop a ferrite material that could be manufactured with no voids." Levy says the research was successful and the process has been turned over to pro-

Contrast. Comparison at 500 X magnification of ferrite reproduce head gap (left) and Ampex ceramic version. Ferrite shows erosion and raised spots where it's losing uniformity.



In Answer To Your Gripes About Every Other Portable Recorder

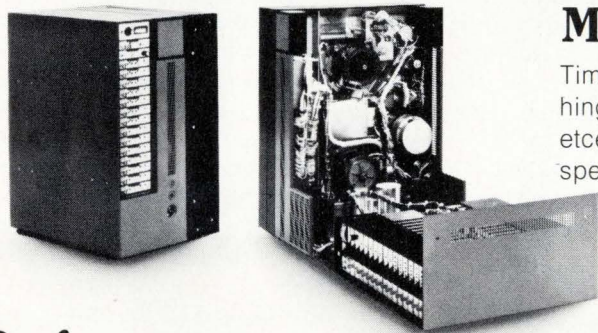
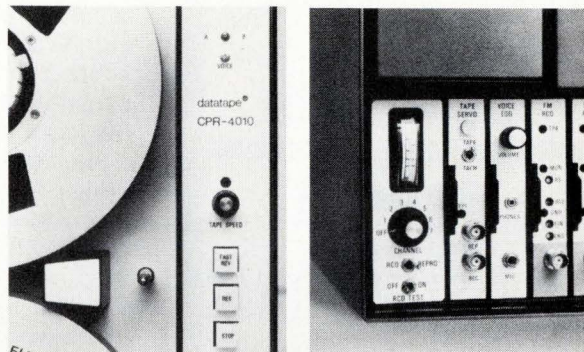
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Maintenance and Servicing

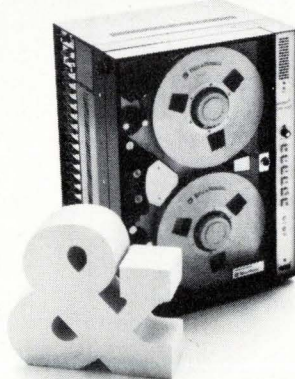
Time for the annual P.M.? It's no big deal. The back panel's hinged. Just flip it down. All motors, power supplies, electronics, etcetera, are right there. (It even runs in this position.) Nothing special needed. How's that for simplicity?

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Briefly, from the top: 7 speed transport, 15/16 to 60 ips; 7 speed direct, all automatically switched, 300 kHz at 60 ips; 7 speed FM record; 40/20 kHz, automatically switched. Any 2 speeds of FM reproduce; low tape flutter and TBE; isolation from reel perturbation via dual capstans and tension sensors. Low mass, closed loop IRIG servo system. The same electronics design as our top-of-the-line VR-3700B.

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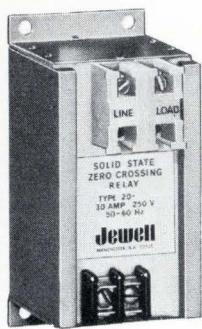
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Electronics review

duction. The first heads, reserved for the company's FR-2000 instrumentation recorder, are available in either half-inch, seven-track units, or one-inch, 14-track units.

The complete head assemblies consist of two record and two reproduce heads. The tracks are staggered, so that alternate heads are used for consecutive tracks. The seven-track assembly will be priced at about \$6,400 and the 14-track unit \$8,000. On the basis of 1,000 hours of use, this puts the new ferrite units at about 31% the cost of the metal ones.

An added advantage of the new design is that both of the most popular recording formats can be accomplished with one head assembly; previously, one head was required for a 1.5-megahertz bandwidth with a signal-to-noise ratio of 30 decibels, and another to record a signal with a 2-MHz bandwidth and a 22-dB signal-to-noise ratio. The single head for both formats will be valuable especially in telemetry when one piece of gear on the ground has to work with many different pieces of equipment aloft.

Up in the air. Also, Levy says, the new material is better for airborne applications than the metal heads. With metal, the temperature coefficient of expansion is 50 $\mu\text{in.}$ per inch per degree centigrade; and with a head gap of only 25 $\mu\text{in.}$, "this meant that we had to go through much pain in order to hold the temperature steady." But this is not the case with the ferrite heads. The material's thermal coefficient of expansion is only 9 $\mu\text{in.}$ per inch per degree centigrade.

Now that the process is defined and production has begun, other head configurations should be rolling out soon.

Commercial electronics

Portable terminal gets quick insurance answers

The life-insurance salesman has a new on-the-spot electronics aid in his eternal quest for the under-

insured prospect. Called the Key-pact, it's a portable actuarial computer terminal developed by Computone Systems Inc. of Atlanta, Ga.

An acoustically coupled terminal in an attache case, Key-pact uses rows of thumbwheel switches made by AMP Inc. to program data that is then transmitted over a WATS line to Computone's computer center. Numerous templates permit the switches to be used for different calculations and analyses: financial planning, premium calculations, proposal calculations, asset accumulation, out-of-pocket expenses, pension planning—and even multiplication, division, and compound interest.

The agent uses the terminal in the prospect's home, usually by having the prospect dial in data such as ages of family members, income, income required if the husband dies, etc. The agent then dials the toll-free number, places the telephone handset on the coupler, and pushes a transmit button. Within a second, the computer furnishes a synthesized female voice reply over a built-in loudspeaker. A typical response might be "\$45,000 of insurance would be required to provide \$500 per month until the youngest child is 21."

The unit costs \$1,350, and computer time costs 60 cents a minute. The company also can supply records of transactions to agent and prospect.

Timesaver. The practical justification of the terminal, of course, is that it shortens and even eliminates the lengthy calculations and research that an agent must go through as he determines how much insurance to recommend to the client—at which point the prospect often has second thoughts, especially if the agent cannot complete the sale in one sitting. The computer also shortens calls, allowing the salesmen to make more visits per week.

But R.A. Philibert of Computone says, "The most important benefit of this technique is the effect it has on the agent's self-image. This positive self-image is reflected back to the

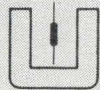
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2N5660	2A	to 400V	0.8V @ 2A	1.00mj	0.25μs	0.85μs
2N5664	5A	to 400V	1.0V @ 5A	1.25mj	0.25μs	1.50μs

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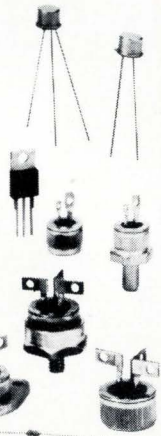
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Electronics review

agent by the insurance-buying public in general and the individual prospect in particular. The computer terminal removes the agent from the 'insurance salesman' category with all its negative implications (in the eyes of the public) and classifies him as a high-technology financial consultant with direct access to the power of the computer."

And to bring home even more forcefully the utility of this application of computer to life, one "high-technology financial consultant" says he has especially good results with engineers and other computer-oriented professionals.

Integrated electronics

TI builds low-power
beam-lead TTL array . . .

In many areas where logic designers would like to take advantage of MOS/LSI's low power requirements, they're nevertheless forced to specify bipolar arrays because of bipolar's high reliability. Now, Texas Instruments is closing the gap by combining two technologies of proven reliability: low-power transistor-transistor logic and beam leads. The result is a line of bipolar arrays in the 54L TTL family with low power needs. TI also will offer the chips separately, including some new Schottky diode-clamped low-power TTL.

TI is first to offer low-power TTL beam-lead parts, though Motorola and Raytheon have beam-lead versions of conventional TTL. Larry A. Gast of TI's special circuits department says that the new arrays will be used mainly in high-reliability military airborne and space applications such as the Grand Tour, communications and other satellites, missile guidance, and airborne computer and guidance systems.

Circuits in the assemblies are beam-lead versions of off-the-shelf low-power ICs, plus the Schottky low-power versions, and a random logic chip that TI can customize.

The random logic prediffused chips, of 50-gate complexity, con-

tain standard components without interconnections, so that only one level of metal is required to complete them when the customer specifies the circuit. Speed-power product is a low 10 picojoules.

. . . as low-power Schottky

TTL approaches the market

Along with the new beam-lead parts and assemblies, Texas Instruments is preparing to introduce the first low-power Schottky TTL devices to hit the market. Schottky devices now being sold are high-speed and competitive with 2-to-3-nanosecond nonsaturated logic such as the Motorola 10,000 and Fairchild 9500 series. But the Schottky diode-clamping technique is also suitable for low-power uses at slower speeds.

Typical speed-power product for the new parts, the 54LS is 20 picojoules, compared to 30 pJ for conventional low-power TTL (54L), 60 pJ for high-power Schottky TTL (54S).

For the record

Awards fly. North American Rockwell Corp. has awarded a second avionics subcontract for the B-1. It's a \$640,000 fixed-price job to Texas Instruments for terrain-following radar. The first, a \$4.1 million award to Radiation Inc., was for power-distribution control.

EE for CBS Labs. Renville H. McMann Jr., 44, has become president of CBS Labs, Stamford, Conn. McMann, an EE, had been executive vice president. He succeeds Peter C. Goldmark, who resigned.

Takeover. Japanese government approval appears certain for transfer of Sony Corp's. 50% interest in Texas Instruments Japan Ltd. to TI. The company would become a wholly owned subsidiary of TI.

Second one. Intelsat 4, a 9,000-circuit satellite, is expected to go into commercial operation over the Atlantic at the end of the month.

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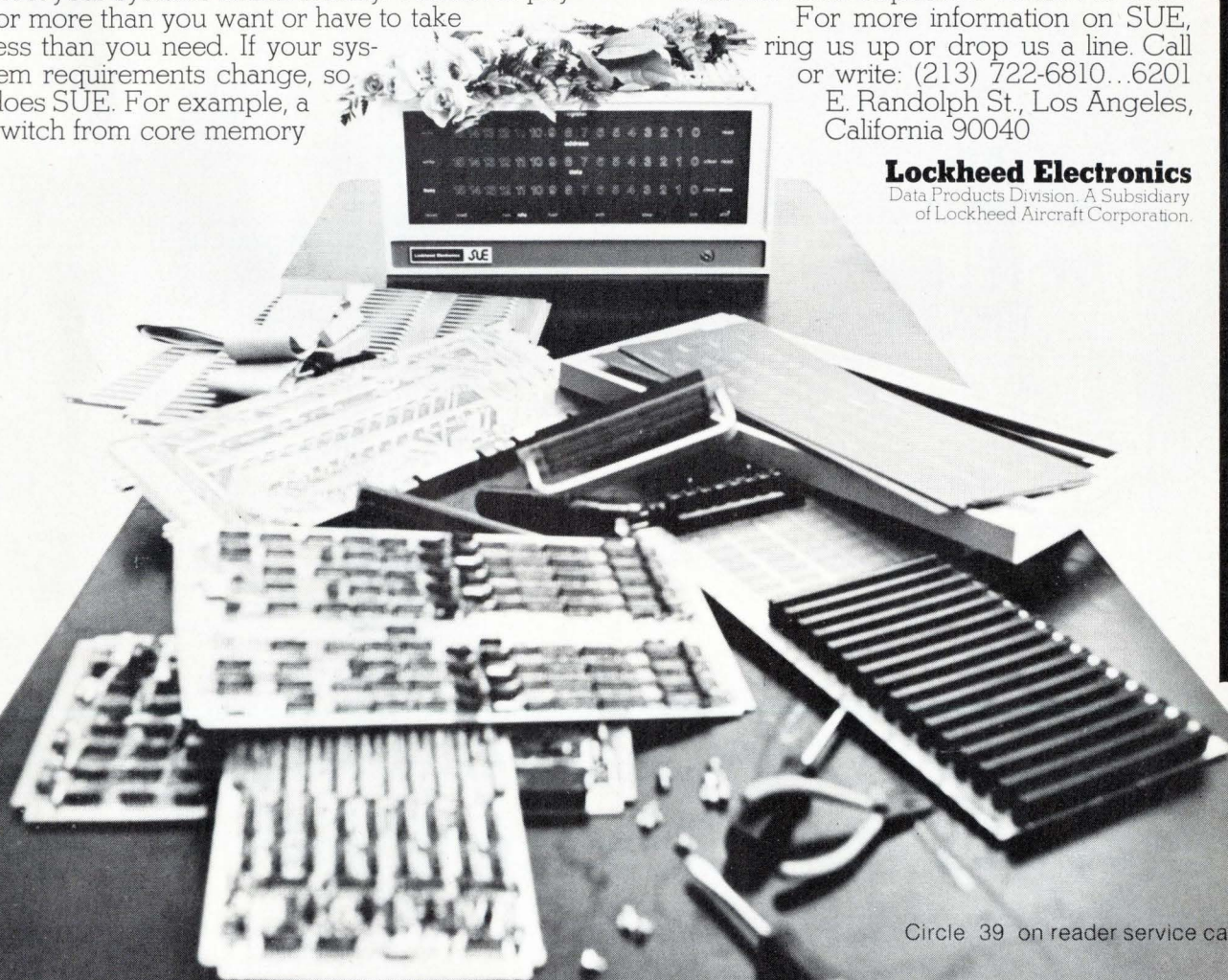
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D/A converter

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214

To show them all would take another 15 pages.

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successive
approximation
12-bit A/D converter


216

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4004

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217

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high speed current 13-bit
D/A converter

218

Circle the appropriate reader service number for complete information on data conversion modules shown here. You'll also receive the 1972 Product Guide. More information is also available from your local Philbrick representative or Teledyne Philbrick, Allied Drive at Route 128, Dedham, Mass. 02026. For toll-free data (800) 225-7883. In Mass. (617) 329-1600.

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this year, there's something really new in minicomputers ...Cincinnati Milacron's CIP/2200

CIP/2200 is brand new. It performs functions that heretofore could be done only by larger computers. See copy above.



minicomputers

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Washington Newsletter

January 3, 1972

Stans sees Poland as new market for U.S. exports

Poland and comparable Eastern bloc nations will probably develop more quickly as a market for U.S. electronics, although the Soviet Union represents a larger long-term trade potential, states Secretary of Commerce Maurice Stans. The Stans estimate came in response to questions following his year-end mission to Russia and Poland for President Nixon.

In view of Soviet inquiries to U.S. computer makers, the secretary's observation that he did not encounter "any great interest" by Russia in U.S. processors surprised industry officials. But the Polish interest confirmed a view of the Electronic Industries Association, among others, which earlier had urged cultivating the East European market.

Justice Department wants computerized stock market net

A national computerized stock information network, linking the major and regional exchanges and the third market makers or brokers who deal amongst each other, is being proposed by the Justice Department to the Securities and Exchange Commission. The Department's antitrust division views the present system of exchanges and floor traders as anti-competitive, and wants a system whereby any broker could find the best market for his stocks anywhere in the country at any given time. Although the department believes the problem is only a regulatory one and is formulating no specific proposals, its ideas include replacing the exchange floors with computers, or keeping the floors but connecting them with other markets.

House censure could revive plan to reorganize FCC

Watch for a renewed move by the White House in 1972 to reorganize the Federal Communications Commission if Congress should wax critical of the FCC for its decision to drop its investigation of AT&T (see p. 44).

A White House trial balloon last year, suggesting that the FCC could perform more efficiently under a single strong leader, was quickly withdrawn when it was criticized as a device to destroy the commission's independence. The proposal, critics noted, would have placed total control in the hands of the President and his successors, doing away with the seven commissioners and their staggered terms of office. A leading opponent of the plan is Dean Burch, FCC chairman and Nixon appointee, while support for the proposition stems largely from the White House Office of Telecommunications Policy, headed by Clay T. Whitehead.

FAA picks six microwave landing system teams

Two doppler scan approaches, by Hazeltine Corp. with Marconi of Canada and by IIT Gilfillan with Honeywell, are among six industry team proposals that the Federal Aviation Administration has selected for the \$3 million concept definition phase of the microwave instrument landing system. The other four proposals, which used the older, scanning beam approach, came from AIL division of Cutler Hammer Inc., with Collins Radio; Texas Instruments with Thomson-CSF; Raytheon with Sperry Phoenix; and Bendix with Bell Aerospace.

Following contract negotiations now going on, awards are expected to be announced later this month [*Electronics*, Nov. 22, 1971, p. 46]. Up to four teams may be chosen at the end of 1972 for the second feasibility definition phase. The five-year, \$50 million commercial development program leads to a large FAA buy in the late 1970s and 1980s.

Washington Commentary

Despite 'copout'
FCC presses Bell on
interconnection . . .

. . . as equipment
makers protest bias
by Bell System

It is difficult to imagine that the United States Government lacks sufficient resources to investigate the utilities it must regulate. But that is what the Federal Communications Commission conceded just before Christmas, when it voted four-to-two to drop its examination of American Telephone & Telegraph Co., the world's largest corporation. In brief, the FCC conceded that its 165-man Common Carrier Bureau with its \$3 million budget, simply couldn't cope with the job of regulating AT&T, along with its other responsibilities for monitoring a \$70 billion industry embracing other telephone and telegraph companies, international communications, and satellites.

Bernard Strassburg, chief of the Common Carrier Bureau, which instigated the investigation, called the vote "a rather singular type of action." The FCC's most outspoken commissioner, Nicholas Johnson, dissented more vigorously, charging that the action "bordered on the irresponsible." And Congress is likely to have more to say on the subject after it reconvenes on January 17th.

But the redoubtable Strassburg says the vote "doesn't mean we're copping out on regulation" altogether, and indeed, he is pursuing a running war with AT&T on the attachment of "foreign" equipment—equipment not made by Bell—to the telephone network. Though that issue was supposedly resolved in 1968, with the FCC landmark "Carterfone" decision, communications equipment makers are still not happy. And Strassburg continues to press their case.

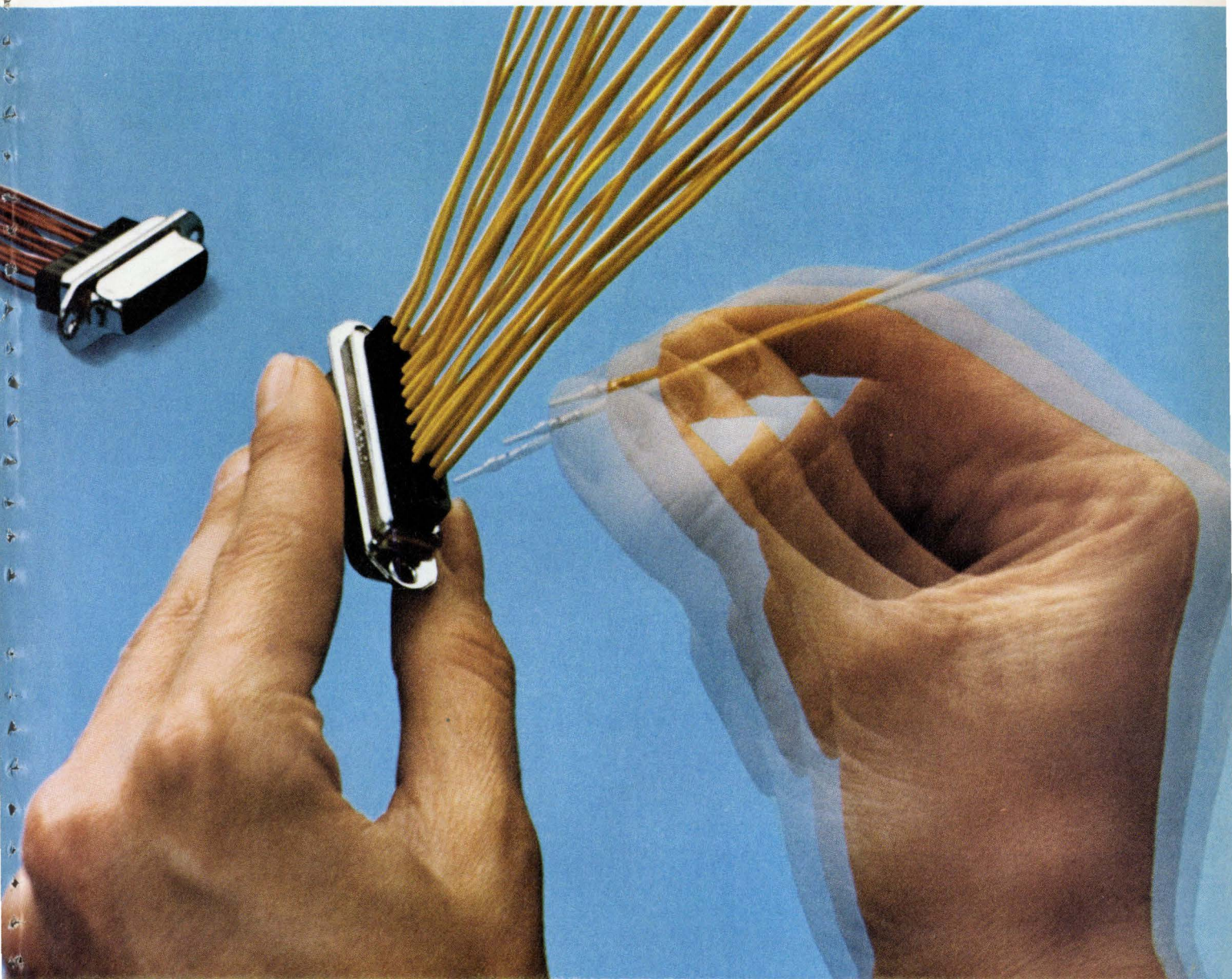
The complaint by equipment makers is detailed by Strassburg to AT&T in a private letter that was submerged by the larger controversy. **Interconnection of non-Bell equipment—even though it meets Bell specifications—still is refused or produces discontinuance of service**, or, says Strassburg, AT&T imposes additional charges for protective "network control signalling units" for equipment bought by customers from independent manufacturers. At the same time, Bell customers who buy the same equipment from the telephone company pay no extra charges. Specifically, he cites examples of independent handsets for automatic dialing, such as "Magical" and "Code-A-Phone." **AT&T's action, he concludes, puts such independents at a competitive disadvantage.**

What the FCC wants AT&T to do is to stop any discrimination against customers who buy terminals from independents, stop requiring separate network control units "over and above those already incorporated into devices" designed to meet Bell specifications, stop charging for them, and, further, make its specifications for network protection equipment available to anyone that wants them, including independent equipment makers.

But what intrigues manufacturing members of the Electronic Industries Association is that Strassburg's letter gives them the opening they have long sought. Though the letter talks of "Magical" and "Code-A-Phone" as "examples" of brand-name terminals, EIA vice president of communications and industrial electronics, John Sodolski, believes **the document has broader implications for modems of just about any type that can be safely used on the switched telephone net.** And, he says, the association is going to explore the possibility of extending the Common Carrier Bureau's position to cover the whole spectrum of terminals. Should that effort prove successful, then the much-discussed "communications revolution," which would expand the equipment market, will be one step closer to realization.

—Ray Connolly

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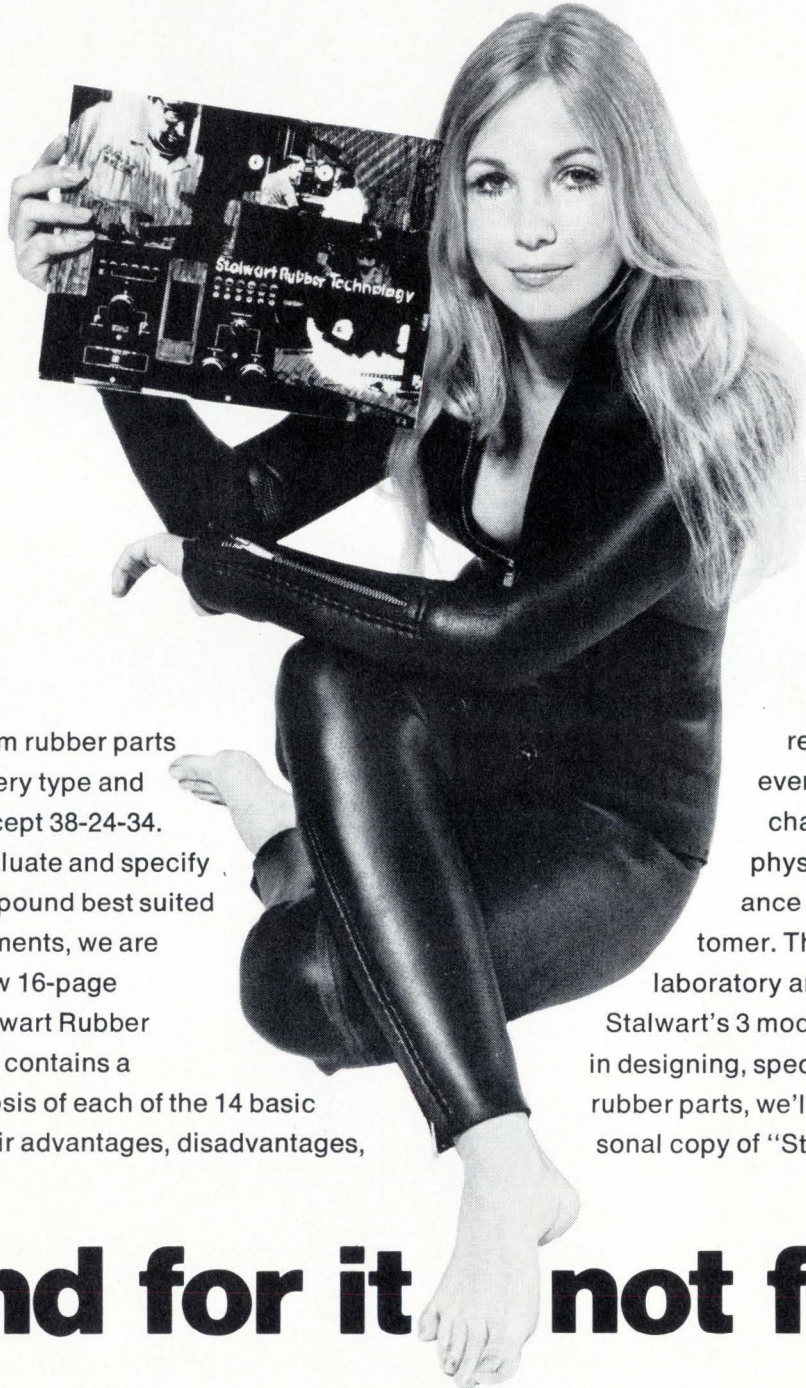
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ECL/MSI ASSURES LOWEST SYSTEM POWER DISSIPATION

Comparison of unloaded and system power dissipation per gate of 9500 Easy ECL functions. With an MSI function, the termination power is amortized over many gates thereby assuring lowest system power dissipation.

Device	Description	Gates/ Function*	Power Dissipation (mW/Gate)										
			0	15	30	45	60	75	90	105	120		
SSI — Gates													
9502	General Purpose Dual OR-NOR	2											
95H02	High Speed Dual OR-NOR	2											
95L22	Low Power, High Speed Dual OR-NOR	2											
9503	General Purpose Triple OR-NOR	3											
95H03	High Speed Triple OR-NOR	3											
95L23	Low Power, High Speed Triple OR-NOR	3											
9582	Triple Line Receiver/Amplifier	3											
9504	General Purpose Quad NOR	4											
95H04	High Speed Quad NOR	4											
95L24	Low Power, High Speed Quad NOR	4											
9505	Four Wide OR-AND	5											
9507	Quad AND-NAND	5											
9595	Dual ECL-TTL Converter	2	not applicable										
SSI — Flip-Flops													
95H29	250MHz J-K	9											
9528	Dual 160MHz D-Type	12											
MSI Elements													
9538	1-of-8 Decoder	12											
9581	8-Input Multiplexer	12											
9578	Quad EX-OR/Comparator	16											
9579	Quad 2-Input Multiplexer	16											
9534	Quad Latch	24											
95H84	High Speed Adder/Subtractor	29											
95H90	250MHz VHF Prescaler	29											

*Number of on-chip ECL Gates not discrete TTL equivalents.

Typical Device Dissipation Additional Dissipation in system due to termination scheme.

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9534 quad latch with gated input and output enable features. Buffering of outputs insures glitch-free operation with approximately 4nS delay. Applications: register, ALU, parallel-serial conversion.

9578 quad exclusive-OR function also for use as 4-bit comparator or dual differential line driver. 3nS delay.

9579 quad 2-input multiplexer with 2.6nS delay. Common select line reduces external wiring for variety of function-generation and multiplexing applications.

Low-Power SSI

New 95L22, 23, 24 low-power gates are pin-identical with standard and high-speed gates. 20mW power dissipation (20% lower than any other available ECL gates), and 2nS propagation delay at no price premium. 60K ohm on-chip pulldown resistors.

For use in an area of high-power density (e.g., memory arrays), and as receiving element at end of long data bus lines.

High-Speed SSI

Three new high-speed gates and a new high-speed flip-flop:

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95H29 J-K flip-flop with 250 MHz toggle frequency features non-ones catching master-slave circuit with multiple gating on inputs. For high-speed counting, register, data storage.

Low-Cost Standard SSI

9507 quad and 2-input AND, 8-input NAND gate. Eliminates a number of external connections in computing and general logic applications. 2.3nS delays without deterioration in rise-and-fall performance under heavy loading conditions.

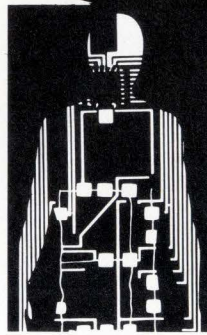
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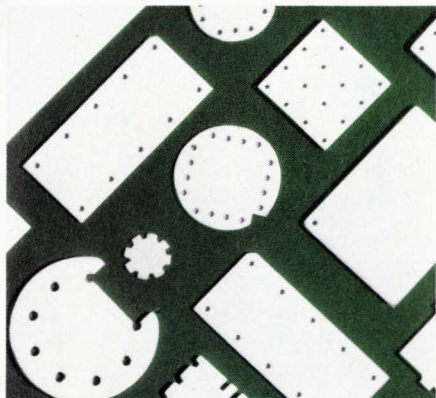
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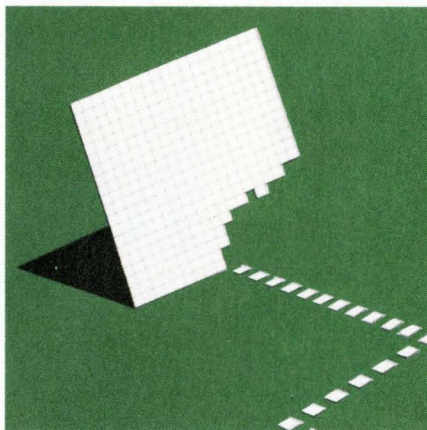




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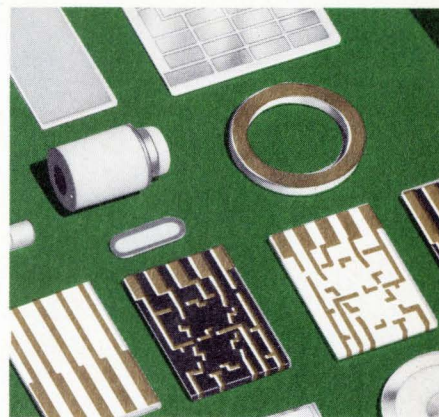


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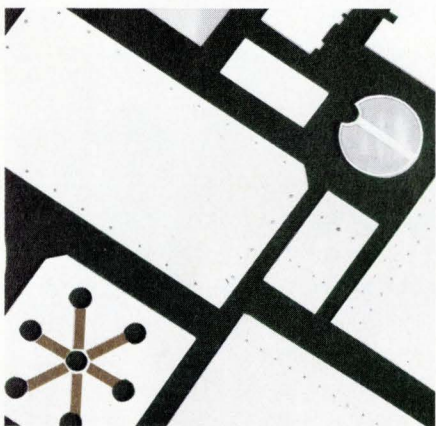
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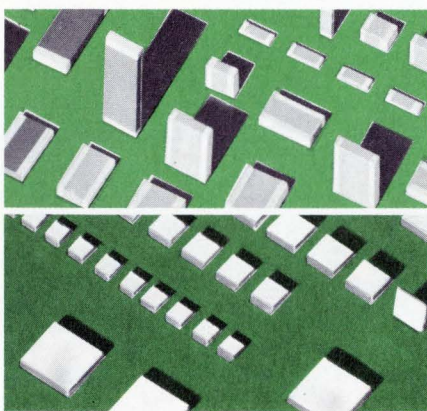


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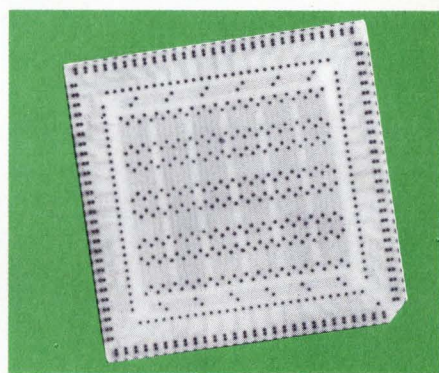
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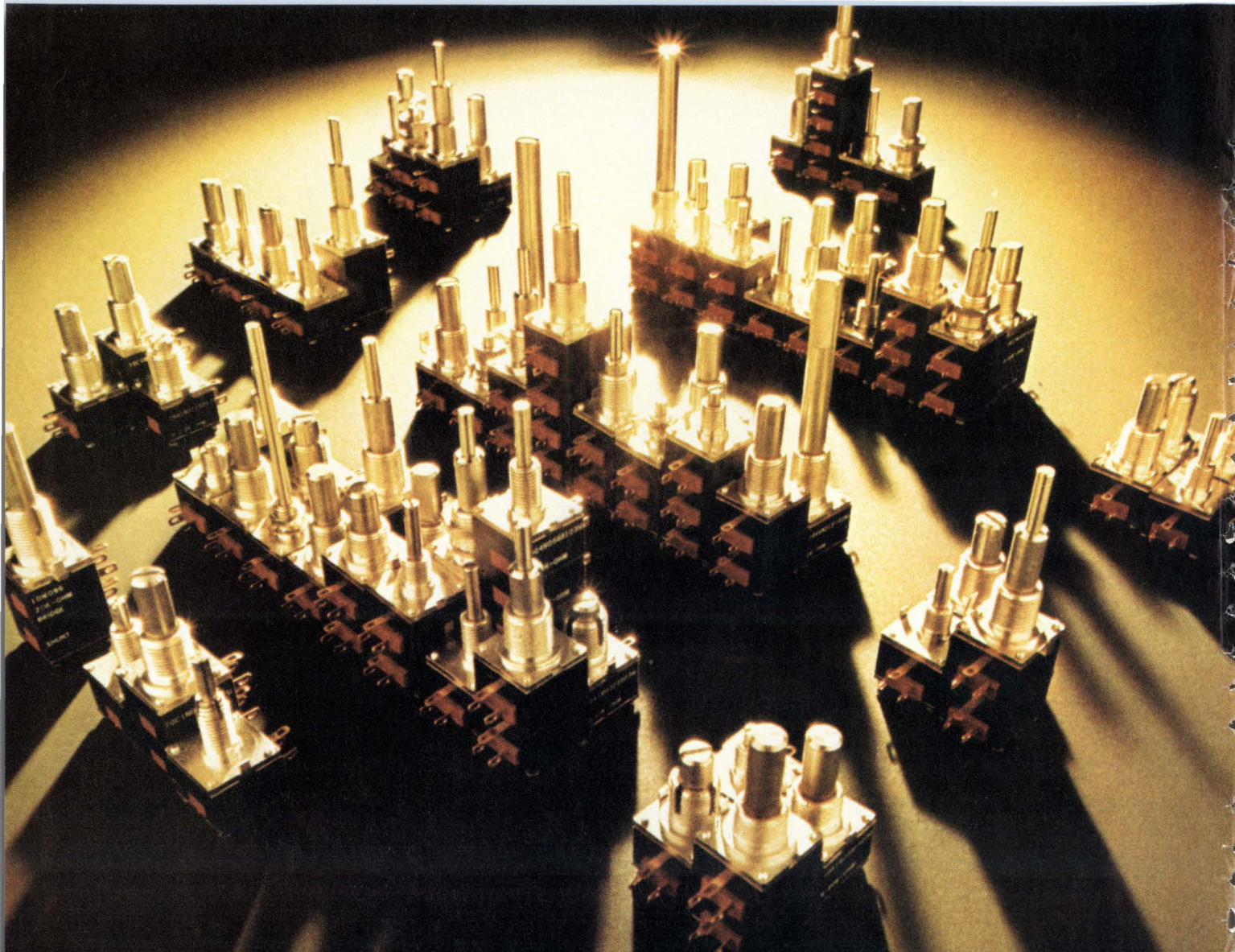
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Electronics

U.S. MARKETS FORECAST

**With a much
needed boost from
Government,
the electronics
industries
will recover
their health,
gaining 9.5%
in 1972**

ELECTRONICS INDUSTRIES SALES*	1970	1971	1972	1975	CONTENTS
FEDERAL	11.77	11.17	11.64	13.40	54 Computers
INDUSTRIAL/COMMERCIAL	9.89	9.91	11.71	16.40	57 Solid state
CONSUMER	3.53	3.89	4.09	4.75	61 Consumer
					63 Commercial
					63 Communications
					66 Components
					67 Production
					69 Instruments
ELECTRONICS INDUSTRIES, TOTAL **	23.59	23.42	25.64	32.65	71 Industrial
					72 Federal
					73 Military
					75 Space

*U.S. FACTORY SALES IN BILLIONS OF DOLLARS BY CALENDAR YEAR.
**MARKET TOTALS ARE ADJUSTED TO REMOVE INDUSTRIAL/COMMERCIAL SALES ALSO INCLUDED IN THE FEDERAL CATEGORY.

The outlook

□ After floundering for two years in the doldrums of economic uncertainty, the electronics industries are setting a firm, new course in anticipation of a vigorous breeze of growth in 1972.

By all accounts, 1971 was a rotten year, one in which most major electronics market segments declined or stayed flat. With reductions in Federal spending, belated action by the Nixon Administration in fighting inflation and recession, and the uncertain late-year effects of Phase 2, 1971 closed out at about \$23.42 billion, below the 1970 level of \$23.6 billion.

But with rather more decisive action from the Administration and the Congress, 1972 looks like a happier year. Federal spending for electronics is slated to be up almost to the 1970 level. Stimulated by the new 7% tax credit for capital investment, computer industry shipments are expected to increase markedly—by as much as 22% in value, according to *Electronics*' survey.

Partly as a result of the healthier computer picture and the push from data communications, semiconductor dollar sales are expected to rack up an 8% or better growth, a sharp reversal of the downtrend that has gripped semiconductor houses since the end of 1969. Consumer products, the one happy surprise on 1971, should continue to register gains in 1972. With the devaluation of the dollar, U.S. electronics firms will find it easier to compete with the Japanese in the U.S.

All in all, total industry sales in 1972 are headed for an upswing of 9.5%—to \$25.6 billion. Thus, after a painful two years, electronics is moving again.

Computers

□ The larger mainframes had a tough time of it last year, but the little guys—the indefatigable minicomputers—continued their readily predictable sales zoom. Fortunately, things look better all around in the year ahead, as the economy finally loosens up after two tight years.

And things also are changing radically. As Robert T. Bond, planning manager of Hewlett-Packard's Data Products group, Cupertino, Calif., puts it: "The year 1971 marked the end of the computer mystique." EDP customers have become more knowledgeable and, under the pressures of the recession, they have increasingly been putting that knowledge to use. They mix equipment from several different suppliers, to suit their needs and their budget as they—not some outside firm—see fit, and minicomputer users, especially, tend more

and more to engineer whole minicomputer-based systems themselves.

According to *Electronics*' market survey, the value of delivered, computer hardware, including peripherals, should expand by about 20% during 1972, up from an estimated \$6 billion in the past year. Way above the overall average, at an estimated 30% growth rate, will be the minicomputers. And peripheral equipment, including tape, disk, semiconductor and core memories, printers, and cathode ray tube terminals, will increase by approximately 23%.

Other views of the industry's growth run a wide gamut. At the low end of the scale, James A. Stone of the market research firm of Quantum Sciences Inc., New York, predicts that gross sales will be up only "somewhat" in 1972. But the net, because of the volume of computer trade-ins, will be almost flat.

A more sanguine note is struck by International Data Corp., Newtonville, Mass., a market research and consulting firm for the computer industry. It believes domestic shipments of all kinds of computers and peripheral equipment reached about \$4.4 billion in 1971, up

Increased sales anticipated for 1972 are keyed to selected markets

3% over 1970, but for 1972 expects a 22% gain to about \$5.25 billion, bringing the industry back above the \$4.9 billion level set in 1969.

But most enthusiastic of all is Frederick G. Withington, a senior staff member at Arthur D. Little Inc., a Cambridge, Mass., consulting firm. He predicts gross sales, in terms of delivered hardware, will hit up around the \$7 billion mark. This is a high figure, he admits, but it will be caused by a tremendous surge in deliveries of replacement machines to users who had held off buying for the last two years. The postponement was caused by the business recession and by the wait to see what the new generation of computers—like IBM's 370, and Honeywell Information System's H-6000—would be like.

So the often predicted recovery may at last be here for the computer industry, and it will be welcomed by all segments—though not all fared equally badly.

A spokesman at Digital Equipment Corp., Maynard, Mass., concurs with this analysis, adding: "Of course, we're not seeing the 20% and 30% growths, and we won't anymore except in selected markets. For example, there could be as much as 40% to 60% growth in communications-related fields—communications front ends, remote terminals, key-to-tape gear, message switching devices, and message concentrators. This growth should begin to appear in 1972." DEC pegs the growth rate of the industry as a whole at about 12% to 15%.

Better times are also forecast by Allan L. Rudell, vice president of Honeywell Information Systems, Waltham, Mass. "Anybody who thinks the market for computers has saturated isn't thinking," he says, obviously pleased with the success of the Honeywell/General Electric computer merger.

HIS is going to aim especially at markets like manufacturing data processing, banking, health and general

The 1972 business outlook

Whether or not Phase 2 puts a lid on inflation, the economy is certain to do a lot better in 1972 than it did in 1971. After three years of very poor growth—the average rate of increase for 1969 through 1971 was only 1.5% per year—the economy will rebound in 1972.

We now look for a Gross National Product of \$1,145 billion, up about \$93 billion or 8.8% over 1971. Real economic growth, excluding price inflation, will come to 5.4%. Prices, on the average, will advance about 3.3%. Industrial output—manufacturing, mining, and utilities—will rise faster than real GNP. Still, the real growth forecast for 1972 is not enough to bring the unemployment rate down below the 5% level by the end of the year.

Despite the lowered confidence, consumers are buying more, and they will be able to expand expenditures even more in the year ahead. Spending for goods and services is expected to go up 9%; for durables, 12%.

Consumers will have more income after taxes during 1972 than in 1971—higher wages, plus lower taxes, plus higher employment, guarantee this. Also, the 5.5% wage increase guideline set by the Pay Board will turn out to be a floor rather than a ceiling on wage gains, and Congress has cut personal income taxes by raising the exemption and the standard deduction. With unemployment dipping somewhat and the labor force expanding, there will be at least a million more jobs in 1972 than in 1971.

Business capital expenditures will rise about 8.5% in 1972, the first real increase in two years. Industry's ef-

forts to overcome its key problems—rising labor costs and worldwide competition—are increasing as investment in automated machinery rises rapidly. A quickening of investment in air and water pollution control is also providing a spur to investment in new and improved facilities, as are liberalized depreciation and the restoration of the 7% investment tax credit.

A 74.5% operating rate for industry provides little reason for corporate managers to expand their capacity, even with the improved investment incentives. However, with a sustained rise in industrial output in 1972, the operating rate should reach an 80% mark by the summer. Then there will be a spurt in new orders and contracts for capital goods and construction.

Investment in inventories will also accelerate in the year ahead. If business starts to pick up at the beginning of 1972, as expected, then industry will have to replenish its stocks to keep pace with rising production schedules.

In 1972, our balance of international trade will show a modest turnaround, after 1971 saw the first surplus of imports over exports. The devaluation of the dollar, the revaluation of other foreign currencies, and the cutting off of the dollar from gold is providing some short-term benefits to our export business by making U.S.-made products slightly more competitive in world markets and, at the same time, making foreign-made products slightly less competitive here.

—Douglas Greenwald, Chief Economist, McGraw-Hill

insurance companies, hospital systems, warehousing, and inventory control and distribution. And like the man from DEC, Rudell cites communications applications as being particularly important next year, "especially for our small H-16 mainframes."

On-line, real-time systems aimed at specific applications are expected by many to grow better than systems designed for the general-purpose data-processing market. In part, this is due to the overselling of accounting and batch-processing systems in the late sixties. And, says Melvin L. Couchman, director of marketing at Systems Engineering Laboratories, Ft. Lauderdale, Fla., "many of the scientific, on-line users are new customers, rather than the replacement customers making up the bulk of the general-purpose EDP market."

The year ahead may also find some important technological innovations strengthening their hold on the market. Semiconductor memories, for example, will become a more important factor in mainframe memory design, as several new computers with the new systems go into production. Another trend will see the increasing application of local processing capability—as in minicomputer-based or smart-terminal-based order entry systems, for example—at the expense of large-scale mainframe capacity.

Most important of all, the user community's outlook has been altered sharply and perhaps permanently. First, two years of recession and tight budgets have forced managements to examine with extreme care the cost-effectiveness of their computer installations.

Second, as would be expected, the passage of time has raised the computer-using community to its

shrewdest and most mature level ever. And the result, readily obvious only during 1971, is that the world outside of IBM no longer holds for data processing managers the unimaginable terrors it once did. "A few years ago, no user would gamble on a mixed system with split responsibility among manufacturers," says Curtis W. Fritze, vice president of corporate planning, Control Data Corp., Minneapolis. "But this has now become an acceptable way of doing business."

Many industry analysts also feel the present period of replacement brought on by a new "generation" of computers may be the last. The situation at IBM, the industry's giant, is unlike any it has experienced in recent years: its rate of growth has slowed, instead of continuing to increase. True, this could be ascribed to the recession, but customers do not seem to be jumping for the IBM 370 generation as they did for the 360. "The binge is over," says SEL's Couchman, referring to the late sixties when "everything got computerized."

And computer empires set up at separate divisions of large companies began to be broken up during the last two years as very top management carefully scrutinized each computer purchase and all computer applications.

North American Rockwell, for example, is reported to be consolidating most of the computer requirements for its various divisions at a single processing center. The result: \$50 million worth of leased machines may be cut to one quarter that total.

"The user isn't jumping to a classier computer as he has in the past," says Melvin M. Posin, assistant general manager, marketing, at Lockheed Electronics Corp.'s Data Products division, Los Angeles. "Now he asks the

question, "What kind of investment must I make in the old system to update it?" The answer may dictate not a switch from a 360/50 to a 370/155 but the addition of a new disk drive and one or two tape stations, he concludes.

For IBM, another problem is that the throughput of the new series 370 machines is so great that one can do the job of two or three or more of the older machines they replace. The result is that IBM has been taking a pasting on returns of machines from new 370 customers.

The computer industry probably has also not felt the final effects of the demise last September of RCA's computer operation, coming a year after GE also went out of the same business. There was of course the problem of credibility faced by the smaller computer firms as cus-

The minicomputer market continues on its upward course

tomers asked themselves: "If RCA went out of the business, whom can I trust to stay in but IBM?"

But as the large, "old-line" computer houses ponder their moves, the minicomputer makers prepare for another boom year. The market continues its remarkable growth—up to \$280 million worldwide last year, according to an estimate by market planners at Digital Equipment Corp., Maynard, Mass. And the forecast made a year ago still holds that worldwide sales will zoom to the billion dollar mark by 1975.

The most unprecedented cause of this growth was that the number of knowledgeable end-user customers—those willing to handle a computer project themselves instead of calling on an outside systems house—has been rising steadily. Data General Corp., Southboro, Mass., for one, is paying close attention to the "smart customer—the one who knows what he needs and buys it," says Allen Z. Kluchman, director of marketing. "He'll buy one minicomputer, try it out, and then come back for 24 more."

The end user's increasing ability to engineer mini-

Remote terminals are the winners in the peripherals marketplace

computer systems himself is fortunate for his suppliers. It expanded the market—and into a high-profit area—at the same time as the economy tightened and original equipment sales declined and became more competitive. During 1971, in fact, the OEM market "had fallen apart," states one OEM supplier, Lawrence Goshorn, president of General Automation Inc., Anaheim, Calif. Even stiffer competition was expected once Texas Instruments introduced its \$2,650 machine last year.

As for competing against its OEMs, the minicomputer makers show little concern. "We'll no doubt lose some sales to our own OEMs, but we'll be supplying the mainframe in either case" is a typical comment.

As the demand for the small machines is met, two large submarkets will come to the fore, points out a

spokesman at DEC. The largest—with as much as 80% of sales—will be for functional systems. These include items like communications, disk storage, time sharing, and industrial data-collection applications. The other submarket will be for more task-oriented or discrete and user systems. These include things like automatic typesetting and other semi-turnkey operations. "There's going to be heavy short-term growth in both of these markets," DEC says. "And if it doesn't appear en masse in 1972, we'll at least see the start of its growth."

The greatest interest in functional systems is being shown by the larger companies, according to DEC, especially in industrial and commercial areas, from large laboratories, and from large educational institutions.

And the result of both of these tendencies will be more sales of remote batch and processing terminals, small disk operating systems, and preprocessors, as well as boosts for small and medium-sized computers.

On the peripheral side of the business, remote terminals are expected to do particularly well by companies like Mohawk Data Sciences, Herkimer, N.Y., and Sanders Associates, Nashua, N.H.

"This year should see the beginning of an explosion in the intelligent terminal market," says Mohawk president, Richard P. Rifenburgh. "Starting last year with batch terminals like our 2400 or IBM's 2780, the cus-

Computers

(millions of dollars)

Computers and related equipment, total

	1971	1972
General-purpose digital systems	4,172	5,080
Analog and hybrid systems	50	52
Calculators	131	218
Peripherals	1,658	2,047

tomers now is requesting the intelligence to do local processing."

Thomas Colligan, director of Sanders' Data Systems division, even sees terminals with some intelligence handling jobs where there was no computer before; he hopes for growth at about 30% to 45% each year.

As for computer memories, 1971 was a tough year for ferrite core houses, and the pressure will continue this year. "Semiconductor memories are coming on strong, and there's been a lot of price deterioration," says Thomas P. Nau Jr., manager of market research and planning, Ferroxcube Corp., Saugerties, N.Y. Two weeks after Nau said this, Ferroxcube announced, in late November, that it was out of the mainframe memory business and concentrating on core memory add-ons to the end user, since these offer them a higher profit margin than the OEM. Nau sees this market ranging between 3,000 and 5,000 units in 1972.

Plated-wire memories seem to be all but dead for the commercial computer market, except for those that Univac uses. However, in the military-aerospace and industrial-control fields, plated wire is doing well, thanks to its nonvolatility.

Bruce Kaufman, president of Memory Systems Inc., Hawthorne, Calif., a plated-wire memory manufacturer,

expects \$3 million to \$4 million in plated-wire sales to the industrial market. And, he adds, this could reach over \$10 million in 1972. He estimates plated-wire sales for military-aerospace applications will hit \$10 million in 1971 and double to \$20 million in 1972, pointing to the recent award of a very large contract to Honeywell for plated-wire memories for the Viking Project.

So far, semiconductor memories' greatest success has been in relatively small-word-size units in terminals, and as buffers and scratchpads in computers. Only three

Semiconductor memories are coming on strong as add-ons and replacements

computer makers have semiconductor mainframe memories: IBM and Data General (bipolar), and Four-Phase Systems Inc. (metal oxide semiconductor).

On the other hand, William R. Arnold, president of Semiconductor Electronics Memories Inc., Phoenix, thinks the semiconductor systems can be produced in high enough volume to compete with cores as add-on and replacement memories.

Fairchild Camera & Instrument Corp., Syosset, N.Y., agreeing with Arnold, is testing the end-user market by signing up Wayne State University, Detroit, Mich., for a 2-million-byte bipolar add-on memory for its IBM System 360 model 67. The Fairchild memory, which will replace the core memory supplied by IBM, is basically identical to the one it developed for the Illiac 4.

Among computer makers, opinion continues to be divided about the efficiency of semiconductor designs. "MOS memories are still too expensive," says Emmons J. Miles, vice president for engineering at minicomputer maker Computer Automation Inc., Newport Beach, Calif. However, the company is taking the plunge this year—and with a fast MOS system. Interdata Inc.'s new model 80 machine, to be shipped in the second quarter, will have an MOS main memory expandable up to 64,000 bytes. "It is the fastest memory we could get hold of," declares Richard Genke, director of engineering at the Oceanport, N.J., firm.

Overall, C. Lester Hogan, Fairchild Camera & Instrument president, predicts: "The mainframe computer business demand for semiconductor products in the U.S. should show gradual improvement, rising from \$224 million in 1971 to about \$260 million this year. However, we don't expect a return to the [steep] pre-1970 growth patterns until late in the year."

Solid state

□ "The year 1972 will bring about the first growth the semiconductor industry has seen in three years," predicts Gene Selven, lately from Fairchild Semiconductor, now director of marketing at Raytheon Semicon-

ductor—a statement that encompasses the market consensus of semiconductor manufacturers. All told, semiconductor sales should pierce the \$1.3 billion mark in 1972, up from \$1.2 billion in 1971.

The brightest spot for the 1972 market is the MOS segment. Its strong growth over the last few years should continue with a whopping 30% gain to \$130 million. The linear segment should grow an additional 13%, going from \$82 million in 1971 to about \$93 million this year. Hybrid sales, especially in high-power circuits, will also come on strong in 1972, breaking \$100 million for the first time. Bipolar digital (TTL, DTL, etc.) will gain \$20-\$25 million, up from a disappointing \$267 million showing in 1971. Discrete conventional devices are expected to continue their gradual decline, dropping \$12 million more to about \$500 million. Thyristors, microwave diodes, transistors, and other discrete special device sales, however, should climb from \$113 million to \$120 million.

The year 1971 saw several major manufacturers drop out of the IC business—General Electric, Sylvania, and Philco-Ford being the most prominent to throw in the sponge.

The question is, will the shakeout continue? Don Sorchyk, vice president and general manager of Harris Semiconductor in Melbourne, Fla., is one who thinks so. "We're now seeing the shakeout that's been predicted for a long time, and I think it will continue," he says. "But the shakeout should stabilize the market. If the companies remaining can stabilize their prices and stop trying to buy the market," he adds, "the next few years should see significant improvement in overall semiconductor business."

In 1972, the big three—Texas Instruments, Dallas, Texas, Motorola Semiconductor, Phoenix, Ariz., and Fairchild Semiconductor, Mountain View, Calif.—will be entering the MOS marketplace in a big way. The ef-

The big three in semiconductors are plunging heavily into MOS

fects on the distribution profile of MOS sales are still far from clear, but they are bound to be profound. Up to now, most MOS sales have been from single-technology manufacturers like American Micro-Systems Inc. and Intel Corp., both of Santa Clara, Calif., and North American Rockwell Microelectronics Co., Anaheim, Calif.

Motorola, one of the giants that has publicly indicated its intention to be big in MOS, is tooling up its product line to meet the demand. An indication of just how bullish Motorola is on MOS can be gleaned from a statement made recently by Jack Haenichen, vice president and director of operations for the company's MOS division: "Seventy-five percent of the conceivable electronic jobs could be done with MOS, but only 10% are being done today with that technology. By 1976, half or more of LSI business will be MOS."

Rod O'Connor, marketing manager of the Semiconductor Products division of Motorola, agrees with his boss' bright prediction for the future of MOS, putting to-

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tal industry sales at \$125 million for MOS products in 1972. And, like many spokesmen in the industry, O'Connor says that "the 2,000-bit MOS RAM will become a standard in 1972, with the possibility of the 4,000-bit memory also coming along, but only in the latter part of the year." Beyond that, he cautions, "the 8,000-bit memory poses many problems for single-package implementation."

One manufacturer that's expecting a banner year in MOS is North American Rockwell Microelectronics Co. Ray Brown, director of product and market development, puts the MOS market at \$125 million to \$130 million. But Brown points out that he has seen estimates ranging from \$140 million to \$160 million for MOS.

In Brown's opinion, one of the reasons the MOS mar-

This may be the year bipolar battles MOS for memory market dollars

ket won't grow faster is that there's been a reluctance on the part of many firms to move into capital investment programs until they see what the effects of the administration's Phase 2 economic plan will be.

He does feel, however, that second-generation calculators "will begin to grow significantly in 1972. These new circuits will be both for new top-of-the-line scientific and accounting machines, as well as for very low-cost calculators," he asserts.

Taking a different point of view is William Eckess, marketing manager for the Microelectronic Products division of Hughes Aircraft Co., Newport Beach, Calif. Although Eckess predicts that MOS device sales will grow an additional 40% in 1972 over 1971—from very close to \$100 million to approximately \$140 million—he sees custom calculator chips not growing nearly as sharply in sales as they have in recent years. He feels the memory market will take up the slack. Last year, RAMs and ROMs accounted for only about 10% (\$10 million) of 1971 MOS sales and were dominated by MOS-memory specialty manufacturers like Intel. Eckess says,

Military, portable equipment, watches are all fair game for C/MOS

"Most industry planners look for memory circuits to grow to as much as 25% of the total MOS 1972 market—roughly \$35 million."

The most popular standard MOS memory circuit is the silicon-gate 1,024-bit RAM, such as the one pioneered by Intel. It was this particular standard circuit, cataloged 1103, that persuaded many major companies to enter the standard MOS market. Almost everyone will second-source the 1103 in 1972, hoping to get some production experience under their belts when their own 1103-type designs can be developed.

However, this could be the year bipolar technology makes a comeback against the surge of MOS in the memory area. The bipolar proponents hope to provide bipolar performance at MOS packing densities and

prices. For example, Fairchild, originator of the space-saving Isoplanar process, will soon announce the first 1,024-bit bipolar RAM early in the year, with a 2,048-bit RAM scheduled for the end of 1972.

In fact, there's strong indication that bipolar technology will dominate in the 1,024- and 2,048-bit memories, and MOS will dominate in the 4,096- and 8,192-bit chips. And because bipolar technology traditionally has provided the performance that's desirable for high-speed computer memories, many mainframe and peripherals manufacturers may be reluctant to design in a MOS 1,024- or 2,048-bit RAM, for fear that bipolar circuits will suddenly become available.

Mike Markkula, U.S. marketing manager for components at Intel Corp., says that in the semiconductor memory area, "a great number of people are making an invalid comparison between bipolar and MOS devices." He feels they are comparing the leading edge of bipolar technology such as Fairchild's Isoplanar, against the middle or even trailing edge of MOS technology, like everyone's standard p-channel or silicon-gate p-channel devices. Markkula thinks they really should be weighing "Isoplanar against n-channel silicon-gate technology—this is the leading edge in MOS."

Many manufacturers agree that much of the MOS action should be in the n-channel silicon-gate area. In fact, there's talk of a very heavy development in that area at Intel. And although Jerry Larkin, of American Micro-Systems, doesn't see many dollars gained from

Linear IC growth geared to consumer and industrial-control markets

devices using the new technologies, he does agree with Markkula that n-channel silicon-gate technology is a good bet to come on strong in 1972.

Regarding technology in the MOS world, Eckess says that users "don't seem to care what technology is used as long as they get the performance they need." But Eckess hopes that the higher performances obtainable with ion implantation will attract more buyers in 1972.

Another pioneer in ion implantation is Mostek in Carrollton, Texas. Berry Cash, marketing vice president of Mostek, sees sales of MOS hitting about \$120 million in 1972, up from \$80 million in 1971. He sees the breakdown as standard high threshold at 35%, low threshold at 60%, and complementary MOS at 5%. He says that ion implantation will emerge as a significant factor in memory circuits over the next few years, with increased use of depletion loads, and adds, "We'll see ion implantation combined with other presently existing and new techniques, such as nitride, and silicon and alumina gates." These techniques will go a long way in reducing the performance gap between MOS and bipolar devices.

Clearly, C/MOS will continue to grow in 1972, especially in the portable-equipment field, where its low power consumption is a distinct advantage. Perhaps the most bullish on the subject of C/MOS for 1972 are planners at RCA's Solid State division in Somerville, N.J., which pioneered in the technology several years ago. Dan Del Frate, marketing manager for all solid state

products at RCA, predicts that the C/MOS market will double in 1972, reaching the \$10 million level. Further, Del Frate feels that eventually C/MOS can address itself to 70% of the digital market, as it is defined today.

RCA planners view the communications market—particularly modern design where high-packing density is not a requirement—as a key one for C/MOS growth, along with the timepiece and industrial control market. Andy Doffo, RCA market manager for C/MOS products, claims that “products for these areas were all in prototype production in 1971, and now we’re beginning to see volume production orders this year. Doffo also says, “1972 is the year that many of the watch and clock manufacturers will start to commit themselves to an electronic watch circuit design. Since C/MOS is most suitable for micropower watch circuits, we’re girding ourselves for volume production.”

What’s not generally realized is that the military and aerospace industries, which represent one of the biggest markets for C/MOS, should grow for the next five years. Indeed, it was for the high-reliability military communications market that RCA first developed C/MOS circuits, and sales still continue strong—“30% to 40% of the total C/MOS market is military and aerospace in 1972,” says Del Frate.

Harris Semiconductor, Melbourne, Fla., is trying to expand its markets into the industrial and commercial segments, both with traditional C/MOS logic and C/MOS memory. An example of the Harris thrust into memory is its soon-to-be-announced C/MOS.

According to Sorchyk, “we are gearing up our product line to penetrate both the traditional military markets and the newer industrial ones, like process control and communications.” Ed Fernandez, product development manager for linear devices at Harris, points out that to survive in that area, “you must build products that will cut across all industry segments.” According to

Digital bipolars make comeback; TTL growth to continue into 1973

Fernandez, Harris’ new four-channel programable op amp is one such product. It should find such diversified applications as analog multiplexers with buffered input and output, integrator ramp generators, and general amplifiers with programable gains.

After a two-year decline, digital bipolar sales are making a comeback. The total is expected to reach \$290 million, up 8.5% from last year’s disappointing \$267 million. Interestingly, the turnabout comes in the teeth of a continuing price erosion, both of TTL and DTL gates and flip-flops, as well as bipolar MSI circuits. Driving the market to higher dollar levels is quickening demand, especially for MSI circuits for medium-sized computers and peripherals, and in MOS-interface equipment.

Robert Ulrickson, digital marketing manager at Fairchild, agrees generally with the industry estimates putting total U.S. factory sales of bipolar ICs, including bipolar memories, at about \$250 million in 1971, and the growth at about 7.5% to \$270 million in 1972. “This growth rate should reach 12% by 1973,” he adds. “And

Solid state

(millions of dollars)	1971	1972
Semiconductors, total	1,224	1,325
Discretes, conventional	514	502
Discretes, special	113	121
Integrated circuits	450	512
Optoelectronics	40	51
Hybrids	93	110

after 1973, I expect growth to continue, but at a lower rate because MOS will make inroads into the TTL and DTL markets and take over new ones.”

C. Lester Hogan, president of Fairchild Camera & Instrument Corp., says, “Demand for TTL is fantastic—two to three million parts will be shipped this year.” “But,” warns Hogan, “sales should peak out in mid-’73, declining from there.” He sees TTL prices declining further and “reaching a level that will allow only two or three major manufacturers to produce this technology profitably.”

As far as TTL pricing is concerned, Tom Thorkelson, marketing manager for digital products at National Semiconductor, says that “the industry is coming to the day of reckoning—it has to operate profitably.” But he

Hybrid circuits are on the rise in consumer, military/aerospace market

adds that “there will be no skyrocketing of TTL prices. We see the average selling price coming down because MSI prices are coming down, and the TTL mix is shifting toward more and more MSI.” Motorola, in the face of general price declines, nevertheless boosted prices on some products about 15%.

As for TTL trends, Thorkelson says that “Schottky is coming on strong, but it’s not going to replace ECL. We’ll be in ECL in ’72. And another trend is toward three-level logic devices. National was the first to market these, and now Fairchild and Signetics are following.”

As for the military portion of the digital bipolar IC business, Ulrickson expects it to be flat in 1972, or possibly to show some small increase. This opinion is seconded by Jerry Sanders, president of Advanced Micro Devices Inc., Sunnyvale, Calif., who says that military business for ICs is starting to pick up again. In general, “while the total military IC market has not grown,” says Sanders, “that for TTL memory and MSI circuits, line drivers, and receivers has.”

While many people think of the semiconductor market as monolithic ICs only, hybrid circuits are very much in the picture, and the hybrid business is growing very well, indeed. Mike Scott, hybrid products marketing manager at National Semiconductor, puts the increase in sales this year at 30%, reaching the \$100 million level. And he’s more optimistic over future growth, saying that “by 1973, hybrids will be a \$400–\$500 million market, if you include the potted modules.” Scott says the

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reason hybrid circuits are getting popular is that reliability is better than with separately wired discretets.

Scott points out that the consumer industry is "going hybrid." For example, Delco Radio is expecting to have its new automobile radio going soon, with five hybrid ICs (thick film) to make up the complete unit. Further, RCA, in its new XL-100 series TV sets is using a five-chip thick film system.

Scott also feels, "It won't be long before the MOS and bipolar memory business starts turning to hybrids for memory stacks—say 4K words to 16 bits, using 1,000-bit chips." Eckess agrees, saying that hybrids have a good chance of getting into the memory market, offering 2,000- to 8,000-bit chips—especially monolithic chips with these packing densities can't be produced in quantities in 1972. Hybrid circuits for the industrial and military markets are expanding as well. Scott says that National will have a \$1-per-bit digital-to-analog converter on the market by the first quarter of '72, aimed especially at the industrial controls market. Several active filters are scheduled for later in the year.

Hughes is forecasting a \$100 million hybrid market in 1972, up from \$80 million last year. Eckess attributes the growth to major military airborne programs that "will be going into production or beyond prototype stage this year." In this market, he includes electronic countermeasures equipment, the Navy/Lockheed S-3A anti-submarine warfare aircraft, the Navy/Grumman F-14 fighter and Air Force/McDonnell Douglas F-15 fighter as programs rich in hybrid opportunities.

RCA is also eyeing the hybrid market. Both power and rf hybrid units will contribute to RCA's new linear sales, says Frank Rohr, market manager for all hybrid products. According to Rohr, power hybrid sales should grow an additional 60% and rf sales by 30% in 1972. In the power area, Rohr looks to computer peripherals, hammer drivers, and servos as best movers for this year. As for rf markets, "uhf mobile communications markets look promising," he concludes.

One product that RCA hopes to use as its leading edge

Discretets still dropping, but silicon power and plastic device sales look good

in the rf segment is a 15-watt 450-megahertz amplifier. The amplifier, scheduled for release early in 1972, is aimed at the uhf mobile radio market, which, Rohr feels, offers the best opportunity. "Right now," he says, uhf mobile represent only 25% of the radios, and we look for growth in this area to be more pronounced than in the low-frequency end."

Not optimistic are most forecasts for discrete devices for 1972. Observers look for the downward trend to continue, "but how far is anyone's guess," says Hughes' Eckess. "The problem is," he says, "we don't see any new programs using discretets."

The best industry estimate on 1972 total sales of discretets (conventional, as well as special devices) is about \$622 million, down some \$5 million from 1971. Slightly more optimistic than Eckess is John Duffy, product marketing manager for discretets at Fairchild, who looks

for a slight increase in total discrete sales this year, "reaching \$616 million, up from \$610 for 1971." In his view, plastic packages will continue to take business away from metal-can units, "especially in the small signal market." Duffy puts the small-signal plastic transistor market as \$64 million in 1972, up \$8 million from last year, and can units dropping to \$58 million from

LED displays and coupler components will dominate optoelectronics market

1971 sales of \$62 million. Observers see this as an indication of further erosion in military business, where the high reliability of cans is a requirement. The slack should be taken up in the industrial area, mostly in communications and low-power control units, where plastic is adequate for most environments.

National is another to adopt a more positive position in discrete devices in 1972. Thomas D. Recine, marketing manager for discrete products, is not only looking to grab some of the small-signal plastic transistor business—he estimates it at \$4 million per month in 1972—but is expecting can packages to increase as well, moving from \$37 million in 1971 to about \$45 million this year.

Perhaps the brightest spot in the discrete segment is the market for silicon power transistors, going from about \$96.5 million in '71 to \$103.5 million in '72. Increased use of semiconductors in the industrial segment is spurring this activity, and most industry observers see a steady increase in silicon power transistors and rectifiers.

Richard Abraham, director of operations for discrete products at Motorola's Semiconductor Products division, says the reason for the growth in power transistors is that ICs still can't handle power. "The part of the market that ICs will cut into will be the small-signal area. There's still no way to do power functions with ICs, though."

Besides that, Abraham points out, "Any time you build any kind of data-processing equipment, you need power supplies."

On rf, Abraham sees "considerable growth," too, "because communications of all types are going to grow quite a bit, and the rf transistor portion should track reasonably well with growth in the total communications market." Beyond this year, Abraham looks for power transistor growth in such applications as automobile ignition and distribution systems and television sets, as power transistors continue to replace the power tubes remaining in those sets.

Solid state optoelectronic devices are expected to continue their strong showing of the last few years, growing to \$51 million in 1973, up from last year's total of \$39.5 million. Brightest will be light-emitting-diode displays—more than doubling to \$12 million—and couplers, expected to reach the \$5 million mark, up from \$2.5 million. Discrete LEDs also will perform well, jumping 50% to the \$6.5 million level. The rest of the market, principally the sensor-emitter functions, such as phototransistors and transistor arrays, is expected to remain flat at

\$12 million because of saturation in the computer market, which absorbs the bulk of these devices for card and tag readers.

In general, 1971 was the year that LED displays were designed into the bulk of new instruments. The effects of this trend will be felt over the next few years, with perhaps a healthy \$25-\$30 million market in 1975. According to Ian McCrea, marketing manager of optoelectronic devices at Texas Instruments, the boom in LED displays can be attributed to the spectacular growth of the calculator and instrument market.

McCrea is equally optimistic about the discrete LED market, seeing the consumer segment picking up as unit prices drop. As material and manufacturing costs drop, major manufacturers such as TI and Motorola will be able to deliver these lamps at prices that will open up new opportunities—among them, light-level indicators for cameras and pilot lights for appliances. Quantity prices as low as 35 cents per unit already have become industry standards in 1971.

In addition, colors other than red are starting to appear, making solid state lamps still more attractive as panel lights. Monsanto has announced a green and yellow LED lamps, and the other manufacturers are soon to follow. Monsanto also has new displays in green and yellow.

Consumer

□ The consumer electronics market was a pleasant surprise in 1971. Manufacturers, anticipating a lack of buying confidence, would have been happy just to make it back to the \$3.5 billion sales level of 1970. Instead, the figure climbed to \$3.9 billion. Expectations are that 1972 will be another winner—the consensus estimates put the market at \$4.1 billion.

But still the soap opera questions hang over the industry. Will Phase 2 policies bring out more of the buying public? Will color TV sales maintain momentum throughout the year? Will conflicting quadraphonic technologies sort themselves out? Will video cartridge players ever find a place in the American home? Tune in next year—and some of these questions still may not be answered.

Another poser for the consumer electronics business these days is: "What is the consumer electronics busi-

ness?" Traditionally, it's been dominated by television and audio products, but a group of newcomers will begin to appear in 1972. Among them will be cheap, hand-held calculators, solid state wristwatches, and elaborate security-alarm systems.

Topping the list of 1971's successes was color television, bellwether of the consumer electronics industry. Rousing third and fourth quarters pushed U.S. domestic sales to the \$2 billion mark. Hardly a week went by in the second half in which color TV didn't set a record on the Electronic Industries Association's sales reports, thanks in part to the karate chops delivered to the Japanese by the prolonged West Coast dock strike and the 10% surcharge. The Phase 1 freeze had little effect on TV, since the tendency was to drop prices.

The sales consensus for 1972 is \$2 billion to \$2.2 billion, based on the anticipated growth of the second-set market for portables, as well as continued, but slower, penetration of the large-screen viewer's home. Meanwhile, monochrome TV set dollar value is expected to continue to fade gradually—to less than \$500 million.

U.S. producers have usually depended on large-screen sales to counter Japanese competition for the small sets, yet 18- and 19-inch models sold very well and should continue strong. By percentage of units sold, the trend will shift toward portables this year.

At the same time, Japan's Sony and Matsushita (Panasonic) are building assembly facilities in this country, and are most likely to challenge the traditionally strong U.S. hold on the large-screen models. And 25-in. sets have all but replaced the 23-in. models, which by the end of the year should be phased out entirely.

Technologically, the trend toward the all-solid-state chassis begun with the 1972 model year will continue. And once again more electronic tuners will be found in more of this year's models. The big selling point now is automatic tuning; eventually the TV receiver will be crammed with factory-set controls.

"The crossover point in price between the solid state

Four-channel explodes onto scene in matrixed vs discrete battle

and tube sets, which was supposed to happen in 1968, should take place in 1973," when semiconductor prices finally drop to the point where set makers can afford to switch, says William Boss, vice president of marketing for Sylvania Entertainment Products division, Batavia, N.Y. "The general move to all-solid-state or hybrids [85% solid state] will have tremendous growth then."

High-fidelity components have tended to march to a different drum in the industry, and the coming year should be no exception. The big focal point, without question, is four-channel or quadraphonic sound. But there are two incompatible systems vying for attention—a handful of matrixing systems under the banner of CBS/Sony, Electro-Voice, and Sansui, which are now theoretically compatible with each other, and four-channel discrete sound, led by RCA Records using the Victor Company of Japan disk approach and supported by Matsushita hardware. The RCA Consumer Electron-

Consumer

(millions of dollars)	1971	1972
Consumer electronics, total	3,885	4,094
Television	2,440	2,585
Audio	1,207	1,242
Automotive	16	27
Musical instruments and kits	222	240

U.S. MARKETS FORECAST

ics division has been trying to sell a discrete four-tape system but has not committed itself officially to following RCA Records into disk-playing equipment.

Add to this mix the Dynaco phase-shift technique, which hypes up standard two-channel stereo records to get room-ambience sounds from the back speakers, and you have the makings of four channels worth of confusion. But despite the lack of a single dominating technology—and the question this raises in potential sales—hi-fi components makers are elated by the prospects of 12% growth this year over last because of four-channel.

"As a speaker manufacturer, I'm shouting hurrah. And as vice president of the Institute for High Fidelity, I'm also shouting hurrah for the whole industry," Herbert Horowitz, president of Empire Scientific, Garden City, N.Y., shouts. "Everybody is happy about four-channel. It is a true innovation that also excites sales.

Similarly, incompatibility does not disturb James Parks, marketing manager for Fisher Radio, Garden City, N.Y. "After all," he points out, "we've got other

Manufacturers of home video players are still looking for a standard

noncompatible systems in tape recordings, yet people buy what they want. Four-channel is the biggest shot in the arm since the advent of stereo."

Any doubts over the attractiveness of four-channel's sales potential is dispelled by the fact that the big mass producers ordinarily inclined toward cumbersome consoles are moving into components with all of their promotional might. Sales estimates ranging as high as \$118 million for all audio components sold with four-channel are being heard—despite the fact that competing systems are far from coming to a compromise.

As one industry wag put it, the consumer could end up with a 6-foot-long amplifier in order to fit in adapters for matrixing, discrete four-channel, phase shift, cartridge, cassette, Dolby noise suppresser, Philips noise suppressor, fm stereo, four-channel fm, discrete four-channel fm, and, by 1973, stereo audio for his video cartridge players.

But audio's confusion over standards is orderly compared to the circus going on over the home video player.

Solid state wristwatches appear to be an electronic idea whose time has come

A year ago would-be producers seemed so exhausted by the test of wills over which of four or five noncompatible systems would prevail that there was serious talk about standardization. But in the meantime, there has been more confusion. All of the contenders have either delayed or cut back, including CBS-EVR.

The clincher came when Motorola/EVR raised the issue of rf interference caused by video players on broadcast reception, and the FCC sent everyone except Motorola back to the drawing board—with a set of requirements that will necessitate a number of new

tradeoffs. (Sony also received FCC approval late last year.)

At the moment there is no consumer market for cartridge TV. Only financially tight Cartridge TV, San Jose, Calif., which also has one FCC-sanctioned model, is promising a consumer product, Cartrivision, by mid-year. All the others, including CBS, with its film-based EVR, Ampex with Instavideo tape, and the Japanese with a bewildering line of ½- and ¾-in. VTR, are going after the commercial market first.

Consumer sales will be slow in developing until producers get units that sell for \$300 to \$400 (compared to \$800 to \$900 now) and there is a worthwhile library of software to play at home.

By that time, however, community antenna television will also be a larger factor in the home, now that CATV has apparently broken out of its small town, rural limits. The key to CATV's growth has been penetration of the 100 top markets, which was worked out late last year.

After lolling around for some 20 years, the market for CATV equipment now looks very good—in fact, explosive sales of distribution equipment should be around \$22-\$23 million this year, after sales of \$21 million in 1971, but hit \$35 million by 1975. Coaxial cable sales, also tracking CATV's big city growth, will hang around \$40 million this year, compared to \$30 million last, according to manufacturers.

Importation of outside channels to the major cities has been the point of contention between cablecasters and over-the-air broadcasters, but a formula giving CATV an entry is being worked out.

A research report recently published by Mitre Corp., McLean, Va., estimated 10-year capital investment for a two-way system estimated by a single cablecaster in an urban market at \$28 million to \$61 million depending on audience saturation and services offered. This year there will be more trial two-way systems than working installations. However, by 1975 two-way capabilities should push total CATV equipment sales up to around \$95 million.

Other electronics applications in consumer goods may well be overshadowed this year by the arrival of all-solid-state wrist watches. Every watch company is evaluating quartz crystal timepieces, operated by either complementary MOS or p-channel MOS circuits, and with mechanical as well as digital readout.

A major U.S. manufacturer is expected to announce soon a C/MOS watch with liquid crystal display that will sell for around \$200. And Westclox will offer an MOS liquid crystal watch for \$200. By the end of the year, as the Japanese and Swiss get into the race, MOS watches in the \$100 neighborhood will begin to arrive, opening a sales potential for IC houses in the millions of units.

Another newcomer to the consumer ranks this year is the hand-held calculator, offspring of the electronic desk-top units that swept to dominance of the commercial calculator field almost overnight. Now hand-held units built by Miida, Royal, and Commodore around single-chip LSI circuits are beginning to appear in discount centers, department stores, and camera shops, as well as office supply houses. No one is sure what the sales this year will be because these little four-function machines are still too new.

A good example of the powerful lure of the market, though, is Royal Consumer Products division, Hartford, Conn., a part of Litton Industries. With its Digital III and IV, made by the Monroe division of Litton, Royal is in a position to market these units to consumer outlets, from mass merchandisers to the corner stationery shop. With quantity discounts and prompt payment, dealers can get these machines for under \$90. Suggested retail prices are \$139 and \$149.

Commercial

□ The commercial market, as usual, is quite sensitive to economic conditions—which were anything but clear as 1971 ended. Phase 2 is proving a mixed bag, and manufacturers were looking for something more substantial to boost sales of office copiers, accounting machines, dictating machines, point-of-sale terminals, and calculators.

Symbolic of this end of the business is the electronic calculator. After flashing into 1971, electronic calculators lost their dazzle by midyear. Prices took a nose-dive amid signs of overproduction. Though unit sales continued to rise, price drops left year-end dollar volume almost the same as 1970—around \$400 million, including Japanese imports. This year, as one industry observer put it, “calculator sales are as much an enigma as the entire economy.” But projections indicate total sales of \$450 million to \$475 million, half of which will be American-made.

Just as the low end of the line has been spun into the broader consumer market, the upper-end programable

Emphasis in educational market shifts to small screens, a boon for CAI

calculators are moving into broader commercial applications. This trend will have a dramatic affect on programable sales, which will hit \$100 to \$140 million this year, compared to about \$70 million in 1971.

Two years ago, when the Japanese began their invasion of the desk-top calculator market, U.S. firms had to buy private-label machines simply to get into the competition. Now, with cost factors more favorable for domestic manufacture, firms such as Commodore, Monroe, and Victor Comptometer Corp. are touting “Made in America” for some lines. The main reasons for the shift are U.S. leadership in LSI circuits—now the heart of electronic calculators—and the declining amount of labor required to assemble the finished product. In addition, the same West Coast dock strike and import surcharge that slowed the flow of Japanese consumer goods to this country also stymied calculators and made domestic manufacture all the more viable.

The education market is also confused, but it looks

healthier than a year ago because of an upsurge in industrial education spending. The whole concept of audio-visual aids has changed toward “individual instruction,” which puts a premium on small-screen presentations—and perhaps presages the breakthrough of computer-aided instruction.

According to Peter Roma, vice president for Video Circuits, Inc., Nanuet, N.Y., a video-tape adapter firm, educational equipment sales to industry have increased, not in spite of the poor economy, but because of it.

This year should also mark the arrival of definitive specifications to guide the design and use of point-of-sale terminals at retail stores—with sales expected to total about \$51.5 million, compared to a mere \$9.8 million in 1971. Manufacturers and retailers are still far apart on these specifications, but some progress has been made toward compatibility.

Retailers so far are just not sold on a single-vendor concept, but want to be able to mix equipment to satisfy their own needs. The effort to ram a single company’s design into point-of-sales use has not worked. So this year, the cautious trial-and-error period should gradually give way to genuine sales, if makers are ready to go along with retailer demand for compatibility.

Communications

□ Alongside most other segments of the U.S. economy, the communications industry looks positively healthy. And there are good reasons for a prognosis of continued good health in 1972 and beyond:

- The Federal Communications Commission decided last May to allow competition among public communications carriers, thus extending more of the equipment base to independent suppliers.

- As a result of an earlier ruling, users can now attach non-Bell System equipment to the nationwide dialed-phone network.

- Sections of the frequency spectrum, including millimeter-wave bands, were opened in 1971 for common-carrier usage; and proposed new allocations in land mobile bands promise to boost that business.

- Data communications is taking off on an upward curve.

- With a half-dozen proposals before the FCC for domestic satellite communications, a go-ahead for several systems seems likely early this year.

- Communications equipment requirements overseas are expected to zoom in 1972.

The most rapidly growing segment of the domestic market is data communications, both the transmission business and “terminal equipment”—which ranges in sophistication from simple teleprinters to computer-front-end processors.

In the terminal and communications control area, a recent trend—of particular significance to the manufacturer of electronic equipment—is the emergence of

Communications

(millions of dollars)	1971	1972
Communications equipment, total	1,720	1,934
Radio	553	634
Navigation	128	131
Terminals and switching	170	197
CATV	59	65
CCTV	23	27

"prime contractors" similar in function to military systems contractors. Systems service companies are taking on responsibility for the purchase of terminal equipment as the end user balks at dealing with too many suppliers, according to Zakar V. Zakarian, president of Western Union Data Services Co., Mahwah, N.J.

Until the historic FCC policy decision last May, only the phone companies had the charter to supply the public with the communications circuits to meet this explosive demand. Now specialized carriers can compete in leasing line-of-sight microwave channels. This decision will almost immediately double the market size for manufacturers of long-haul communications equipment, according to Harry Newton, a consultant for New York researchers Frost & Sullivan Inc. "This market last year was \$100 million," says Newton, "and will jump to over \$200 million annually in 1972 and remain there throughout most of the decade."

About one-third of the long-haul stations planned by the specialized carriers are terminal stations that convert the microwave signals down to baseband for reamplification. At this point, the baseband signals may be dropped out or additional signals added. Typical cost for this kind of station is just under \$500,000, and about 70% of the money spent is for electronics.

A look at the electronics makeup of these microwave stations shows why manufacturers are closely following events in the specialized-carrier issue. The multiplexing

Common-carrier equipment market is opening wide to independents

and terminal equipment alone runs several hundred thousand dollars for a typical 400-channel baseband station. Large service companies will contract with key systems manufacturers for the installation and acquisition of the components for the repeater stations. And in most cases, these systems contractors look outside their companies for a large portion of the equipment. Raytheon Co., of Lexington, Mass., for example, does not manufacture multiplexers and will look for outside suppliers if it gets a turnkey job.

Microwave Communications Inc., Washington, D.C., received two years ago the first FCC approval to build a trial link, between St. Louis and Chicago. This link is now operating, and the company is planning construction of about six additional links this year. MCI will concentrate first on the eastern U.S., and systems contracts will be distributed among several manufacturers.

Domestic satellite systems, which will back up existing telephone and data transmission networks, are at best two years away from operation. But the FCC hopes to signal the go-ahead to several of the eight contenders early this year, and equipment contracts should follow.

These systems promise less costly nationwide transmission rates, especially for one-way transmission of CATV and network TV. For an investment of as little as \$50 million, one of these proposed systems could provide links that transmit information from coast to coast just as readily as from New York to Washington.

Meanwhile, the highly competitive market for Intel-sat ground stations hovers at the \$60 million to \$70 million annual level. With 65 stations operational and 17 under construction, it is expected that about 20 new contracts will be let in 1972. Principal U.S. contenders are ITT and GTE International.

The FCC's Carterfone decision of 1968 for the first time allowed the interconnection of user-owned or leased equipment to the Bell System dialed network.

Manufacturers, service organizations team up for interconnect sales

The resulting interconnect market, as it is now known, is just beginning to become a major factor for communications equipment manufacturers. Included in this market are data modems and multiplexers.

Modems, which provide the interface between the computer and the voice network, constituted a \$45.8 million market in 1971 and are expected to show a 25% gain this year. The trend toward higher bit rates for use with the dial-up network will continue in 1972. An "error-free" 4,800-bit-per-second modem was introduced in 1971 by Paradyne Corp., Clearwater, Fla., and other makers are expected to follow.

James D. Wylie, marketing vice president at Paradyne, points to a related trend: error control in large computer systems is being built into the modem instead of being an added function of the central processor. The technique can cut costs of the system's error-control function by better than 50%, Wylie says.

This year, for the first time, stored-program computer control will be economical for PBXs with fewer than 300 lines, says Lowell E. Hoxie, senior vice president of Dittberner Associates, a Washington, D.C., consulting firm. He adds that there will also be installations of PBXs in the under-30-line class that will be able to serve as key system replacements. The most active service features that will be marketed this year include direct inward dialing (DID) and automatic identification of outward dialing (AIOD) for billing purposes.

Facsimile terminals in operation at the end of 1971 totaled about 40,000 units, and the number will jump to between 70,000 and 80,000 in 1972, according to Peter S. Philippi, vice president and general manager of Magnavox Systems Inc., Fort Wayne, Ind.

Several manufacturers are now developing machines capable of transmitting an 8½-by-11-inch document over the dialed phone line in one minute, down from the 4 to 6 minutes now required. This milestone will sig-

nificantly reduce both transmission and operating costs.

Philippi says the Magnavox 1-minute machine will use electronic scanning, eliminate redundant transmission by sending pulses only at black-white or white-black transitions during the scan, and employ a transmission rate of 3,600 or 4,800 bits per second.

As technology develops, says Joe Verruso of Litton's Datalog division, Melville, N.Y., the functions of the facsimile and the office copier will combine in the corporate copy center, making economical a copier with built-in transmitting capability. Teleprinter service may then no longer be economically feasible, adds Verruso.

AT&T says it has nearly \$12 billion in interconnect equipment installed on customer premises. This represents about 20% of Bell's total investment, and is now exposed to competition from other interconnectors. Many big communications and computer companies are eyeing this market intensively, ready to jump in when the timing appears right. IBM, for example, makes an automatic PBX system for the European market. With the domestic sales and maintenance organization that it has, the computer giant is likely to invade the U.S. market after that market matures a little more.

Meanwhile, AT&T seems determined to keep the lion's share. Western Electric, AT&T's manufacturing subsidiary, has completed a plant in Denver to make a new line of PBX equipment. The company will reportedly offer a PBX line for sale, rather than lease, to let it compete more directly with interconnect challengers.

Sales of mobile radios, a market of 2.1 million units

Communications helps microwave area, but the big money is marked DOD

in 1970, are moving upward slowly, and are expected to reach 2.9 million in 1975 and 3.7 million by 1980, according to Glenn Petersen, general manager of the General Electric Mobile Radio department, Lynchburg, Va. Those projections are based on the assumption that the number of available channels remains constant. "If we change that assumption and add channels while the number per channel stays constant, the units jump to almost 5 million by 1980," Petersen says.

And additional spectrum space appears on the way. Says Wendell Harris of the FCC's mobile radio branch: "If rulemaking docket 18262 is approved this year, about 75 megahertz of additional spectrum will be available for land mobile common carriers." The added frequency bands would mean significant growth, since only 4 MHz is now available.

From now on, a-m radio in the 2-MHz marine band will be virtually dead as far as new communications equipment is concerned. The FCC's edict requiring vhf fm and single-sideband equipment for all new licenses became effective on Jan. 1. Present users of a-m channels, however, have until Jan. 1, 1977 to make the shift, so the major jump in sales of vhf equipment is not expected until 1976. There are now between 250,000 and 300,000 marine radio sets in use, and the \$18.6 million market in 1971 is expected to rise slightly in 1972.

Annual increases of 100% or more are characteristic

of data communications equipment installations in most European countries, according to Mirek Stevenson, board chairman of Quantum Science Corp., New York, N.Y.

At least one U.S. company sees a sizable chunk of that business available in 1972. According to Michael Harrison, assistant marketing manager at Teledyne Microwave division, Sunnyvale, Calif., circulator/isolator sales for U.S. companies will move upward by 25% to about \$50 million. About \$10-\$12 million of that sales volume will come from Europe, where communications growth will exceed the capacities of European firms.

The communications industry may fill in some of the market voids resulting from 1970-71 cutbacks in Government spending for microwave equipment, but the Government is still the biggest spender.

The microwave components market was a \$200 million business in 1971. This market should creep up to about \$220 million in 1972, says James W. Cauger, product sales manager at Microwave Associates, Burlington, Mass. "The reason for the low dollar figures," Cauger adds, "is a market-wide depression of prices, caused by overcapacity. Most of this excess exists in garage-shop or other low-overhead operations, and these take a long time failing."

Tom Hylltin, marketing manager for microwave components at Texas Instruments, sees a slight increase in defense spending over last year. Several companies are now getting contracts for C- and X-band phased-array modules, he points out, adding that probably \$10 million in Government money will go into solid state phased-array modules this year.

"One of the things people are beginning to realize," Hylltin says, "is that the microwave industry is no big pot of gold. The R&D investments by companies are being cut significantly. There are now simply fewer people working in the field."

Richard Clark, who manages a new military program at Watkins-Johnson, Palo Alto, Calif., underscores the lack of enthusiasm over non-Government microwave markets: "If I were to go look for business right now," says Clark, "it would have to have the military tied to it to be worth the effort. We wouldn't throw microwave communications inquiries away, but much of this talk about industrial equipment just doesn't materialize."

The commercial market will be highly competitive in the next several years, according to Wayne Grove, engineering manager for microelectronics R&D at Hewlett-Packard Co. For example, he says, "a broadband coax switch, operating from 1 to 12.4 GHz, having less than 1.5-dB insertion loss at X-band, and with 40-dB isolation, would sell for about \$100 in nominal quantities. Within the next several years, a similar unit will sell for \$40 to \$50 in the same quantities." He attributes this price reduction to improvements in packaging and production, and larger volume.

Richard J. Bell, vice president of marketing at Yig-Tek Corp., Santa Clara, Calif., couldn't be more pleased with the commercial microwave market. Yig-Tek makes YIG filters and oscillators for communications and instrumentation. Bell pegs the YIG filter market at \$3 million in 1971. He does not have a good fix on 1972, partly because 40% of the business is in equipment that

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has never incorporated YIG devices previously. In distance measuring equipment for aircraft, for example, YIG devices are replacing varactor diodes, Bell says.

The microwave tube market, which fell about 12% in 1971 to about \$140 million, is expected to slide another 2% to 3% in 1972, says Clifford Rockwood, marketing manager for Varian's Eimac division. "If the economy picks up, then the uhf/vhf television business will also, but now electronic countermeasures are the only bright spot," Rockwood adds.

Components

□ Start with a full cup of conservatism, and sprinkle the mix with optimism—those are the ingredients of component makers' forecasts for 1972.

This year, standard components like resistors, capacitors and connectors will exhibit borderline growth at best. The heady 40% to 50% annual growth enjoyed by encapsulated hybrid circuits only three or four years ago will probably fall to a 10% to 15% level. Connector suppliers, hit hard by the drastic decline of the military market, are focusing on industrial and consumer areas to take up the slack. And electromechanical relays, having successfully fought off the threat from solid state competitors—at least for now—seem to be perking along with steady, if unspectacular, growth.

Inventory buying on the part of equipment makers, or the lack of it, continues to dampen component sales. And price erosion is still gnawing away at profit margins, forcing companies to lower prices to remain competitive and stay in business. In 1971, many companies showed significant unit volume growth, around 10%, but dollar volume grew only marginally, by about 2%. Price erosion is also affecting product manufacturing as component makers seek reduced labor and materials cost—without degrading product performance.

Moreover, some new markets are not developing as quickly as expected. Besides the overestimated computer market, newer and smaller areas, such as pollution control, education, mass transportation, and anti-crime electronics, are not creating the hoped-for component demand. But component houses are still looking towards these new markets and others to take up the slack left by a depressed military business.

Components

(millions of dollars)

	1971	1972
Components, total	5,335	5,639
Antennas and hardware	388	423
Capacitors	439	460
Connectors	286	312
Tubes	1,046	1,056
Resistors	348	354

Generally, the component houses do not see any major technological innovations developing within the next few years, partly due to large layoffs of engineering personnel. Instead, they predict a refinement of existing technologies and evolutionary, as opposed to revolutionary, changes in various product lines.

The current economic situation has precipitated at least one significant marketing-strategy reversal. Several hybrid module makers, feeling that their general-purpose products are eventually going to be preempted by integrated circuit manufacturers, are going after the specialized customer who requires the integration of two or more circuit functions that cannot be bought as a chip. The hybrid module people also expect data converters to play a major role in their growth.

One of the largest module suppliers, Analog Devices Inc., Norwood, Mass., is looking for a 15% to 20% increase in sales. The company plans to introduce between 30 and 40 new products in the coming year, with at least 20 new entries in the data converter area.

Another company in the hybrid module business, Teledyne/Philbrick, Dedham, Mass., anticipates about 15% overall growth. "You have to go after those people who are currently manufacturing in-house," says Neil Foster, marketing manager.

Zeltex Inc., Concord, Calif., also a module maker, is a bit more bullish. Alex Boley, marketing director, is optimistic about the economy, and expects his company's sales to double within 18 months. "We see ourselves becoming a little more specialized," he notes, "getting into

Modules will be aimed at special jobs that integrated circuits cannot do

medical electronics, instrumentation amplifiers, and oceanography applications." Zeltex has just introduced a successful line of data converters.

Burr-Brown Research Corp., Tucson, Ariz., attributes the slowdown of module growth to a flattening out of sales for the hybrid operational amplifier. The company intends to change gears and take the end-equipment approach. Jim Burns, director of new business development, explains, "We will be concentrating on satisfying functions—not selling specific products—in data acquisition applications, biomedical instruments, and computer peripherals."

Resistor manufacturers have a generally conservative outlook, expecting perhaps 5% growth, and stressing product improvement and new markets. In trimmers, for example, price pressures from industrial and consumer electronics customers are forcing the makers to redesign their products to meet specifications while reducing the materials and labor costs. Dale Electronics Inc., Columbus, Neb., cut the number of parts in its trimmers from 13 to 9. And Centralab, a division of Globe-Union Inc., Milwaukee, is developing a 1/2-inch-diameter industrial carbon potentiometer with a plastic, rather than metal, case.

Dale pointed out another interesting result of the dollar squeeze—customers are now taking advantage of component performance margins. For instance, smaller

resistors are being operated at higher ambient temperatures. A 1/8-watt resistor now frequently replaces a 1/2-watt one, and a 1/10-watt resistor substitutes for a 1/8-watt unit.

In the process of recovering from the 30% drop that potentiometers suffered in 1970, the Trimpot Products division of Bourns Inc., Riverside, Calif., expects "big things" from its new Knobpot. Intended for test, measurement, and process control applications, Knobpot is both a potentiometer and a digital readout.

Like the resistor houses, capacitor companies are wary, predicting around the same 5% increase in sales and expecting the most growth from chip capacitors. The manufacturers feel that the use of both tantalum and ceramic capacitor chips will grow at much the same rate as hybrid circuits, about 10% to 15% in 1972. The sales of standard product lines such as mica capacitors are expected to decline slightly.

According to Al Irwin, sales manager of Mallory Capacitor Co., Indianapolis, 200 million tantalum capacitors were produced in this country in 1971, and about 5

With military sales down, connectors plug into industrial, commercial areas

to 10 million of them were chips. Tantalum chips are now being designed into new products, so chip production should "take off well in 1973."

Probably the largest capacitor maker, Sprague Electric Co., North Adams, Mass., anticipates a significant increase in the sales of dual-in-line-packaged components. In addition, the company intends to introduce some new packaging concepts shortly. Sprague will be dropping several low-demand capacitors from its offerings in 1972, having re-evaluated its entire product line.

Also predicting a weeding out of capacitor offerings is Erie Technological Products Inc., Erie, Pa. Chick Ciacchini, marketing manager, says Erie expects a sales growth of 10% to 15% in 1972, mainly because of its Monobloc chip capacitors.

Conservative forecasts are also coming from connector circles, and the consensus is—military business is down but industrial/commercial sales are up. To offset the narrowing military market, Amphenol's Industrial division, Chicago, intends to meet the specialized demands of consumer and industrial products. The company will soon offer a do-it-yourself connector kit that the user can assemble into a specialized connector.

Eyeing the room-for-growth commercial market is ITT Cannon Electric division, Los Angeles. "We entered the commercial market early in '71," says Bob McFarland, product line manager, "and now we'll go after the data processing, telecommunications, and medical electronics people. We are also investigating the possibility of automotive and housing applications."

One commercial area that's been virtually a one-company market will begin to open up. Manufacturers of peripherals have had to use IBM-supplied connectors if they wanted their own equipment to be compatible with IBM computer systems. In 1972, AMP Inc., Harrisburg, Pa., will offer an alternative, the Amplimate connector, which will mate with the IBM 48-position Serpent.

Elco Corp., Willow Grove, Pa., is also emphasizing new connectors. The company's planned 1972 introductions include new backplane interconnections, card insertion connectors, input-output rack-and-panel connectors, and low-insertion-force Varicon connectors.

Yet another force in the connector business, Burndy Corp., Norwalk, Conn., is very confident, anticipating a 10% to 15% growth this year. Burndy puts its faith in the equipment users who will be buying this year instead of just thinking it over.

The picture looks reasonably bright for electromechanical relays, despite some competition from solid state devices. Relay manufacturers say the only real area from which solid state relays have expelled electromechanical units is in logic applications. And, to date, solid state relays comprise only about 2% of the total relay market. Walter Richert, director of research and development at Potter & Brumfield, Princeton, Ind., points out that solid state relays are still young and that makers are just starting to get feedback from users. It will take about five years to complete the learning curve for solid state relays, says Richert.

Electromechanical relays for industrial applications are maintaining a steady sales level for Guardian Electric Manufacturing Co., Chicago. According to Robert Heyne, general sales manager, new markets and new products are retaining the prosaic relay's sales vigor. In fact, says Heyne, 50% of what his company sells today goes into products that did not exist 10 years ago, and 20% are for products that are not five years old.

While component companies continue to upgrade their products with improvements the customer often does not see or know about, some components are undergoing an obvious design metamorphosis to meet the price demands of specific markets. Harry Meyer, director of engineering, Micro Switch division, Honeywell, Freeport, Ill., notes that meeting cost pressure often means dropping features, not reducing specifications. For example, Micro Switch waived redundancy in favor of lower cost by using two lamps instead of four in one of its lighted pushbutton switches.

Whetting the appetite of switch module makers is the desk calculator market. At least two companies are hard at work developing a low-cost keyboard switch. They are Oak Manufacturing Co., Crystal Lake, Ill., and Cherry Electrical Products Corp., Waukegan, Ill.

Designs on the way will involve fewer parts, more molded parts, and advanced production techniques.

Production

□ The new tax credits on capital equipment purchases are expected to give a welcome shot in the arm to the electronic production machinery business. But helpful as this infusion is, it is not the major source for optimism among manufacturers about 1972 prospects. With their customers under increasing pressure to automate

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production lines to meet stiff price competition, manufacturers foresee sales improving by as much as 25%.

Cost-cutting schemes are most evident in integrated circuit packages, where simpler plastic and ceramic designs will reduce package prices to nearly half what they were in 1971. Thick film circuits will be used more extensively in commercial and consumer equipment as circuit makers follow Delco Electronics and the RCA television operation in setting up cost-cutting automated production lines. Proponents of flat cable, long frustrated by the lack of reliable connectors, are optimistic about breaking that logjam in 1972. One of the most pervasive packaging technologies—printed circuits—is expected merely to creep upward this year.

The hold-off in capital equipment purchases, combined with the pressure to automate, is proving a blessing to those in the service bureau business. "We've been seeing a big expansion in this area," says Jack Staller, president of Microsystems Technology Corp., Burlington, Mass., maker of computer-controlled semi-automatic wire-wrapping machines. Staller says that electronics producers have been holding off on capital

Pressure is steady for lower-priced packages to house less costly chips

equipment purchases with a wait-and-see attitude, and instead of buying, have been going outside for their production needs. However, he does expect confidence to return and sales to rise by as much as 25% in 1972, with the turnaround beginning in mid-1972.

"After a drought for so long, it's got to rain a little," comments John Hohl, vice president of Universal Instruments Inc., Binghamton, N.Y. The remark typifies the outlook of most production equipment makers. Hohl says he's looking for at least 20% to 25% growth in 1972. However, in the viewpoint of Martin Weiss, financial vice president at Kulicke & Soffa, Fort Washington, Pa., it could be misleading to talk percentage gains, because the past two years have been so bad that almost any increase would constitute a significant percentage gain. But Weiss does point out that the drop in capital equipment purchases is starting to catch up with some semiconductor makers, who make up the major portion of K&S customers. Newer production machines, he says, are more efficient—thus more profitable to own.

Looking a little deeper, William Huggle, a director of the Semiconductor Production Equipment Manufacturers Association, says that, outside the U.S., only Japan seems to be coming alive with requirements for new equipment. Without considering the effects of surcharges or the international money situation, he sees a good market in Japan for MOS production equipment such as oxidizers and nitriders. There does not seem to be a good market there for bonders, since most of that equipment is made in Japan. In the U.S., there is still an excess capacity, he says, adding however that he does see an upswing here in sales of MOS equipment.

Semiconductor companies welcome the prospect of some lower prices for packages to house large-scale integrated devices. Ceramic package prices are dropping

as more simplified designs are introduced, and low-cost, pre-molded plastic packages are also taking hold.

The price erosion of ceramic packages is illustrated by the experience of Metallized Ceramics Corp. of Providence, R.I. Frank Rydwansky, manager of applications engineering, says Metceram's gross dollar sales dropped about 25% in 1971, even though more packages were sold than ever before.

The total package market, according to Ray Martino, vice president of U.S. Electronics Services, Clifton Heights, Pa., was about \$15 million in 1971. Of this, he says, pre-molded plastic packages took about 4% to 5%, or about three-quarters of a million dollars. Martino expects unit sales to grow substantially in 1972, but continued price decreases may hold down the value of the market to the \$20 million level. He expects pre-molded plastic packages to increase their share to 10%.

Late 1971 saw ceramic packages in the 40-lead configuration selling for about 90 cents and his own plastic packages selling for about 35 cents, Martino says. In 1972, these will drop to about 60 cents for ceramic and about 26 cents for plastic, he adds.

One of the newsmakers in the ceramic LSI package area in 1971 was the edge-mount package, which was used by SCM-Marchant Group, Oakland, Calif., in its portable calculators. Hammond Organ Co., Chicago, Ill., also swung to edge mounts; however, beyond these two users, there was interest, but few commitments.

At American Micro-Systems Inc., Santa Clara, Calif., one of the suppliers of the MOS/LSI chips in the edge mounts, James Barnett, packaging development manager, says the edge mount "is a specialty item only, now." Barnett looks to simplified packages, such as AMI's own SLM (single-layer metalization, pronounced "slam") package, as the wave of the future. The SLM, he says, can now be made for less than 50 cents for a 40-lead version, and may drop to the 25-cent level by year's end. At that price, it will give plastic a run for the money.

The edge mount, however, is sure to survive as a hybrid, multichip circuit substrate. Manufacturers such as the Texas Instruments Connector Products department, Attleboro, Mass., and AMP Inc., Harrisburg, Pa., are producing connectors for edge mounts. One of the major needs is a rugged contact that can withstand the abrasiveness of the ceramic. Thus, with this development already achieved, multichip edge mounts, similar to edge-mounted printed circuit boards, are practical.

Thick film circuits will continue to make inroads in the commercial and consumer markets in 1972. RCA set the stage last year with its automated production line for hybrid circuits that go into the company's XL-100 color television sets. Other consumer electronics producers are sure to follow the thick film route. "They're obviously the way to go," says George Lane, president of Electro Materials Corp. of America, Mamaroneck, N.Y., makers of conductive and resistive pastes for thick film circuits. Lane expects between 25% and 50% increases for thick films in 1972.

Like thick films, flat cable has been touted for a long time, but not until 1971 did it really begin to take hold. This year however, the market could double for flat cable and the associated connectors, according to Leroy

Gray, marketing manager at Burndy Corp., Norwalk, Conn. Designers, he says, are beginning to recognize the economies in making all terminations to a connector at the same time, which can be done with flat cable. And, with newer connectors that are rugged and give reliable contact, he says that flat cable has arrived.

Printed circuit sales will increase in 1972, but will not reach the banner year of 1969, when combined independent and captive production was valued at about \$455 million, according to figures of the Institute of Printed Circuits, the industry association. The sharp drop in 1970 to below \$400 million was followed by a nearly level 1971, but pc production should amount to more than \$425 million this year. Unfortunately for the independent suppliers, much of the gain will still occur within the confines of the big in-house producers.

Instruments

□ After a flat 1971, instrument makers are predicting a 7% sales increase for 1972. But that forecast presumes improved domestic sales will more than make up for a tailing off in European sales. And it was those European sales—some \$400 million—that kept 1971 from being a bad year.

The biggest disappointment of 1971, say instrument marketing men, was the failure of an anticipated mid-summer surge in the economy to materialize. They also found their customers continuing to be careful about purchase of basic test instruments. Buyers are no longer acquiring a bench unit because it has an extra capability that may be needed only rarely, but are sticking to less sophisticated, single-purpose machines.

On automatic test systems, however, the opposite is the case—customers seem willing to go all out. Lowered production costs is the rationale with which users of production testers of components, pc cards, subsystems or systems justify their open-handedness. Eventually, they argue, the equipment will pay for itself.

The systems, which range upward from small groups of instruments controlled by a programable calculator and connected to large-scale-component or card testers, “are getting smarter,” to use the phrase of Al Oliverio, marketing manager for Hewlett-Packard’s instrumentation division, Palo Alto, Calif. The reason: “complex ICs are now available at reasonable costs.”

For instance, read-only memories can be employed as special-purpose processors or controllers inside an instrument—H-P’s computing counter is one example. A suitably programmed read-only memory can instruct the counter to read out in pounds, psi, or any other units.

And the advent of low-cost controllers such as mini-computers and small hard-wired controllers allows people to configure systems to fit special needs. H-P has developed a card-and-box system that reduces instruments to the pc card level. The customer buys the functions he needs—such as an analog-to-digital converter, a

counter, and a DVM—and plugs them into the box. The box, which has a back-panel wiring system arranged around address and data buses, can then be connected to a minicomputer, and the result is a special automatic test or measurement system.

In general, the automatic testing area has burst wide open. Within the last year, Fairchild Camera & Instrument Corp.’s Systems Technology division, Sunnyvale, Calif., announced a complete new family of six test systems that are built on a modular concept like that used by IBM in its System 360 line [*Electronics*, Dec. 6, p. 113]. Tektronix, Beaverton, Ore., announced a new LSI test system [*Electronics*, Sept. 27, p. 92]; the John Fluke Co., Seattle, Wash., entered the systems business with an instrument and subassembly test and calibration system [*Electronics*, Sept. 27, p. 91]; Systron-Donner Corp., Concord, Calif., set up an automatic test equipment division and announced a new pc card test system; and several other major automatic test systems were introduced.

At General Radio in Concord, Mass., senior vice president Bill Thurston feels that automatic testing systems will be the company’s most important product area in the next year. The company is introducing nine new systems with price tags ranging from a low of about \$20,000 to a high in excess of \$100,000. They will include digital and analog circuit testers, passive circuit testers, laser trimming systems for thick film circuits, anodizing trimming systems, and rf network analyzers.

Thurston expects these systems to sell well despite high price tags and a sluggish economy because of their ability to increase productivity. They can, he claims, pay for themselves in one fiscal year.

And 1972 looks like a year in which those systems will find customers. Tektronix’ Frank Elardo, field marketing manager, points out that “with the proposed 7% tax credit, companies will now invest in capital equipment, especially if that equipment holds the promise of lowering production costs.” But there are traps to be avoided in using automatic test equipment. H-P’s Oliverio says

Automatic systems are proliferating with spur from U.S. tax relief

that “a study has shown that a man who buys an automatic measurement system will spend 200% of the cost of the system to use it. This includes software, training, and just plain learning to live with it. It’s expensive to operate a test system—even if the hardware was free.” Thus, Oliverio feels that only a few can support them.

Instrument buyers are also shifting away from technology for technology’s sake. Frank Marble, director of marketing for Systron-Donner Corp., says, “It used to be that if you had a new instrument that did something different or unusual, everyone bought one; but this is not the case now.”

Both Tony Odderstol, sales manager at Monsanto’s Electronic Instrument division, West Caldwell, N.J., and Brian Franklin, sales manager at Dana Laboratories, Irving, Calif., agree that today’s customer is demanding and getting instruments at about half the cost

U.S. MARKETS FORECAST

Instruments

(millions of dollars)

	1971	1972
Test and measuring instruments, total	841	896
General	715	758
Microwave	87	96
Nuclear	39	42

of three to five years ago. With very few exceptions, Franklin points out, "the purchasing of highly sophisticated instruments on the basis of their prestige value is a thing of the past."

To back up his contention, Franklin says that Dana's original model 5300 digital voltmeter was available in six versions with varying capabilities. "We found that the customer wasn't ordering much of that capability, so we did away with a half-rack version." Dana introduced a new lower-cost version of the 5300 last November, and Franklin says "we now have essentially a systems instrument with one plug-in module. We cut our manufacturing costs and inventory needs and can give better delivery."

But while all agree that there is no money to spend on expensive toys, the money situation has loosened up some. In Oakland, Calif., E-H Research Corp.'s Larry Hahn, bench instrument marketing manager, says that "buyers actually have some money now and they are breathing a little — and when they breathe a little better, so do we. Customers are now buying equipment that they have actually needed for some time."

The trend toward lower cost single-purpose instruments, in the opinion of Monsanto's Odderstol, will prevent the counter-timer market from reaching the \$40 million high-water level of 1969. Nevertheless, he does see an increase of approximately 15% over 1971's \$28 million.

At the John Fluke Co., Jerry Froland, marketing manager, also is seeing careful customers. "People are buying just what they need," says Froland, "If they need a 4½-digit DVM, then they are buying our \$700 unit and not the \$1,500 one. If they need a 5½-digit DVM, then they buy the mainframe and add the plug-ins as they need them." He calls this the onesity-twosy business—not high volume—and says that "over the next year, this type of business will see a 10% increase in dollars if we make a push to get the bucks." Because the customers want quality, "they are turning to the established manufacturers, and not the newer companies that offer some new gadget or frill." But he adds that "we will have to make a strong effort to get the business" because the competition is keener.

Tony Schiavo, product line manager for DVMs and data amplifiers at Dana, agrees that today's customer is not just price-conscious, but more value-conscious than ever before. "Customers are worried about service, about ease of calibration, and these things aren't easy to put into specs," he observes.

The Dana spokesman is describing both the Government and the industrial customer. "Uncle Sam has changed from a state-of-the-art specification philosophy to actually looking at the job to find out what he really

needs," Schiavo notes. And because instruments are going into plants with less electronics background than the traditional aerospace customer, more user-oriented features are being built into instruments.

Schiavo says the DVM market began to turn around for the better for Dana last spring. He looks for continued improvement at his company and throughout the industry. "Money has begun to loosen and customers are ordering again," he says. Dana's own bookings through last November were a third the previous year's. The DVM market had slipped from about \$30 million to \$22 million in the past few years, Schiavo says, but the upturn that the "good manufacturers" have already seen may take it to \$25 million in 1972. He sees it as a year when the instrument industry will be adjusting its

Utility prevails at the bench with users picking carefully

product lines to the needs of a very value-conscious customer. For example, cold-cathode tube displays will predominate in 1972 instruments because they cost less than light-emitting diodes.

The same is true in the digital panel meter field. Russel Walton, president of Electro-Numerics Inc., Sunnyvale, Calif., expects that "while LEDs and liquid crystal readouts will make some inroads in digital panel meters, they won't come on big for another three years or so because of their higher cost." He says that the less expensive Numatron tube offers the same IC-compatible planar display as crystals of LEDs plus the added advantage of different colors.

Probably the biggest problem in the digital panel meter market will be what Walton calls the "shakeout of the crud. There are just too many suppliers that don't make a quality product," says Walton.

The trend toward lower-cost instruments with fewer frills is also being seen with oscilloscopes and instrumentation tape recorders. Tek's Elardo says that "our

Scopes, recorders also follow trend to low-cost, no-frills devices

customers will continue to go after the low-cost, yet high-performance, scopes such as the 5100 2-megahertz and the 7400 50-MHz unit." The 7400 is the economy model of Tek's 7000 series of plug-in mainframe instruments. Tek has also come out with a low-cost portable scope that sells for under \$600.

And Mel LeGette, national sales manager for the Instrumentation division at Ampex Corp., Redwood City, Calif., says that "while the overall instrumentation tape recorder market has declined, the portable recorder market has held level." These machines typically cost from \$1,000 to \$14,000 and are generally less sophisticated than their laboratory big brothers.

LeGette puts the instrumentation recorder market at about \$59 million in 1969. This fell to about \$43 million in 1970 and dropped still further to \$40 million in

Medical

(millions of dollars)	1971	1972
Medical equipment, total	579	639
Diagnostic	431	470
Patient-monitoring	34	39
Therapeutic	31	35
Prosthetic	82	94

1971. "This will drop another 3% or so in 1972," he says, "although these figures are hard to pinpoint because it's difficult to separate out the special-purpose machines that are designed for the Government." His figures are baseline numbers that do not include such special Government recorders. One possible area for growth in this market, he suggests, is cassette machines.

A rather better year can be expected for the pulse generator market. Hahn of E-H feels that a 20% increase over the \$11 million of 1971 "is attainable and not unrealistic." Hahn says that "we haven't seen the 1969 sales levels yet—we are now about the 1970 level when sales began to decrease." He had hoped instrument sales would have picked up sooner, but attributes the slow rise to the "wait and see what's new" attitude before Wescon and the general sluggishness of the summer. Mel Brown, president of Berkeley Nucleonics, Berkeley, Calif., a manufacturer of precision pulse generators employed in calibrating radiation measuring equipment, says that the "market for nuclear instrumentation was about \$80 million in 1971, and I expect 1972 to be up about 8% to 10%."

Medical electronics: a growing child accounting for \$640 million

The medical equipment market will approach \$640 million in 1972, a \$60 million increase over 1971. Moreover, the Department of Health, Education, and Welfare predicts the figure will surge to \$1.32 billion by 1975, and adds that the burgeoning use of computers in support of instrumentation will contribute significantly to patient-monitoring and clinical-laboratory markets.

Dramatic growth is also expected for: health care delivery services and devices; diagnostic electronics, such as automated multiphasic health test clinics; and remote delivery of rural and ghetto health care, which will rely heavily on medical telemetry and highly automated equipment operated by paramedical personnel.

Clinical laboratory instrumentation is an \$80 million to \$100 million market, now rising some 15% to 20% annually as the demand for clinical tests increases. It's relatively cluttered with companies wanting to automate, "so it's going to grow by the competitive mechanism rather than by the inventive," says Ross Robinson of the Abbott Laboratories Advanced Technology division, Chicago. Yet only 10% of some 3,000 available clinical tests have been automated. The market will be helped by mergers and eventual franchising of the small, private clinical labs unable to invest in instru-

mentation, plus the trend in hospitals to big, central, sophisticated labs.

Industry is predicting lots of activity in physiological monitoring systems, a field cluttered with aerospace companies. From an estimated \$25 million in sales last year, cardiac monitoring will jump to \$28 million in 1972, "and higher, if electronics companies discovered other interesting organs to monitor besides the heart and lungs," says one physician user. As for heart and lung monitoring, the push will be toward computers.

While electronics companies report that they aren't upset about the possibility of the Food and Drug Administration's getting a legislative mandate to set design and performance standards, and to preclear medical electronics for efficacy as well as safety, hearings will probably be held on several bills later this year. However, device legislation is not high on the Administration's list of health care priorities. But standards would mean costly additional testing, manufacturing, and record-keeping procedures for manufacturers.

Industrial

□ More than any other sector, prospects for industrial electronics are geared to the U.S. economy and the indication that action from Washington will be successful in spurring capital equipment spending. Coming out of a poor 1971, in which expected second-half sales didn't materialize, manufacturers of process-control equipment and numerically controlled machine tools are pinning their hopes for a turnaround this year on President Nixon's tax credit for capital equipment outlays.

That credit, according to surveys by the U.S. Commerce Department and McGraw-Hill's economics department, should stimulate capital spending by 6.5% to 7%, for a total of about \$87 billion. By contrast, 1971's capital equipment spending only grew by 2.2% over the 1970 level—not enough to keep pace with inflation.

Increased pressure to improve productivity and reduce costs is one factor that will entice industrial firms to take advantage of the tax break. Updating is needed in many industries. As one automation equipment supplier warns, "It can no longer be delayed."

This is particularly true in the metal-cutting industries, a leading indicator of the general economy, maintains Jack Morey, manager of marketing analysis at the General Electric Co., Manufacturing and Process Automation division, Waynesboro, Va. He foresees an increase of as much as 25% in N/C equipment sales, attributable to cost-cutting pressures facing makers.

Others, however, are less sanguine. Peter Senkiw, president of the Numerical Controls Society and head of his own systems consulting firm, holds that faster, more efficient operation—the major selling point of N/C—doesn't mean a thing if the equipment sits idle from lack of orders. Senkiw thinks that it will take at least until fall for "some indications that we've finally

Industrial

(millions of dollars)	1971	1972
Industrial equipment, total	590	674
Motor controls	84	90
Numerical controls	36	43
Inspection systems	45	50
Process controls and instruments	93	113
Computer process systems	258	283

turned the corner." He adds: "When we do, the increase will be gradual."

Meanwhile, sales of N/C equipment have plummeted from a high point near \$70 million in 1969 to nearly half that amount in 1971. The *Electronics* forecast shows that in 1972 it will about reach the 1970 level of

Minicomputer sales spread as end users find more applications

\$43 million. Some companies are already questioning if they should remain in the business. "We're lucky to have other products," says an official of one N/C house.

Direct numerical control systems—N/C operated by a central computer—will be the first to meet their manufacturers' sales expectations when the turnaround does come. With money still quite tight, the less expensive DN/C approach should do well, Senkiw says, particularly for systems that can gradually increase the number of tools under computer control.

Probably the most vigorous actions will come in sales of minicomputers. "Following the original equipment manufacturer, the end user in the industrial community is becoming much more attuned to the minicomputer," says Joseph M. Lombardo, manager of data acquisition and control systems for Digital Equipment Corp., Maynard, Mass. Because of increased end-user participation, Lombardo predicts that minicomputer sales in the industrial marketplace will reach as high as \$160 million this year—up from \$130 million in 1971 and \$100 million in 1970.

The automotive industry is one of the leaders in implementing such new control systems. And for increased efficiency, it is automating many of its operations. The auto companies may also be changing their buying habits, notes Melvin L. Couchman, director of marketing at Systems Engineering Laboratories, Fort Lauderdale, Fla. He says the car makers seem to be looking for suppliers of turnkey test systems; in the past, they have tended to integrate their own systems of electronics, mechanical test hardware, and programing software.

Detroit is also looking to automate the materials handling and warehousing portion of its operation, as witness the new system designed by Cutler-Hammer's Industrial Systems division for General Motors' disk brake production facility in Saginaw, Mich.

However, the automation of materials handling and warehousing activities has not developed at the rate expected a year ago, according to both Cutler-Hammer

and another important supplier in the field, the Industrial Systems division of Aerojet-General Corp., Frederick, Md. The reason is familiar: the economy is down, and along with it went investment in capital equipment.

Sales of programable controllers have been similarly held back. However, some controller suppliers see 1972 as a growth year. Don Chace, DEC's PDP-14 product line manager, predicts as much as a 50% growth over a disappointing 1971, when in mid-year he had to chop his early sales estimates in half.

Applications in the automotive industry are doing well, asserts Lee Rosseau, president of Modicon Inc., Bedford, Mass., and "sprinklings" of programable controllers are beginning to turn up in batch chemical, textile, and other process control systems.

In process control, companies like Foxboro Corp., Honeywell's Industrial Products division, and General Electric all report higher sales of systems in 1971 than in the previous year, and look for this upward trend to continue in 1972.

"It's been a mixed bag, but on the average, we're ahead," says Philip Smith, general manager of GE's Marketing and Process Automation Systems Marketing department, West Lynn, Mass. He finds steel, mining, metals, and textiles "pretty flat," with inquiries from the petrochemical and chemical industries picking up. "The base of new projects is not abundant," says a spokesman at Foxboro Corp., Fort Washington, Pa. He adds

Programable controllers may finally show that hoped-for sales spurt

that large-scale computer-controlled process installations definitely have been affected by the economy.

Monitoring equipment for water pollution and waste-treatment facilities are starting to use more electronics. In fact, some companies, according to one source, are buying standard data acquisition equipment that has been around for awhile, but is new to these industries.

Federal

□ Outside the major markets of defense and aerospace, new Government electronics business in 1972 shapes up as a catch-as-catch-can kind of business. Though there is growth in all the principal markets—health care, education, and ground transportation systems—most of the increases (see table) will be offset by a combination of factors reflecting a 4% inflation factor and a widely-dispersed market for a variety of demonstration systems.

Dollars for health care electronics, the largest single element in this area, should climb by \$14 million to an estimated \$174 million, an increase of almost 9% from 1971. Though the forecast growth is a bit greater than the 8% gain last year when the market expanded from

\$148 million to \$160 million, industry officials see an essentially stable situation. Nevertheless, the consensus of manufacturers represented in Washington is that the market is worth pursuing—and is likely to double in value in five years.

Education, traditionally a slow starter, is unlikely to realize any major expansion until electronic system prices can be sharply reduced. Thus, education will reflect a somewhat smaller growth in 1972—8% vs 9%. What's more, much of that money is scattered around to local state and county operations as grants, a distribution system for which the industry still must develop marketing services.

The outlook for the electronics industry in the non-military corridors of Government is brightest in the younger, more centralized agencies, such as the Law Enforcement Assistance Administration (LEAA) in the

Electronics for transportation —in air and on ground—moves along

Justice Department, the Urban Mass Transportation Administration in the Department of Transportation, and the U.S. Postal Service.

LEAA's fiscal 1973 appropriation is expected to be somewhat higher than this year's \$698.4 million, which is more than ten times the agency's 1969 budget. The largest single chunk—some \$416.3 million—will go directly to the states.

Electronics companies will also find contract money at the National Institute for Law Enforcement and Criminal Justice, LEAA's R&D arm, whose budget this year almost tripled to \$21 million. The institute will continue funding research in such areas as voiceprint analysis and the development of personal police transceivers.

Research and development funding in the \$800 million Urban Mass Transportation Administration (UMTA)—is bankrolled at a record \$75 million this year, with almost \$54 million earmarked for the hardware-intensive early demonstration projects, such as Boeing's personal rapid transit network in Morgantown, W. Va., which uses Bendix electronics.

Closely linked to UMTA projects is work in intercity rail transportation, which is being done at the Federal Railway Administration's Office of High-speed Ground Transportation. Also, the Federal Highway Administration has quadrupled its R&D funding for automated highways and urban traffic control networks to \$28 million.

An important trend in HEW, which will affect the nature of medical electronic purchases within the department and outside, is the change in emphasis from health care research to health care delivery—from the National Institutes of Health (NIH) to its sister agency, the Health Services and Mental Health Administration.

HSMHA has asked Congress for \$38 million to start its Health Maintenance Organization Service. Of the potential \$38 million for the health maintenance service and \$14 million more allocated for R&D in experimental health delivery systems, Jack Brown, associate deputy

administrator for development at HSMHA, estimates that \$10–\$12 million will be spent for hardware.

The Federal Aviation Administration's electronics budget is also going up. Out of the FAA's operating budget, which is expected to rise above last year's \$1.5 billion, the agency expects to spend about \$100 million in air navigation and air traffic control (ATC) equipment, buying new radars, communications gear, instrument landing systems, and other electronic equipment.

FAA research and development funds will also rise, from \$71 million in fiscal 1972 to about \$110 million in fiscal 1973. The major electronics R&D projects that FAA will fund in 1972 include \$2 million for development of a discrete-address beacon system; \$14 million for a microwave instrument landing system, for which \$2 million in contract definition phase awards are expected early this year; \$2 million for further testing of collision avoidance systems; and \$25 million for R&D of various ATC automation projects.

The U.S. Postal Service says it will be a multi-billion electronics market in nine to ten years, due to increased mail load and increased mechanizations. The service estimates it will spend \$80 million this year for development and engineering activities. Also, the Postal Service is implementing a bulk mail network of 21 major centers that it expects will cost more than \$950 million by 1975. Other on-going programs include encoding and printing of letter mail, remote visual displays, and facsimile, microwave, and laser transmission of mail.

Expenditures by the Environmental Protection Agency for instrumentation are small, but electronics companies are most likely to find contracts in the fledgling agency's research, development, and demonstration budget. In 1972, about \$100 million has been set aside for control and monitoring technology.

Military

□ By far the most significant factor impacting 1972 Federal electronics spending—and defense in particular—is President Nixon's program for re-election. Inextricably linked to it are White House efforts to stabilize the economy and turn it upward—and to return workers, including electronics engineers, to jobs.

A part of this effort that will impact the electronics industries is the plan being put together by former SST project leader William A. Magruder, now a Special Assistant to the President. The aims are to push U.S. technological innovation, productivity, and competitiveness in world markets by supporting increased industrial R&D in electronics and other technologies [*Electronics*, Sept. 27, p. 33]. Details of this program will be disclosed by the President in January.

Although the fiscal 1973 budget is still being worked on, defense spending, by far the largest item in the Federal budget, is expected to turn upwards as the Administration employs it as leverage on the economy. *Elec-*

Military R&D steps higher

Defense dollars for research, development, testing, and engineering (RDT&E) are rising once more—rising, says Congress, to more than \$8.1 billion in the fiscal 1972 appropriation just passed. What the numbers say is that the \$7.51 billion base (not counting transferred and separate funds) for military RDT&E is up more than 7% this fiscal year. And indications are that it will rise a bit more in the fiscal 1973 budget, which President Nixon delivers to Congress within weeks.

The electronics content of this year's RDT&E spending will run to a bit more than one-third of the total budget base, or some \$2.55 billion—a rise of more than \$200 million from the prior year, according to estimates of the Electronics Industries Association. The EIA estimate that the Defense Department will lay out some 33.5% of its R&D monies for electronics "is probably pretty accurate," says a ranking Pentagon budgeteer, though he concedes no one keeps precise spending breakouts on a technological basis.

The keys to defense electronics spending will be found in four areas. Two are covered by the "new initiatives" promoted by John S. Foster, Director of Defense Research and Engineering. The initiatives embrace both development efforts for some major improvements of existing hardware and smaller funds

for exploring some totally new approaches [*Electronics*, Jan. 4, 1971, p. 33]. Some 30 new initiatives are reportedly already funded at more than \$50 million, and another \$70 million to \$80 million is anticipated for approval in fiscal 1973.

The two other areas include competitive prototyping [*Electronics*, Aug. 30, 1971, p. 65], which officials say now appears better suited to less costly electronic subsystems than to major weapons, such as ships and aircraft. The fourth area is on-going large programs for which subcontracting money is beginning to become available as specific subsystem requirements are spelled out.

This last category requires the most money. It includes the Navy's undersea long-range missile (ULMS), for which Lockheed recently received more than \$25 million in development funds; a new ULMS boat; an extended-range Poseidon (EXPO) missile; and the Air Force B-1 strategic bomber, for which Radiation Inc., was recently named multiplexor subcontractor to prime contractor North American Rockwell. What's more, there is a heavy emphasis on a variety of strategic and tactical missiles for all three services, which are forecast to spend more than \$2.2 billion this year—an estimated 10% increase over 1971.

tronics estimates that outlays for defense electronics, which slipped another 5% in 1971, will rise more than 4% in 1972—but not enough to bring spending back to 1969 dollar totals.

Though some of this increase will be offset by inflation, Government and industry officials see more net defense spending and more for electronic hardware designed to improve the U.S. strategic balance after years of heavy emphasis on tactical systems.

The major upcoming programs that contain a high electronics content include: the Navy's Undersea Long Range Missile System (ULMS); a submarine class designed to replace the Poseidon/Polaris fleet; the Air Force's Airborne Warning and Control System (AWACS), for which Hughes and Westinghouse are competing as radar contractors; Grumman's F-14 for the Navy, and McDonnell Douglas's F-15 for the Air Force; the Navy's new DD-963 destroyer class, awarded to Litton Industries; and the Air Force B-1 strategic bomber, now in R&D at North American Rockwell. Admittedly, some of these are politically chancy for, as an Electronic Industries Association survey notes, "the B-1 will be the first victim of a successful strategic arms limitation talk" with the Soviet Union. The study notes that its member "respondents were fairly evenly divided over the potential success of the SALT talks."

But even in light of the transition from a hot to a cold war, the 1972 outlook invariably favors electronics technology over others. "Intelligence and communications become paramount concerns," explains one Pentagon planner. "We need better data and we must find ways of using it better, getting it quickly from here to there. That's a communications problem requiring everything from computers to satellites and lasers."

The emphasis on electronic detection and counter-

measures is likely to make the Navy and its antisubmarine warfare requirement the top customer for military electronics in 1972, followed closely by the Air Force. Also, in terms of new business opportunities, the Navy's potential is still the most viable in the eyes of defense budget planners. The Navy has new 1972 funds for five nuclear attack subs, the first nuclear-powered guided-missile frigate, seven DD-963 destroyers, two submarine tenders, and three rescue and salvage vessels. Money is also available for conversion of two guided-missile frigates to upgraded weapons, and six missile subs to Poseidon systems. Long-lead-time money is provided for four more attack submarines and another nuclear frigate.

The Navy has money to buy 290 aircraft, compared with the allocation for 188 planes for Air Force, where emphasis lies on such development programs as the B-1 and the A-X, a new close-support plane. Navy buys will include A-6 all-weather bombers, the EA-6B countermeasures planes, E-2C early warning aircraft, A-7 attack fighters, more P-3C antisubmarine patrol planes and their carrier-based counterpart, the S-3A, the AV-8A Harrier for the Marine Corps, the F-14A, and the RH-3D mine countermeasure helicopter. Major missile development money is also included for the Aegis fleet air defense system and the long-range standoff system, Harpoon.

The Navy's R&D outlook presents the best long-range potential for military electronics manufacturers. Faced with a visible expansion of Soviet seapower, constrained budgets, and a political requirement to keep out of foreign involvements not critical to U.S. interests, the Chief of Naval Operations, Adm. Elmo Zumwalt, is contemplating broad changes within the service.

Already the Navy is moving toward a single carrier class, which should lead to elimination of the distinction

between attack and antisubmarine warfare. Though Pentagon R&D officials point out this is aimed at coping with a probable reduction in the size of force, set at 15 carriers, its impact will be to put a greater variety of aircraft on fewer ships and to increase the pressure for compatible electronics on all aircraft. The USS Saratoga is already experimenting with this concept, adding more attack aircraft to its ASW squadrons.

Space limitations on such all-purpose carriers is also expected to increase the appeal of vertical-take-off-and-landing (VTOL) planes like the Hawker-Siddeley AV-8 Harrier, now entering the Marine Corps inventory. The acquisition of the British plane, coupled with the fact that Zumwalt is encouraging more joint operations with navies of U.S. allies, could herald an increased use of more foreign technology in the Navy.

The race between Russia and the U.S. to produce

Electronics to garner more than 33% of stepped up RDT&E's \$8.1 billion

missile and attack-class submarines indicates continuing growth for electronics for at least the next two years. The single largest identifiable R&D program for surface ship surveillance is the Ocean Surveillance Information System OSIS now being studied by System Development Corp., Santa Monica, Calif. OSIS planners envision achievement of real-time tracking of military and commercial vessels in the world's oceans. Its potential for satellite and aircraft sensors and for digital communications is touted as being in billions of dollars for the next decade. Apart from OSIS, Navy specialists already conceive that extremely high altitude aircraft—whose location will not disclose fleet positions—will replace many existing shipboard radars, eliminating many of the electromagnetic incompatibility problems between different shipboard equipments. "That is a trend you can count on," says one official.

For antisubmarine warfare, the emphasis continues on development of expendable sonobuoys and, more recently, towable sonars. As submarines run quieter and deeper—sometimes below the ocean boundary layer that precludes their detection by thermal sensors—the need for improvements in sonar signal processing and classification has become a prime Navy concern.

Defense officials not only want detection sonobuoys for ASW, but also countermeasure sonobuoys whose acoustic signals could be employed to protect a ship's location. "Money is a major factor there," an official says. "This has got to be one-shot equipment."

As for towable sonars—units that are not an integral part of any particular ship but could be attached to most any in the fleet—they suggest a trend within the service to move costly electronics outboard, increasing flexibility and, hopefully, lowering costs by cutting procurement units.

Major Air Force buys include C-130 transports as well as more of the fighters originally developed for Navy use, the LTV A-7 and the McDonnell Douglas F-4. Missile funds on the strategic side will go for more Minuteman 3s with multiple warheads and for Boeing's

short-range attack missile (SRAM). Tactical missile buys scheduled for 1972 include the anti-radar Shrike, the air-to-air Sparrow and Sidewinder, and the first buy of Maverick, the air-to-ground missile for use by the A-7 and F-4 against such targets as tanks and artillery.

The direction of Air Force R&D programs is away from the tactical aircraft used in Vietnam. In fact, the threat of tighter budgets—and the view that future Presidents will avoid direct involvement of U.S. forces in any war except one against the U.S. or its NATO allies—has Air Force planners emphasizing strike and air superiority aircraft for long-term goals.

The next generation of close support aircraft dubbed AX—attack experimental—is in the "maybe-maybe not" category because of the plane's tactical role and the tight money in aerospace. And Air Force plans for the remotely-piloted vehicle (RPV) have produced more news than yeas among Congressional staffers. The prospect of two or more RPVs mounted on the wings of a larger command and control aircraft may delight avionics suppliers, but Congress regards such added systems as "exotic and expensive," according to one Congressional staff man.

Though the Army has new money for 400 more OH-58 light observation helicopters, that figure represents a significant decrease from the number procured in each of the past two years, because the Army's requirements are declining.

Congress has also hinted that the Army should take another look at its big sensor program called STANO, for surveillance, target acquisition and night operations. In effect, Congress warned that sensors should be good for detecting relatively light traffic not only on a remote jungle trail but also in heavily industrialized areas.

Space

□ The budgetary climate at the National Aeronautics and Space Administration has grown cold since the halcyon days of the Apollo program, and now the agency's two major space programs are in trouble.

Because of inflation, the approximately \$3 million NASA is likely to get for fiscal 1973 will be worth about 5% less than the \$3.3 billion allocated last year, and, because of the long lead time required for any space program, the outlook for more electronics—usually about one-third of the agency's budget—into the mid-1970s is not bright.

But not all of NASA's programs are in trouble. Scientific and planetary budgets will be increased slightly next year. For example, the Viking program—automated probes to Mars—set for 1975, is going ahead, with Martin's Denver division, Denver, Colo., building the lander and the Jet Propulsion Laboratory, Pasadena, Calif., managing the orbiter.

NASA received \$180 million in fiscal 1972 for the \$800 million Viking program, which should reach peak fund-

ing in the spring or summer this year, according to the Office of Space Science. The High Energy Astronomical Observatory satellite program is also underway. TRW Systems Group, Redondo Beach, Calif., will build the first two [*Electronics*, Dec. 6, 1971, p. 50].

The signing of that \$70 million contract this year however, will release all the money for the \$200 million program. Subcontractors have not yet been named. The \$100 million Mariner Venus/Mars probe program, which the Boeing Co., Seattle, Wash., is building under a \$47 million contract for JPL management, looks to be safe on schedule after slippage.

The space shuttle and the so-called "Grand Tours"—now renamed the Outer Planets Missions—face changing moods in the White House and in Congress. Their concern now focuses on the sluggish economy, unemployment, and the environment. One hopeful note in

At NASA, the space shuttle and the outer planets missions are in trouble

this election year is that large programs like the shuttle and Outer Planets Missions help create jobs, especially in politically restless areas such as aerospace.

NASA considers the shuttle crucial to its manned space flight program, and NASA administrator James C. Fletcher concedes that manned space is in trouble if the shuttle isn't funded [*Electronics*, Dec. 6, 1971, p. 42].

Originally conceived as a \$10–\$13 billion program, the space shuttle was proposed as reusable booster-orbiter of C-5A size that would dock at a space station, unload men and materials, and return to earth. This concept, requiring some new electronics, would have cost about \$2 billion a year in the mid-1970s.

Now the space agency is talking about a simpler booster-orbiter costing about \$5 billion, with peak funding of about \$1 billion annually, Fletcher says. This budget-priced version would use off-the-shelf electronics and have a smaller booster. NASA has not yet chosen its most desirable concept from proposals for piloted, partially usable, or disposable boosters.

With an eye toward political realities, NASA is asking for less development money this year than it really wants for the shuttle. But even the approximately \$200 million it seeks doesn't look firm, Fletcher says. Lack of adequate funding has already caused a stretch-out of the definition studies by McDonnell Douglas, St. Louis, Mo., and North American Rockwell, Downey, Calif.; these reports will not be submitted until April, or perhaps even later.

Like the shuttle, the Outer Planets Mission faces tough going this year. Already, the tour of the outer planets has been scaled down to an economy price. The original program featured visits to Jupiter, Saturn and Pluto in 1976 and 1977, with special trips to Jupiter, Neptune, and Uranus in 1979. The ticket would cost up to \$900 million; but last year, Congress couldn't see putting up more than \$20 million. If NASA's requested funds don't get approved, the agency may have to cut back the scope of the program.

Among its options, according to an official in the Of-

fice of Space Science, are a reduction in the payload, a cut in the number of missions, or dropping off the last planet. If NASA can launch the program this year, most of the money will be spent in the next two years.

Such financial and scheduling uncertainty over NASA's bigger space programs could also curtail many experiments proposed for these projects. The Outer Planets Mission is particularly susceptible to uncertainties since the project must be ready to take advantage of the favorable alignment of the outer planets.

Programs for communications and earth resources satellites "will probably go up some," says Vincent L. Johnson, deputy associate administrator, Office of Space Science. He also predicts that there will be several new starts in the \$10 million to \$50 million range for prototype satellites in such areas as meteorology.

Typifying NASA's practical experimentation are the \$200 million applied-technology satellites F and G that Fairchild Industries, Germantown, Md., is building for launch in 1973 and 1975. About half the funding has been allocated for the program. Philco-Ford Space and Re-entry Systems division, Palo Alto, Calif., is subcontractor for communications electronics, Honeywell Aerospace, Minneapolis, Minn., for stabilization and control, and IBM Federal Systems division, Gaithersburg, Md., for telemetry and command.

The Orbiting Solar Observatory I, J and K series program also is firm, with about \$21 million out of about \$90 million paid to prime contractor Hughes Aircraft Co., Culver City, Calif., by the middle of this year.

NASA's aeronautical research budget will go up modestly over the fiscal 1972 \$100 million level, and applied space research is likely to hold level at \$75 million. Research will be concentrated in five areas: simulation of future air traffic control models, electronic airplane control systems, automated vertical-takeoff-and-landing aircraft avionics systems, a microwave collision avoidance system for general aviation, and communications and research systems for aeronautical satellites.

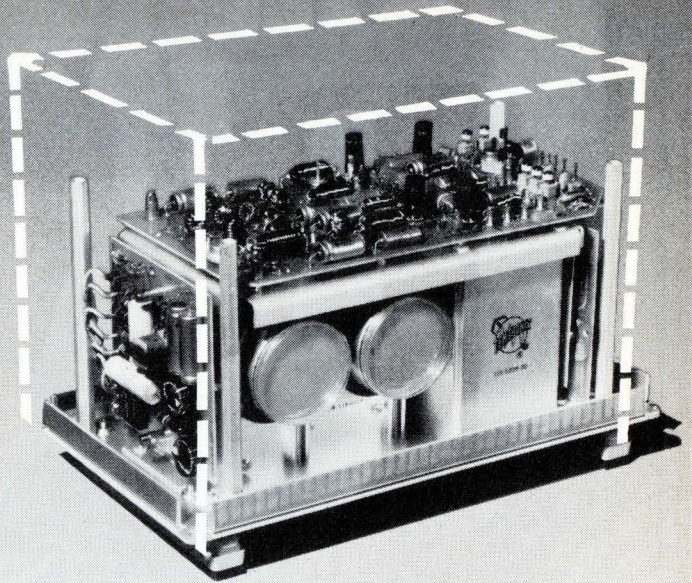
Indicative, too, of NASA's pragmatic turn is its re-

Funds for unmanned satellites to Mars and for earth orbit look safe for 1973

search into short-takeoff-and-landing (STOL) aircraft. The agency recently awarded \$1.5 million contracts to McDonnell Douglas; Grumman Aerospace, teamed with Boeing; and Lockheed Georgia, teamed with North American Rockwell Aerospace, and Cornell Aeronautical Laboratory. The contractors are to provide design concepts by mid-year for a quiet STOL transport. Toward the end of the year, the agency plans to choose one of these contractors to build two prototypes, including control, guidance and display systems, in an estimated \$100 million program to be completed in 1974–75. An example of NASA's interest in STOL avionics is its \$2.3 million contract with Sperry Rand's Flight Systems division, Phoenix, Ariz., to build a digital avionics computer. □

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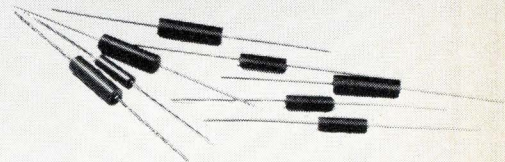
Ceramag 24



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

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When Test and Measurement Count

Designer's casebook

Nomograph determines aperture time error

by Stephen Muth
ILC Data Device Corp., Hicksville, N.Y.

A simple nomograph does away with the tedium of calculating the error due to aperture time for a sample-and-hold circuit. It can also be used to compute the conversion error of an analog-to-digital converter which has a varying dc signal or a low-frequency ac signal as its input.

Being a measure of the repeatability of the analog sampling switch characteristic, aperture time reflects the uncertainty of when exactly the switch opens. Errors due to it vary with the signal rate of change at the sample point. The voltage that is sampled and held can have an error of:

$$E = (dv/dt)T$$

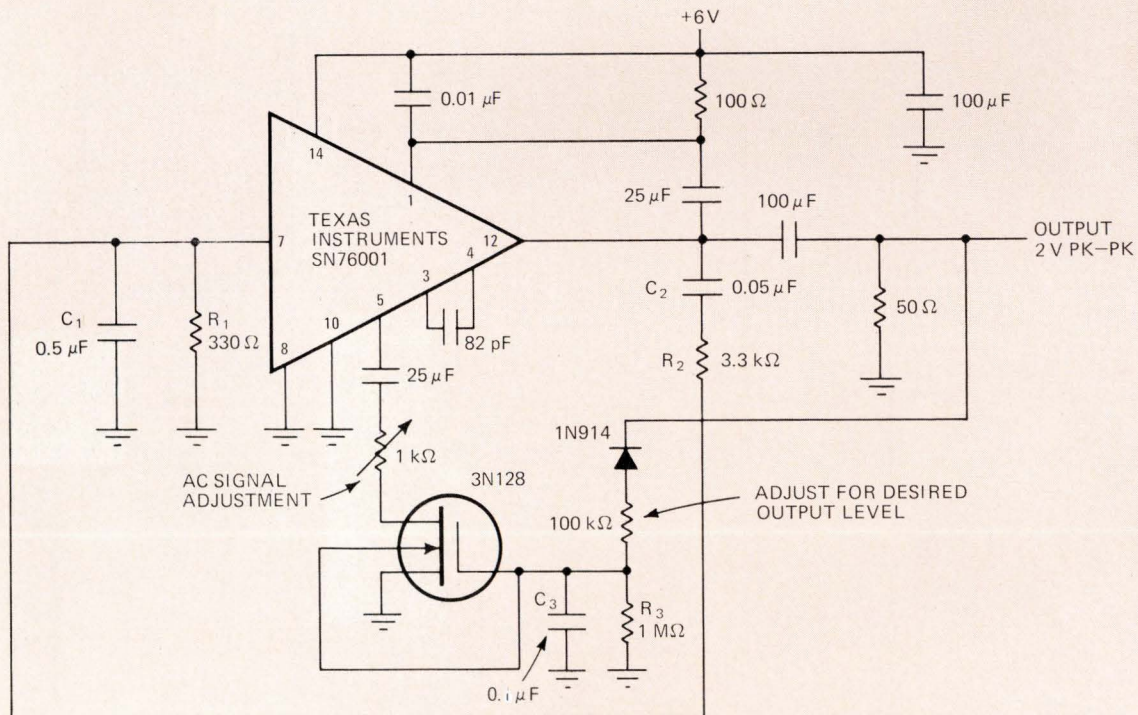
where E is the voltage change or error, dv/dt the maximum signal rate of change, and T the aperture time.

Computation aid. Nomograph solves equation for percent-of-full-scale error due to aperture time of sample-and-hold circuit. Error, E, can be written in terms of signal rate, dv/dt, and aperture time, T: $E = (dv/dt)T$. Using straight-edge to intersect all three axes gives the answer. (Signal rate is represented by frequency axis.) Conversion error of a/d convertor can also be found by using the same technique.

The nomograph shown is based on this relationship, and assumes a full-scale input voltage swing at the frequency of interest. If the signal is less than full scale, the error will be smaller. When the only limit on the input signal rate of change is slow rate limiting, dv/dt is easily computed and the nomograph is not necessary.

As an example, suppose the maximum allowable error for aperture time is 0.5% and the upper frequency limit is 2.6 megahertz. Use a straight-edge to intersect the frequency axis on the bottom and the error axis in the center. Maximum permissible aperture time is read from the top axis—300 picoseconds. (The present limit for aperture time in high-accuracy—0.1% linearity—sample-and-hold modules is about 100 ps.)

To find the error of an a/d converter with a conversion time of 22 microseconds and a dc input varying at 20 hertz maximum, treat conversion time as aperture time and signal rate variation as frequency. Use of straight-edge and nomograph shows the maximum error to be 0.3%. It should be noted that the error of the a/d converter can be reduced by two orders of magnitude by employing a sample-and-hold module to keep the converter's input constant for its full 22- μ s conversion time.



SCR reset for integrator provides high speed

by Marshall W. Williams
University of Georgia, Athens, Ga.

A fast-switching three-gate reset circuit allows steady or varying dc voltage to be converted into TTL-compatible pulses for driving counters or other data storage or data processing devices. The circuit, actually a digitizing integrator, performs short-term integration on the input voltage. Each time an SCR conducts, the integrator section is reset, and a pulse output is obtained.

Because of its fast reset action, the circuit exhibits good linearity and accuracy. An output pulse rate of 10,000 counts per second injects an error of only 1%, which decreases to 0.001% at 10 counts per second (corresponding to a 25-millivolt input to the integrator.) Error, in this case, refers to the deviation from linearity of input voltage versus output frequency.

To avoid elaborate isolation circuitry, the SCR's cathode is connected to the integrator's summing point, permitting the integrator to accept only negative voltages. Positive voltages can be accommodated by preceding the integrator with an inverter stage.

The reset circuit consists of cross-coupled NAND gates that form an R-S flip-flop and another NAND gate, connected in a 1-microsecond-delay inverter configuration, that keeps the flip-flop's Q output normally low. The integrator output is fed through a forward-biased diode to the base of a transistor, allowing the transistor to turn on only when the integrator output reaches approximately 1.4 volts.

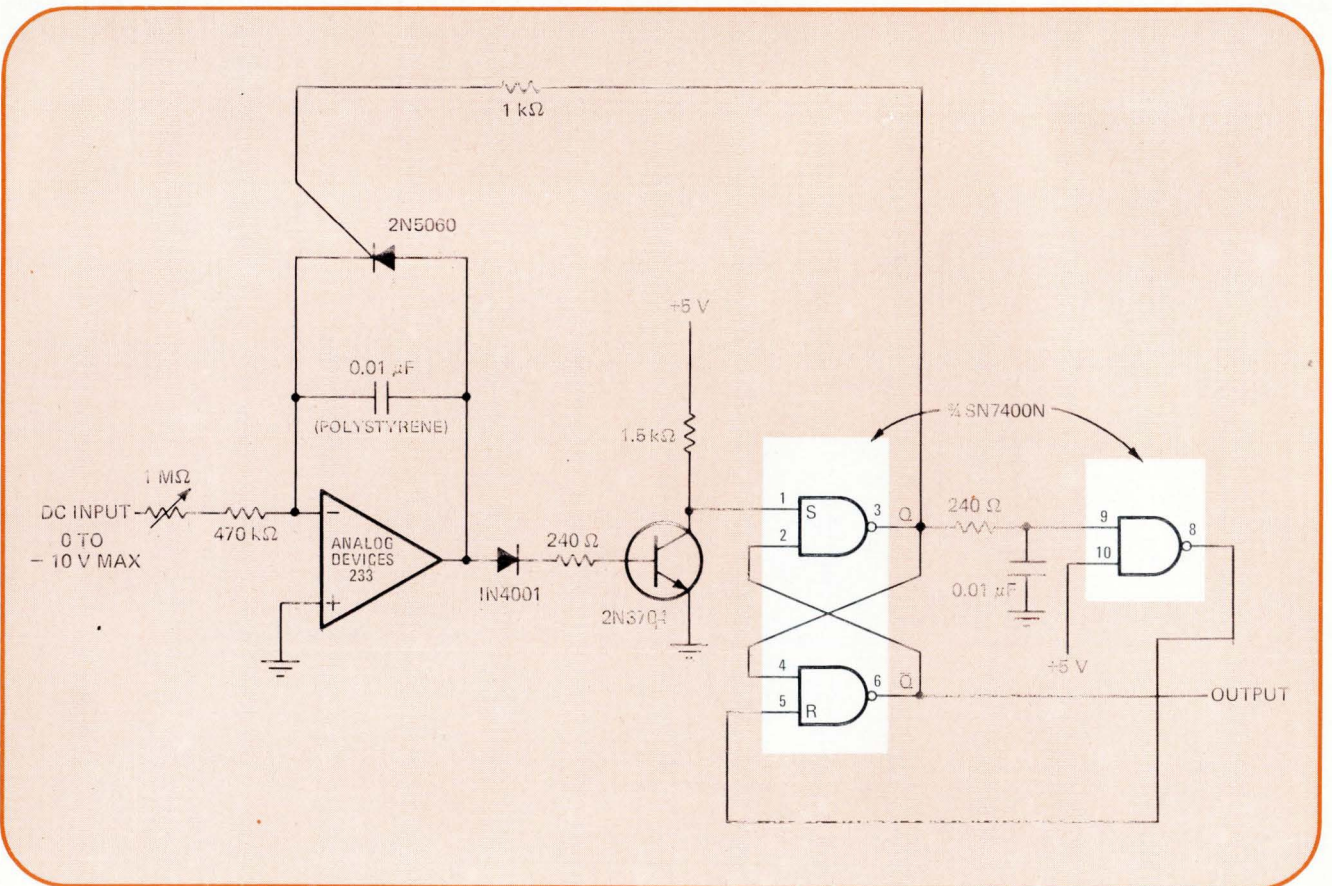
When the transistor conducts, its collector goes low, applying a negative-going transition to the flip-flop's S input. The Q output of the flip-flop now goes high, turning on the SCR gate and producing a negative-going TTL-compatible pulse at the flip-flop's \bar{Q} output.

As the Q output goes high, a delayed positive pulse is fed to the inverter gate, causing its output to go to logic 0 and resetting the flip-flop. The integrating capacitor is discharged to approximately 0.7 v (the turn-off voltage of the SCR) to initiate the next integration period.

With the input resistor values shown, integrator reset rate may be adjusted to around 0.25 millisecond when -10 v is applied to the input; lower input voltages give proportionately longer integration periods. A chopper-type operational amplifier is indicated in the diagram, but almost any op amp will work if larger drift errors can be tolerated.

Designer's casebook is a regular feature in Electronics. We invite readers to submit original and unpublished circuit ideas and solutions to design problems. Explain briefly but thoroughly the circuit's operating principle and purpose. We'll pay \$50 for each item published.

Digitizing integrator. Dc input voltage is integrated and converted into TTL-compatible pulses by reset circuit that switches SCR to discharge integrating capacitor. When integrator output turns on transistor, Q output of flip-flop (cross-coupled gates) goes high, switching on SCR. Logic output pulse at flip-flop's \bar{Q} output is terminated when inverter gate resets flip-flop and SCR turns off.



MOSFET network minimizes audio oscillator distortion

by Glen Coers

Texas Instruments Incorporated, Dallas, Texas

Because a MOSFET feedback control keeps the output level constant and prevents limiting, a low-distortion audio oscillator can deliver several volts into a 50-ohm load. The circuit uses a 1-watt audio amplifier as both an oscillating element and a power amplifier, and provides a total harmonic distortion of less than 1%. Moreover, it operates from a single supply, and holds output level change below 0.2 decibels if the supply voltage changes by 6 volts.

The oscillator circuit is a Wien-bridge type, in which resistors R_1 and R_2 , and capacitors C_1 and C_2 function as frequency determining elements. First, R_1 is chosen between 100 ohms and 1 kilohm. Then $C_1 = \frac{1}{2\pi f_0 R_1}$, where f_0 is circuit resonant frequency. The values of R_2

and C_2 are directly proportional to R_1 and C_1 , respectively: $R_2 = 10R_1$ and $C_2 = C_1/10$.

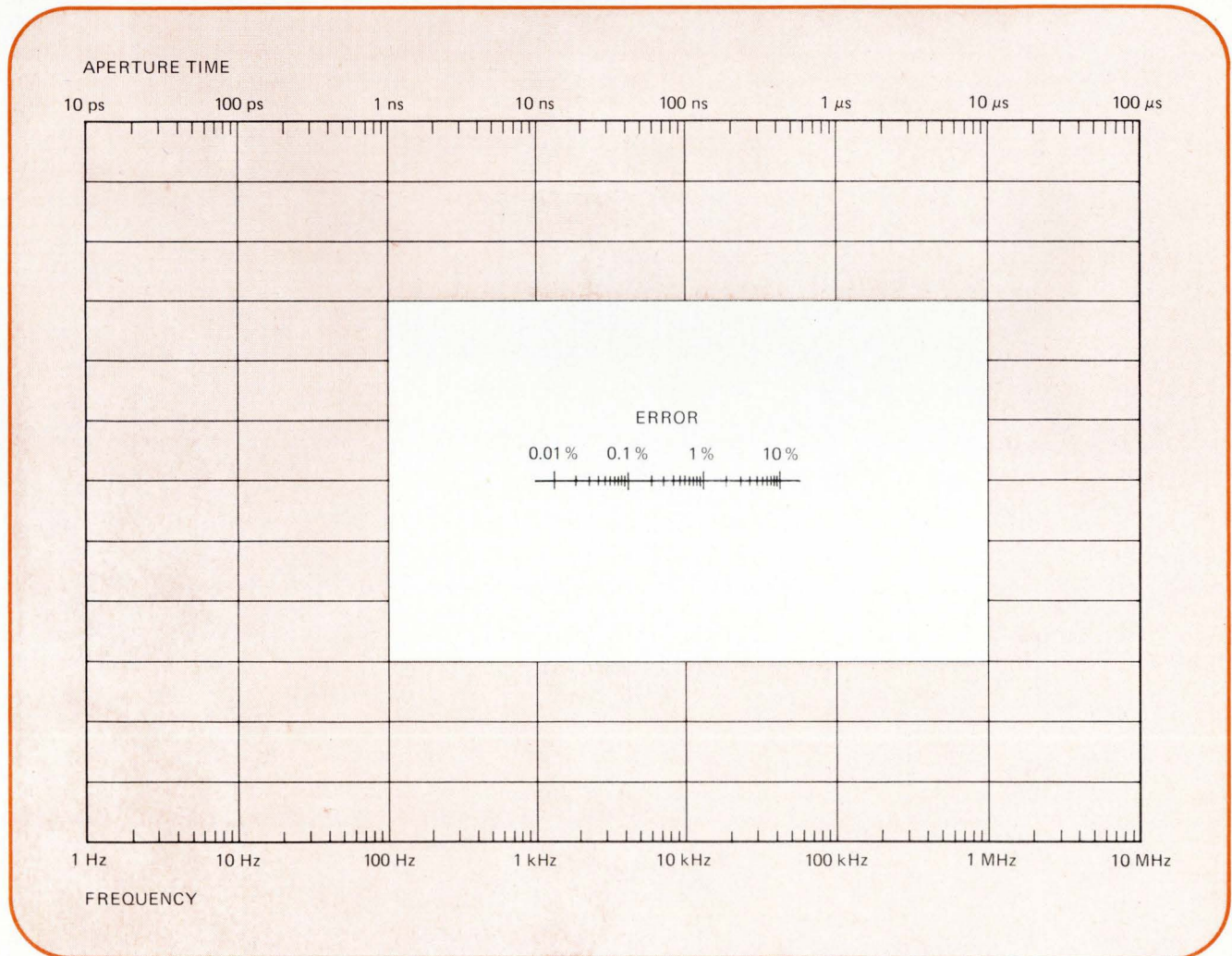
An automatic gain control network at the negative feedback terminal of the audio amplifier assures a low-distortion sine-wave output. The MOSFET acts as a variable resistor. Its resistance is set so that the gain of the amplifier and the loss of the frequency determining network are equal when the desired output is reached.

Negative half cycles of the output are rectified by a diode and filtered by capacitor C_3 . Resistor R_3 provides a slight discharge path so that the peak level of the rectified voltage is maintained at the gate of the MOSFET, keeping output level constant.

If amplifier gain increases and output amplitude also rises, more negative bias is applied to the MOSFET's gate, increasing MOSFET resistance to reduce amplifier gain and output amplitude. If the amplitude decreases, the MOSFET becomes biased in the forward direction so that its resistance is lowered, and both gain and amplitude are increased.

The audio amplifier used has an open-loop gain of 70 dB. Attenuation of the frequency determining network is 26 dB.

Power audio oscillator. MOSFET acts as variable resistor to control gain of audio amplifier, which functions as both oscillating element and power amplifier. If output amplitude becomes larger than desired, MOSFET is back-biased, increasing its resistance and lowering amplifier gain. When amplitude falls below desired level, MOSFET is forward-biased to decrease its resistance and increase amplifier gain.



LM311B LM201A LM201C LM301A
 LM307D LINEAR VOLTAGE REGULATORS 723B 723C 823A 823B LM104
 LM105 LM204 LM205 LM304 LM305
 COMPARATORS 710 711 LOW POWER
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 6047 54L LOW POWER TTL TS54L00
 TS54L04 TS54L10 TS54L20 TS54L30
 TS54L51 TS54L54 TS54L55 TS54L71
 TS54L72 TS54L73 TS54L74 TS54L78
 TS54L85 TS65L86 TS54L91 TS54L93
 TS54L95 TS54L98 TS54L99 HIGH
 NOISE IMMUNITY LOGIC 301 302 311
 312 303 322 323 324 321 325 326 331
 332 333 334 325 341 342 343 361
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 101 111 114 115 116 117 119 121
 122 123 124 126 131 134 141 142
 151 161 171 172 181 HYBRID HIGH

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 SU2080 SU2081 SU2098 SU2099
 SU2098A SU2098B SU2099A 2N5045
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Another self-aligning MOS process has interconnecting advantages

Self-aligned thick-oxide process cuts the gate-to-drain capacitance of MOS transistors, using standard MOS masks; unlike other self-aligning methods, it easily produces devices with three interconnection levels

by Robert H. Wakefield Jr., Edmond R. Ward, and James A. Cunningham, *Texas Instruments Incorporated, Dallas, Texas*

□ The high packing densities of MOS circuits may have made LSI practical today, but their low switching speed is still a big hang-up. The limiting factor is the capacitance between the gate and drain in the MOS transistor. This capacitance can be reduced by self-aligned gate structures, like the silicon gate or the ion-implanted source and drain.

A new, more versatile and reliable approach to self-aligned gates called SATO (self-aligned thick-oxide) is amenable to many of the same processing steps as standard MOS devices. It allows two or three levels of interconnections on the chip. It offers a wide choice of materials for the gate insulator and the gate electrode. And it can be processed with many of the same masks used for standard MOS circuits, permitting easy conversion for significant increases in speed.

Means to self-alignment

In those standard MOS circuits, the gate typically overlaps the drain by about 5 micrometers, and, because of mask misalignments during processing, can often overlap by as much as 10 μm . Although 5 or 10 μm is not very much, the thin gate oxide in the overlap area produces enough capacitance between the gate electrode and the drain region to limit the rate at which charge can build up on the gate electrode and turn on the transistor. Although the capacitance can be reduced with precision masking and alignment procedures, the resulting yields can drop drastically, either because the gate metal doesn't fully cover the thin gate oxide or the gate oxide itself doesn't meet both source and drain diffusions. In either case, the low-resistance channel under the gate won't connect the diffusions. The trend has therefore been toward self-aligned gate structures, where alignment is an inherent part of the process.

Perhaps easiest to understand, for example, is the ion-implantation method, where the gate metal is applied first and then ions are implanted into the semiconductor to form the source and drain regions. Since the ions do not penetrate the gate metal, the edges of the gate turn out to be almost perfectly aligned with the edges of the source and drain regions. However, ion-implantation, as well as the other self-aligned gate approaches, presents more difficulties than SATO.

SATO, which produces a typical gate-drain overlap of only 1.25 μm , starts with a deposition of silicon nitride over the wafer; then windows are etched out for diffu-

sion of source and drain regions (see Fig. 1). The silicon nitride that lies between the sources and drains—the areas where the gate oxides will later be placed—is next protected with photoresist, and all remaining silicon nitride is removed. The thick field oxidation then is carried out while the silicon nitride is still in place in the gate region. When the silicon nitride is removed, the thin gate oxide is grown, and then contact openings are made, and the gate metal, source, and drain contacts as well as interconnects are applied. Since the silicon nitride served as the mask for source and drain diffusions, and is later replaced with a thin gate oxide, self-alignment of gate and source is automatic. A photograph of a typical device is shown in Fig. 2.

Material benefits

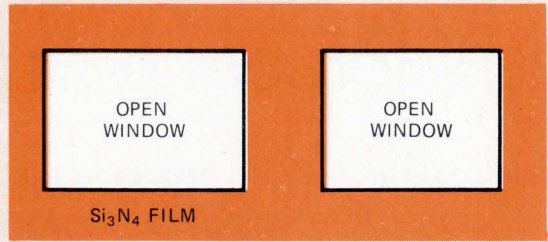
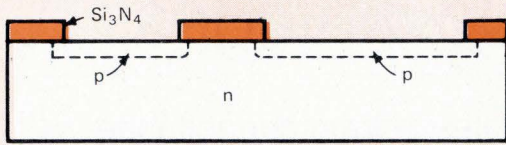
The use of silicon nitride as a mask has several advantages. Since it is a dense material, only a thin layer need be used—1,000 angstroms is enough. As a result, source-to-drain spacing, diffusion line widths, and transistor widths can be controlled more closely.

The step from the gate oxide up to the thick field oxide, which covers the rest of the wafer, is only half the field oxide thickness (since growing the field oxide consumes about 5,000 angstroms of silicon), and the smooth taper means that metal and photoresist can cross the step without any danger of thinning, a common failure mode of many MOS devices.

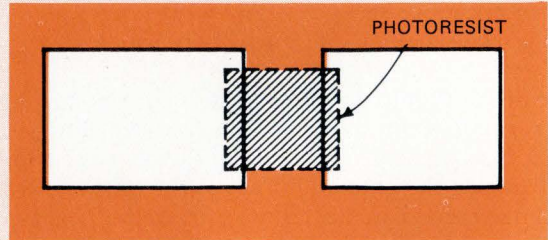
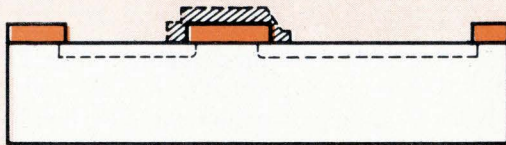
Another point in favor of SATO is that no high-temperature processing is required after formation of the gate oxide. All subsequent steps are identical to those used for conventional p-channel MOS. The gate oxide may be thermally grown SiO_2 , or any combination of thermal oxide and deposited insulation materials. Phosphorus-stabilized SiO_2 insulators also can be used to reduce pinholes and improve threshold voltage stability (the phosphorus performs a gettering action for alkali ion contamination).

In contrast, the silicon-gate method shown in Fig. 3(a) may not use phosphorus stabilization of the thin gate oxide because the gate oxide and the polycrystalline silicon gates are formed before the high-temperature diffusion of source and drain regions. If the gate oxide were treated with phosphorus first, the phosphorus might diffuse into the underlying silicon during the high-temperature process and cause shifts in threshold voltage. And lowering the diffusion tempera-

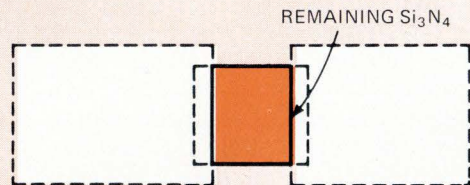
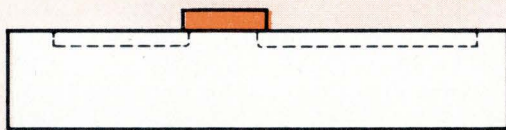
(a) DEFINE SOURCE AND DRAIN REGIONS IN Si_3N_4 AND DIFFUSE BORON.



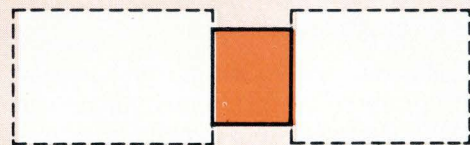
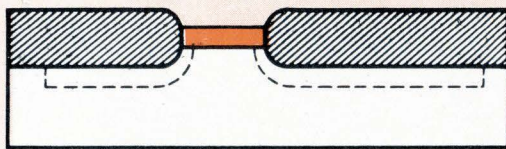
(b) COVER GATE Si_3N_4 WITH PHOTORESIST.



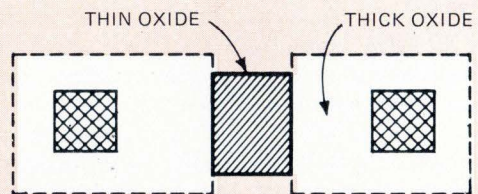
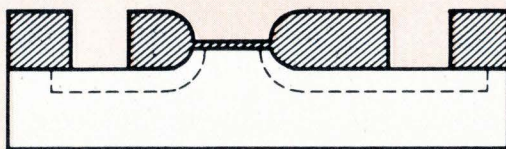
(c) REMOVE ALL EXPOSED Si_3N_4 .



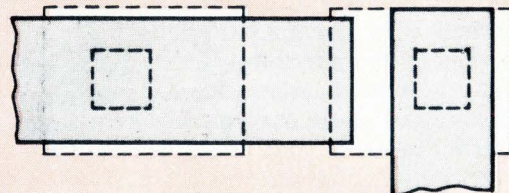
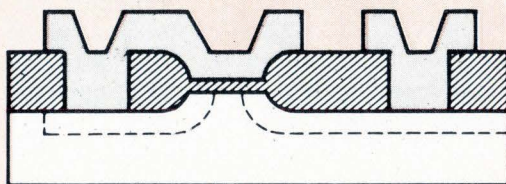
(d) PERFORM THICK FIELD OXIDATION.



(e) REMOVE Si_3N_4 . GROW GATE OXIDE. ETCH CONTACT OPENINGS.



(f) APPLY AND ETCH Al CONTACTS AND INTERCONNECTS.



1. SATO steps. The self-aligned thick-oxide process begins with windows etched in silicon nitride for source and drain diffusion. Next, all silicon nitride except that covering the gate area is removed, and the thick field oxide is grown, consuming silicon and reducing height of the step up. The silicon nitride then is removed, and the gate oxide is grown, with edges that align with the source and drain regions.

RMOS for sale

Another approach to self-aligned gates, the molybdenum gate, or RMOS (refractory metal-oxide semiconductor), was being developed at General Electric Co.'s integrated circuits product department, Syracuse, N.Y. [*Electronics*, April 12, p. 68]. In this approach, the gate metal acts as the mask during diffusion from a boron-doped oxide of the source and drain regions. (The deposited doped oxide is needed because unprotected molybdenum oxidizes at temperatures of standard liquid source diffusions, which are commonly used with silicon gate devices.)

However, GE recently decided to shut down its IC department, and the molybdenum gate's future is uncertain. D. J. Harrington, former marketing manager of the GE department, reports, "RMOS does provide higher-performance MOS circuits for equivalent geometries than silicon gate. This was largely due to the higher-conductivity first-level metal and higher gain for an equivalent gate voltage. General Electric had solved most of its manufacturing difficulties with the technology, and had seen profitable yields. The process in its present form, and masks for all RMOS circuits, are available for purchase."

2. Mask mates. Two 1,024-bit RAMs made with the same set of photomasks allow comparison of SATO (a) with conventional processing (b). In the SATO version, the self-aligned gates are visible, while the lack of definition of the lines indicates a flatter surface.

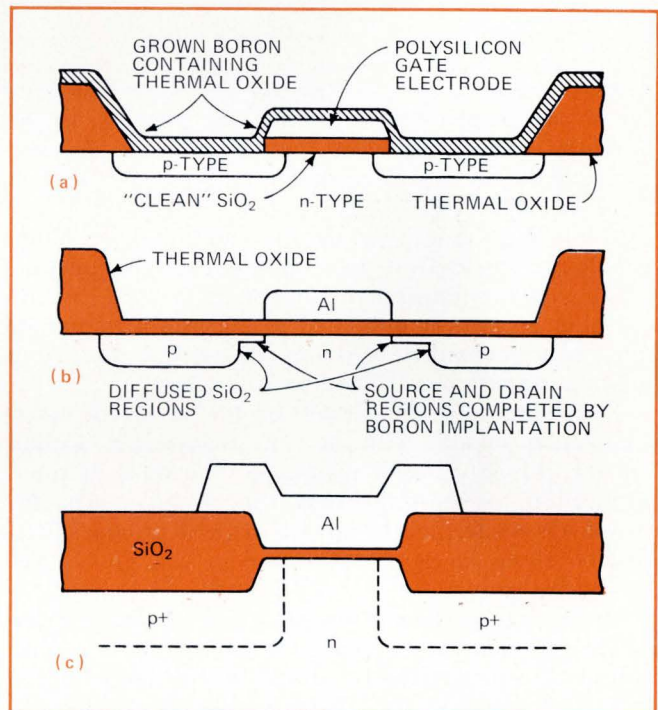
tures would probably produce source and drain regions that are too shallow. Finally, since gate insulator edges are exposed to the high temperature, contaminants can more readily diffuse into the gate insulation.

Of course, it should be acknowledged that silicon gates produce lower-threshold p-channel devices because of the work-function advantage of the polycrystalline silicon used for the gate. However, silicon gates can also be used with SATO. Also, although phosphorus stabilization of the gate oxide may be impractical, the polysilicon can be covered with phosphorus glass to eliminate pinholes in the insulation between it and the metal interconnections on the next level.

Narrow control

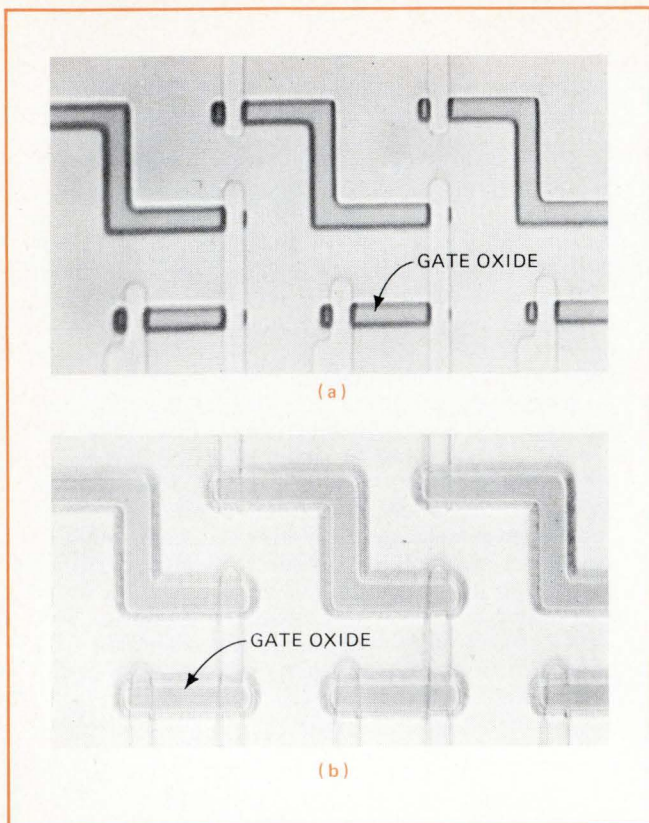
Dimensional control of devices also appears better with SATO than with the silicon gate. In silicon gate, the first etching step to define transistor widths is performed with oxides that are 1 to 1.5 micrometers thick, an order of magnitude thicker than the corresponding layer of silicon nitride in the SATO process. The photoresist often fractures round the relatively high 1.5- μm step. Besides, since the transistors may be only 5 μm wide, it's hard to control this dimension when etching through an oxide that, at 1.5 μm , is nearly a third as deep.

High temperatures can be a problem also with the ion implantation method, in which aluminum gates are commonly used. The temperature needed to activate the implanted boron is close to the silicon-aluminum eutectic (577° C) and, if held at this level for too long,

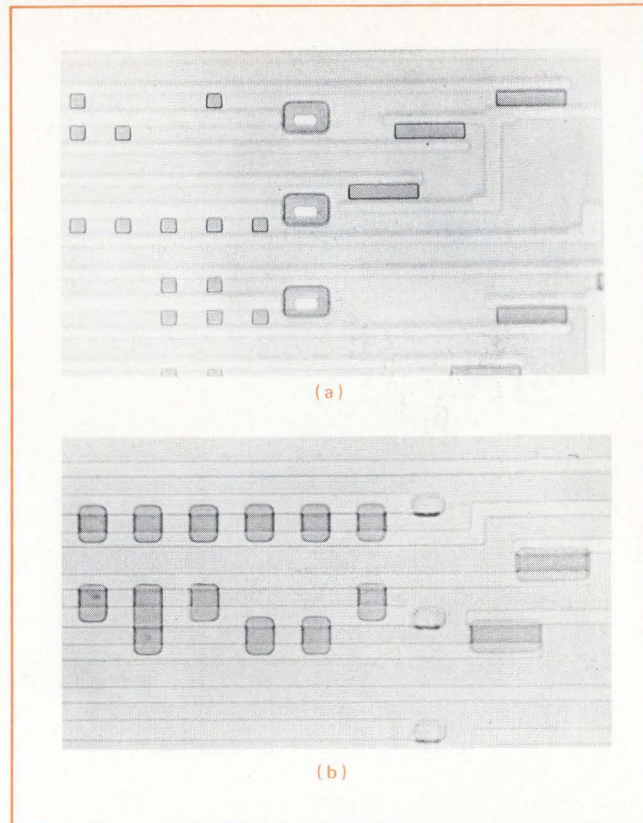


3. Self-aligners. Three basic MOS structures, the silicon gate (a), the ion-implanted source and drain (b), and SATO (c), all achieve self-alignment of the gates, but SATO offers additional advantages in flexibility of interconnections and in choices of metals.

will cause the aluminum to penetrate the gate insulation and create a short circuit between gate and silicon substrate. Other problems may arise because of the sharp radius of curvature of the implanted pn junctions near the aluminum gate electrode. This would reduce the breakdown voltages in this area. In addition, since no lateral diffusion takes place during or after implantation, the pn junction near the SiO₂-Si interface is in a



4. Easier etching. In the TMS 3003 dual 100-bit shift register, the conventional version (b) shows the difficulty of controlling the gate dimensions when etching through the thick field oxide, a problem that's eliminated with the use of silicon nitride as a mask in SATO (a).



5. Less oxide. In the SATO version (a) of a 2,048-bit ROM, the reduction in area of the thin oxide is evident in comparison with a conventional circuit (b) made with the same photomasks. The alignment of the thin oxide edges with source and drain stripes is also plain.

region of high dislocation density and may have different characteristics from a classical planar type junction. (Note that the ion-implantation method used to form self-aligned gates is unrelated to the use of implanted ions in the channel to lower thresholds; the latter method can also be used with SATO, in fact).

There are also differences in the levels of interconnection possible with the various processes. Counting the p-type diffused regions as one level of interconnection, the ion-implantation method provides only two levels while the silicon-gate method provides a restricted three levels. SATO, however, can give a full three-level system.

In SATO, the choice of metal is unrelated to the formation of the self-aligned gates. Thus, for example, aluminum can be used for single-level systems such as large high-speed ROMs, but for multilevel circuits, silicon can be used as a first level followed by aluminum. The silicon can be doped as it is deposited to avoid a high temperature diffusion (silicon sheet resistivities of 50 ohms/square can easily be obtained). The gate dielectric will remain free of heavy boron concentration that may affect stability, and still can be phosphorus-stabilized before silicon deposition. The silicon can cross over diffusions, and aluminum can cross over both silicon and diffusions.

In the silicon-gate process, however, silicon may not cross over diffusions, since it is doped at the same time as the diffusion regions—that's why many engineers refer to the silicon-gate method as offering two and a half

levels of interconnections. However, an extra diffusion step for the silicon interconnector can be added to provide full three-level capability, and the silicon can even be used to contact the diffused regions. But that involves extra processing steps.

SATO versus standard MOS

SATO offers the opportunity for a direct comparison with conventional MOS circuits, since in many cases it can use the same set of photomasks. The photomicrographs show several advantages of SATO. In the 1,024-bit RAM shown in Fig. 2, for example, the flatness of the SATO device surface and the self-aligning gates are visible. From Fig. 4, which shows a dual 1,000-bit shift register, the difficulty of controlling active gate dimensions while etching through thick field oxide can be appreciated. In Fig. 5, a 2,048-bit ROM, the significant reduction in thin oxide area is evident.

In the future, it's expected that the SATO process will see most usage in high-speed circuits where packing density is of primary concern, such as 1-kilobit dynamic shift registers, random-access memories, and complex calculator circuitry. For example, the TMS 3412, 13, and 14 are dynamic shift registers (quad 256, dual 512, and single 1,024 bits, respectively) that use deposited silicon as the first level interconnect. These devices have 5-MHz operating speeds, and are directly compatible with TTL at both input and output. Capacitance of the clock line is only 70 pF, which allows the user to drive a large number of units with inexpensive clock devices. □

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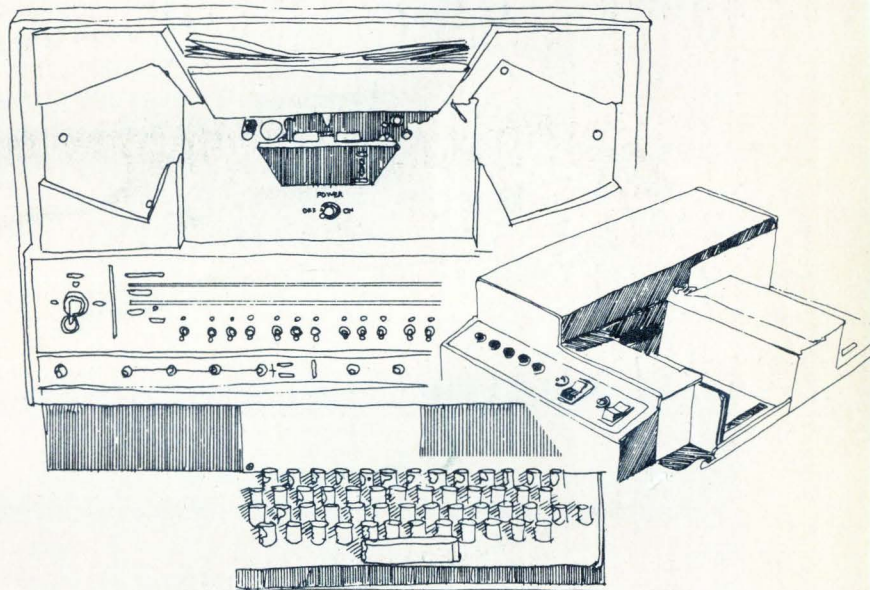
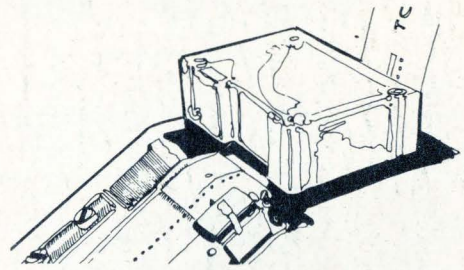
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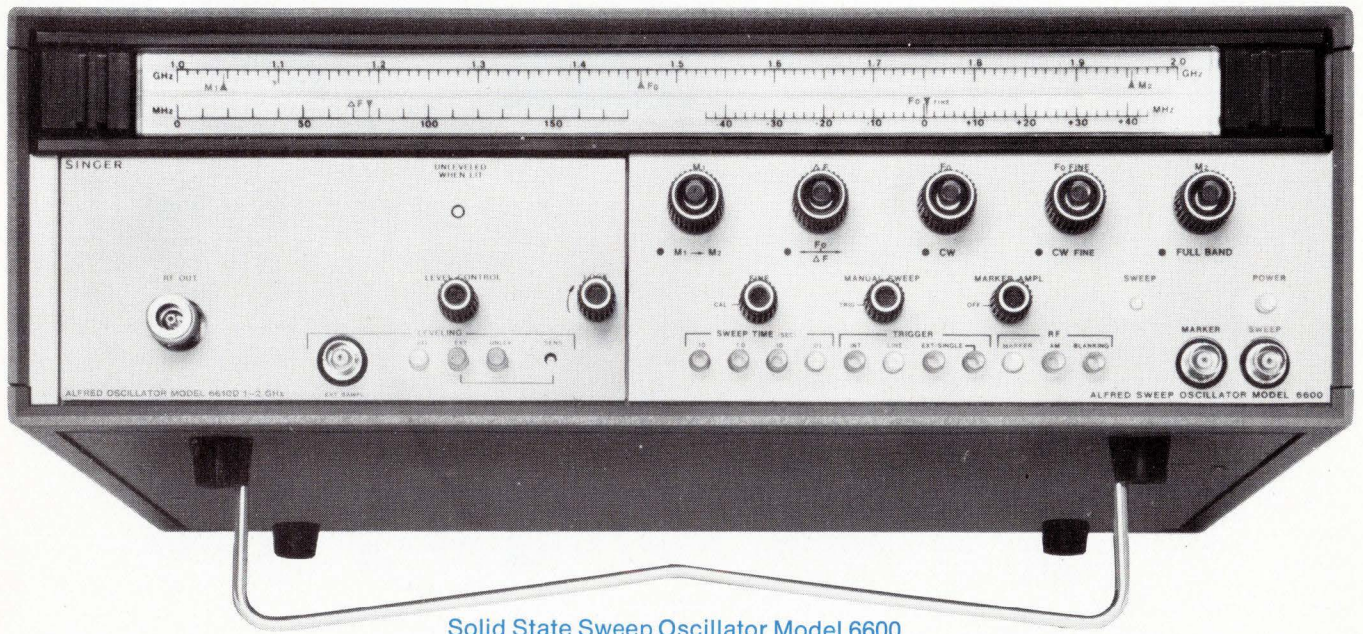
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Probing the news

Analysis of technology and business developments

Ringling in the New Year —with guarded optimism

Foreign competition and Government policies worry industry leaders, although gains in economic health raise spirits

The view of the electronics industry's future from the top echelons of various companies is one of deep concern, yet cautious optimism. In interviews with board chairmen, presidents, and general managers, three major problems emerged: an inability to compete with Japan on an equal footing; loss of momentum of the country's technological leadership; and doubt about the effectiveness of the Nixon Administration's economic game plan, especially Phase 2.

On the plus side, conditions seem ripe for recovery—perhaps slow at first, but building to a substantial pace by the second half. As John Buchholz, group executive for Amphelol Components Group, Oakbrook, Ill., observes: "By the second half we'll be running to catch up, which is a pleasant predicament compared to the last two years."

Buchholz, who describes himself as having "cautious, positive, optimism," says, "When you come out of a dip, as our industry has, the tendency is to shy away from great optimism. But believe me, the industry is in a lot better condition today than any of us cares to admit."

And under the surface there seems to be a sense of enthusiasm about the year ahead among electronics managers. Buchholz sees increases in R&D spending by 5% to 10% and increases in technical personnel hiring by 10%. In some cases, the problems concern how to handle expanded production and sales.

However, silver linings often come with black clouds. Even the most forceful executives find some of the current problems too potent

to alter. For example, foreign competition is too big for any company to tackle singlehandedly.

And these days the phrase "foreign competition" means the Japanese and their penetration—sometimes domination—of this country's electronics markets. Though primarily aimed at consumer and commercial products, the impact has been felt by components manufacturers whose OEM customers are being hurt or are shifting production offshore. Compounding the frustration is the feeling that the Japanese can compete in the U.S. but that American competition in Japan is restricted.

Equality now. One of the most outspoken advocates of changing national trade policies and procedures to equalize the ground rules is Joseph S. Wright, chairman of the board of Zenith Radio Corp., Chicago. A lawyer, Wright resents being called a protectionist, but is adamant about what he feels is systematic discrimination by foreign countries against American electronics.

The reasons for concern are easily understood by the industry, says Wright, but only recently—since the bombshell of Phase I exploded—has foreign competition clearly been a matter for top-level attention, and this is at least the beginning of a good situation.

"When we talk about doing something about unemployment, we mean creating jobs. Yet the consumer industry has seen 120,000 lost jobs in four to five years as production has gone to the Orient and Mexico. So the Government has a



Fair play. "The government has a stake in changing our trade policies to help create more jobs."—Joseph S. Wright, chairman of the board, Zenith Radio Corp.

stake in changing our trade rules, not to create walls or quotas, but to allow us to compete fairly."

The Zenith executive also fears that engineers will follow production abroad. "I don't know how we can continue to do engineering here and production offshore. I would prefer not to do so, but if production continues to move overseas, engineering jobs will follow. I don't see any way it can be avoided, particularly when you compare Japanese and American salaries for engineers."

Should we join the club? Equal ground rules in foreign competition have also been demanded by components manufacturers, even in the high technology semiconductor business. "One thing of concern to us today is the artificial trade barriers that prevent the free flow of U.S. goods into Common Market nations and Japan," says C. Lester Hogan, president and chief executive officer of Fairchild Camera & Instrument Co., Mountain View, Calif. "In Japan, it's 'Japan Incorporated'—the government and indus-

Probing the news

try control business with outsiders.”

Because there appears to be little hope for a change in this setup, and the Japanese will begin making their own advanced semiconductors, such as MOS/LSI for calculators, Hogan has now embarked on a plan to establish a 50-50 joint venture in Japan in order to “get into the club,” that is, to sell to Japanese manufacturers more easily.

But Robert A. Farrall, president of Clairex Corp., Mount Vernon, N.Y., decries the flight of electronics production offshore. “If the only way to compete with the Japanese is to build a plant in Japan, you’re not competing, you’re joining them,” he charges. “It may help stockholders, but the jobs go to Japanese—not U.S. workers. If the only thing left here is marketing, that’s fine, if you’re a salesman, but it doesn’t solve the problem.”

Farrall, a physicist who turned engineer before entering management, also worries about jobs for engineers. He points out that when Clairex, a phototransistor and electronic assembly firm, set up its Puerto Rican production facilities, the tax incentive arrangement required that the company retain its original production plant in Mount Vernon. “Maybe the Government should put the same requirement on plants going up in the Orient and Mexico. That way, at least, we hold on to the engineering jobs in this country. Irrespective of the economy in 1972—which is bound to be good—these are problems that won’t get solved easily, because with Japanese products, the designs are good, the quality is good, and the prices are right. That doesn’t leave much ground to compete on.”

Government’s partners. Charles E. Sporck, the young president of National Semiconductor Corp., Santa Clara, Calif., sees the Japanese competition as a reflection of U.S. trade policy. “What it really comes down to,” says Sporck, “is that our Government permits the Japanese to operate in a different mode here than we are allowed to operate in there. Trade barriers, high import duties, and a myriad of other things are being applied by the Japanese to re-

strict our business there—it’s an active partnership between the Japanese companies and the government—whereas here it’s more like active opposition.”

He is not angry at the Japanese—“I would do the same thing given a chance”—but he is angry at the U.S. Government. “Washington has to start paying attention to the important industries like electronics, and it must support development in the U.S. the way the Japanese government does. Development in the U.S. is coming to a screeching halt.”

When R&D is cut. Neal W. Welsh, the chairman of the board for Sprague Electronic Co., North Adams, Mass., emphasizes two levels between trade and R&D. “I don’t think the public realizes either its stake in the electronics industries or the degree to which it has been hurt by competition from abroad. Consequently, people are relatively passive when Congress cuts R&D funding or fails to protect domestic markets against competition, especially from Japan.”

“Goods from overseas account for about 92% of all radios sold in the U.S., exclusive of auto radios, and 64% of all capacitors, if one includes those used in goods shipped in from abroad. At the end of 1970, 37% of all television sets sold here had been made overseas, and if one limits this to black-and-white sets, the proportion is much higher,” Welsh points out. He contrasts this with shoes and woollens. “Only 21% to 22% of woollens sold here came from overseas last year, and only about 29% of the shoes; yet both these industries can claim a degree of tariff protection that electronics industries cannot.”

Moses Shapiro, fast-talking chairman of the board and chief executive officer for General Instrument Corp., New York, agrees. However, he feels that the Government is on the right track with recent moves—first surcharge and now devaluation. He comments: “All you want to do is make sure that both sides play under the same set of rules.”

Foreign competition also bothers equipment manufacturers. Robert C. Wilson, newly appointed president and chief executive officer of Collins Radio Co., Dallas, Texas, muses, “Every other country is anxious to help its industry. They un-

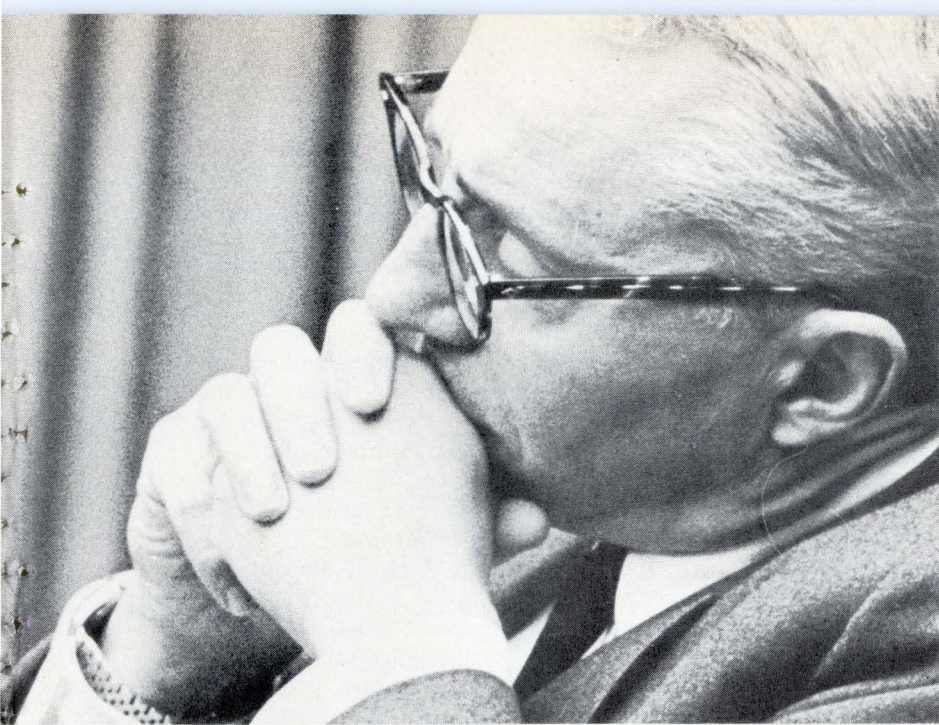


50-50 trade. “Artificial barriers prevent the free flow of U.S. goods into foreign nations.”
—C. Lester Hogan, president and chief executive, Fairchild Camera & Instrument.

derstand how vital it is to them. But somehow, this country has this out of perspective—maybe because of the many years that things have been so good. There’s no misconception about what’s the baby and what’s the bath water in foreign countries. There, government is business, or close to it. Our society—not just the Government—will have to change its attitude, because it’s a whole new ball game, and the question is whether we’re ready for it.”

The competitive ground that electronics executives uniformly agreed was the foundation of U.S. strength is technology. And, despite the gloom prevalent on the subject of foreign competition, maintaining technological leadership is a common cause for short-term optimism. For Fairchild’s Hogan, it’s technology plus the risk capital to pay for new developments that will spell the difference.

Making it. For James Sheridan, president of Monroe division of Litton Industries, Orange, N.J., it’s technology plus strong marketing. Since he became president in 1970, Monroe has completed the difficult transition from electromechanical to electronic calculators, adjusted to fierce competition for the domestic market, and moved into new families of LSI machines. Sheridan, who came up through the sales ranks, at-



Space disgrace. "To the electronics industry, the cut in space funds is a genuine blow."—D. Brainerd Holmes (above), executive vice president, Raytheon Co.

tributes this success to maintaining a balance between Monroe products made in Japan and those produced here, plus building an extensive direct sales force.

"Nothing in the cards will preclude working with our Japanese supplier. We'll continue to do those things we are best suited to do—mainly in the printout machines—and they will do what they are best suited for," says Sheridan. However, he adds that Monroe has just had the best year in its history, and spending for product planning is at an all-time high. "We do the design engineering for our entire line, and I don't think we will ever stop doing it from here," he concludes.

Hassles. While generally agreeing that advancing technology is the industry's strong card, there are some executives who are hassled because the changes are too quick. In this regard, L. J. Sevin, outspoken president of Mostek Corp., Carrollton, Texas, complains, "We're safe from the Japanese, but not from each other. The basic problem in electronics is the oversupply of talent. People believe in the elasticity of the semiconductor market and in price cutting to get a market share. But in some cases, the price is bombed before anyone even has the product. To affect us, the price freeze would have had to include a



Safe water. "A NASA agency to clean up the Mississippi River would expand technology as well,"—Donn Williams (above), president, North American Rockwell.



Home and abroad. "We will continue to make what we do best, and our Japanese supplier will do what it does best."—James Sheridan (below), president, Monroe.



Offshore. "If the way to compete with the Japanese is to put plants in Japan, you're only joining them."—Robert Farrall (below), president, Clairex Corp.

Probing the news

floor as well as a ceiling," he quips.

Speaking for a test equipment firm, William C. W. Mow, president of Macrodata Co., Chatsworth, Calif., adds, "U.S. companies stress technology too much. Practically every day someone announces a new process in the semiconductor industry. I contend that, with present technology and systems design, we can make our systems play music. We have to predict the future ahead of the need. We have to have equipment available when it's needed, and the question is whether or not we can settle on a technology long enough to produce the equipment."

For the long term, however, there is far more concern in executive suites across the country about the underlying decline of U.S. technology, hastened by cuts in Government funding. Men raised on the rapid turnover of new ideas and strong in their commitments to growth through innovation are baffled by the seeming lack of support

from Washington and the hostility toward technology current in society today. Among those most distressed by these trends is D. Brainerd Holmes, executive vice president for Raytheon Co., Lexington, Mass., who was the first director of NASA's Manned Space Flight program. Generally credited with getting NASA's management off the ground, Holmes is saddened by faltering space development and sees this as a symptom of bigger problems.

"Space offered tremendous increases in technological know-how—and without a shot fired in anger. But we have now allowed this effort to stagnate—lose any momentum it might have had—and thus are going to get a very small payback from what could have been an extremely productive program. It may take us another 10 years before the body politic finds out just how much we have wasted by cutting space funding," Holmes remarks. "To have invested the money and then to have stopped the program is an immature decision and unworthy of us as a nation."

The Raytheon executive continues: "We seem doomed to continually play costly games of catch-up, wasting money by the barrel when a more or less continuous policy of less frantic research and development not only would cost less over the long run, but keep our military preparedness and our space effort at respectable levels. To the electronics industry, this is a genuine blow. It is these complex efforts that fuel advances in the state of the art, and of late there just hasn't been much fuel to go around."

"Much of the outcry about overpriced systems and technology is based on fact," Holmes says. "Major causes are the massive staffing and cumbersome procurement policies used by the Government. This ups the price of almost anything by 25%. Another 25% could be chopped off if the Government could cut specifications that aren't really needed and piles of documentation that must go along. We could have gone to the moon for \$15 billion instead of the more-than-\$20 billion it actually cost us. Without massive investment

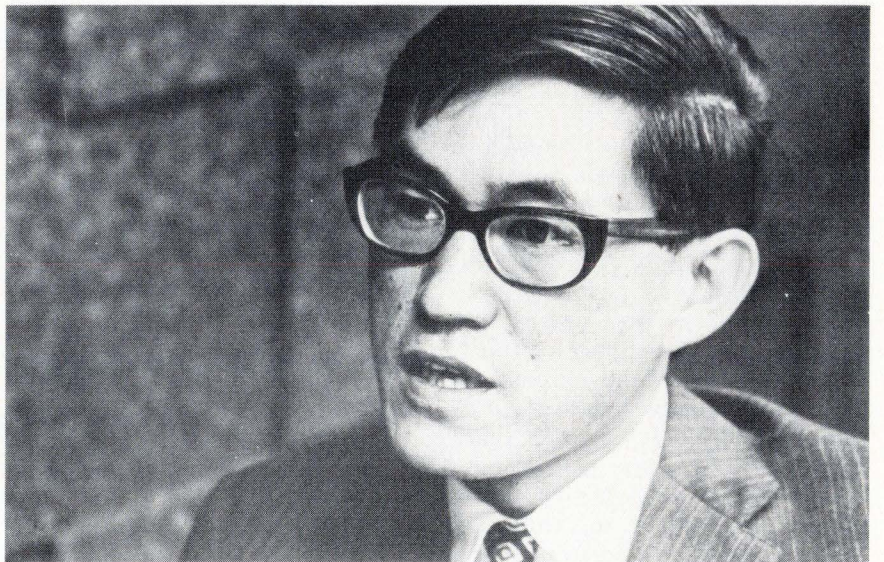


Lost resource. "It has cost a lot to build an engineering resource, and now we're losing it."—William Stevenson (left), acting president, Lockheed Electronics Co.

Phases. "I wish I had never heard of Phase 2; it's a complicated mishmash."—Edward Reavey (right), vice president, Motorola Consumer Products Division.



Keeping up. "The question is whether or not we can settle on a technology long enough to build the test equipment."—William C. W. Mow, president, Macrodata Co.



in facilities at the various centers and the Cape, we could have done it for \$10 to \$12 billion."

Donn L. Williams, president of North American Rockwell Corp.'s Electronics Group, Anaheim, Calif., and a veteran aerospace manager, is far less pessimistic. Williams feels that far from fading into second-class status, the U.S. electronics industry is more like a football player who has taken off 40 pounds of flab and is ready to get into a new game.

Ecological fallout. As a solution for maintaining NASA-like R&D in today's ecological climate, Williams has recommended that the agency, under a new name, take on the task of cleaning up the Mississippi River in time for the nation's bicentennial celebration in 1976. With one agency managing the program, using many subcontractors, and with a clearly stated national objective, Williams believes, there's a far better chance for success than by approaching ecological problems piecemeal. A coherent management approach to ecological problems would result from the Mississippi River project, as well as a great deal of technology that would be applicable to water pollution elsewhere. "We can have both national security and ecology—the technology that brings security can solve the ecological problems," Williams contends.

As for his own company's re-

Three-way relief. "Our approach to the union is to get a competitive plant, a competitive product, and halt inflation."—Merle Kremer, president, GTE Sylvania.



search, "if we invest in four major projects in the Electronics Group, that's about all we can afford. The high cost of developing businesses from the technology we have is a problem."

Another electronics arm of an aerospace giant, Lockheed Electronics Co., Plainfield, N.J., is also calling its shots more selectively. William A. Stevenson, acting president, says his principal weapon in this type of market is playing his company's product strengths via innovative marketing. The strategy calls for avoiding completely new markets and pushing present capabilities.

Our loss. However, he is at the same time outspoken about the harmful effect of the loss of engineering talent created by cutbacks in the aerospace industry. "It has cost the country a lot in money, time, and effort to build engineering resources, and now we are losing this natural resource," Stevenson remarks.

Although the lofty issues of the future of technology are worrying electronics chiefs, the near-term outlook is also a top topic. The main shadow in this favorable picture appears to be Phase 2 of the Nixon Administration's economic game plan. Phase 1 was good for morale, but laudable as the objectives may be, Phase 2 is a headache, say many company executives.

Haunted. Inflation is a specter that still haunts Merle W. Kremer, president of GTE Sylvania, New York. "Phase 2 controls prices, but wages will go rolling along, especially in areas of the electronics industries like ours where contracts were settled a year ago and have a couple of years to go," he points out. The labor situation became critical at one of Sylvania's plants where closing down operations hinged on high union wages. "Our approach to the union is to get the plant more competitive. We pay the highest wages in the area, and unless we get relief, we will have to make more products elsewhere," Kremer claims. However, the union has agreed to lower its demands, averting a shutdown.

Other criticism centers on administration. "I wish I'd never heard of Phase 2," Edward P. Reavey, Jr.,

vice president and general manager of Motorola Inc.'s Consumer Products division, Chicago, complains. "Phase 1 served its purpose of providing a psychological lift, but Phase 2 is a complicated mishmash, hard to administer. There would be less trouble if it were dropped."

Jerry Sanders, president of Advanced Micro Devices, Inc., Sunnyvale, Calif., would also like to see Phase 2 dropped, but in this case dropped to reward employees beyond the 5.5% guideline set down by the Pay Board. "During the last year, we went from a loss position to a profitable operation, and we quadrupled sales, but now that I want to reward my people, I can't do it adequately. We brought people into the company at salary levels that were equal or slightly lower than they were getting elsewhere; our plan was to give raises as the company grew. And now that we've grown, I'm being restricted by Phase 2 from giving the increases they deserve," Sanders maintains. He also feels that there should be guides on productivity in the present wage rules.

The worst thing. Other Government policies are also a source of discontent. This is a leading problem for Recognition Equipment Inc., Dallas. Herman L. Philipson, Jr., president of REI since its inception in 1961, charges, "Absolutely the worst thing on the face of this earth from our point of view—is the Office of Foreign and Direct Investment in the Department of Commerce. By limiting our ability to expand overseas, it's working against the stated Administration policy of encouraging exports. It takes the stand that the lease of a \$1 million system overseas is the same as building a \$1 million plant. So it either forces companies such as ours to license foreign companies—which doesn't create jobs here, or help the balance of payments—or else it forces us to engage in expensive machinations to export. I'd like to see our Government set up an active program for export financing for small companies as it does for aircraft, ships, and military equipment." □

This article was written by Gerald M. Walker with reporting from *Electronics* staffers James Brinton, Paul Franson, Lawrence Curran, Stephen Wm. Fields, and Kemp Anderson.

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Probing the news

Communications

Bell System calls for mobile telephone net

But Motorola and others are filing protests with the FCC because wireline carriers would grab all the bandwidth

by Ray Connolly, Washington bureau manager

A radically new, nationwide land-mobile and air-ground telephone network proposed by the American Telephone & Telegraph Co. has a number of communications companies—Motorola Inc., in particular—hopping mad. The reason: AT&T wants exclusive use of the 806-881-megahertz band to be given to wireline common carriers for both mobile public telephone and private dispatch services. Motorola and others oppose creation of such a "monolithic system."

AT&T has asked the Federal Communications Commission "to insure the success of this venture" by both granting the exclusivity and supporting "the provision for large-scale nationwide mobile telephone and automatic dispatch services" by the wireline carriers. Motorola, has told the FCC that it opposes AT&T's concept of giving over the entire band for both the public mobile telephone and the private dispatch services. The Chicago-based company, however, favors allocating just the mobile telephone service to the wireline carriers.

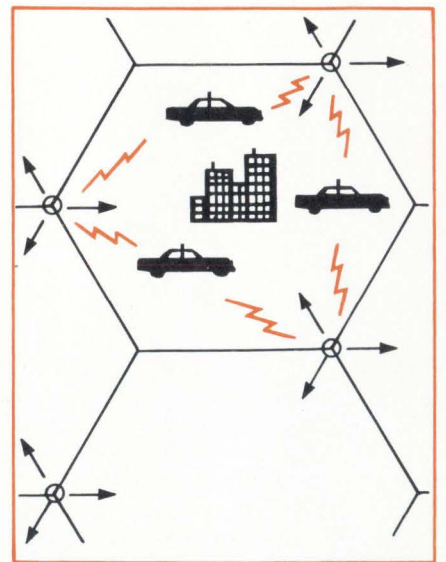
Contention. The positions of both AT&T and Motorola were outlined just before Christmas in comments to the FCC on Docket 18262, covering future use of 806-960-MHz band. In its first report on the docket earlier last year, the FCC set aside 75 MHz of bandwidth in the 806-881 MHz band for wireline carriers, with another 40 MHz for private land mobile in the 900-MHz region.

Bell proposes a five-year development plan for its high-capacity mobile communications system leading

to nationwide "high quality and low cost services." Motorola argues that a system combining public and private services "is not cost efficient for the user," and that "there is no substantial foreseeable market for a consumer mobile telephone service over the next decade. In addition, the company contends that "private land mobile needs more than the 40 MHz" now proposed of the full 115 MHz cited in the first FCC report. Indeed Motorola protests that "radio common carriers are presently not afforded any spectrum."

Complete coverage. There are almost no significant technological criticisms of the Bell concept of using hexagonal geographical areas—cells—with directional antennas on

Double duty. Antennas at alternate corners of a hexagon could be used to hand off mobile signals to adjacent cells, as well as divert them around obstructions within a cell.



three cell corners to overcome "shadow" losses by obstructions such as hills or tall buildings (see diagram).

How big is a cell? It varies, says Bell's proposal, depending on the traffic. The hexagonal cells in each area will be smaller in large urban areas where traffic is heavy; larger in rural areas where traffic is light and man-made obstacles less frequent. Antenna output of about 10 watts appears "an economical maximum for a small-cell system," according to Bell. First service is proposed for major cities.

The key to the switching and control functions of the system is what AT&T calls "sophisticated processors" and, in the case of small cells, minicomputers. The Bell plan calls for small cells of 300 to 3,000 mobile units to use a mobile switching office to complete paths between mobile users and either the landline network or proper dispatcher position. The message switching office alters that path as the telephone user moves and also controls paging and locating of mobile units, channel assignment, billing, and supervision. Bell may modify its electronic switching system to meet message switching requirements.

Division of the 75 MHz sought in the 806-881-band, says AT&T, should initially be subdivided into 64 MHz, yielding 800 duplex channels, to land mobile, and 11 MHz, or 220 duplex channels, to air-ground. The air-ground service would be capable of operating within more than one cell because of flight altitudes.

Bell's call. Though AT&T's proposal is already generating opposition from manufacturer's other than Motorola, Bell moved to soften such criticism by citing its intent to "depend upon general trade sources" for development and manufacture of mobile telephone units.

However, other manufacturers note that Western Electric, Bell's manufacturing arm, might be considered one of those sources. Indeed, one critic, who declined identification pending his company's filing, says "AT&T wants to be the sole customer for many manufacturers. They set the specs and, in effect, they also would set the price. If they don't like the price, they always have Western Electric." □

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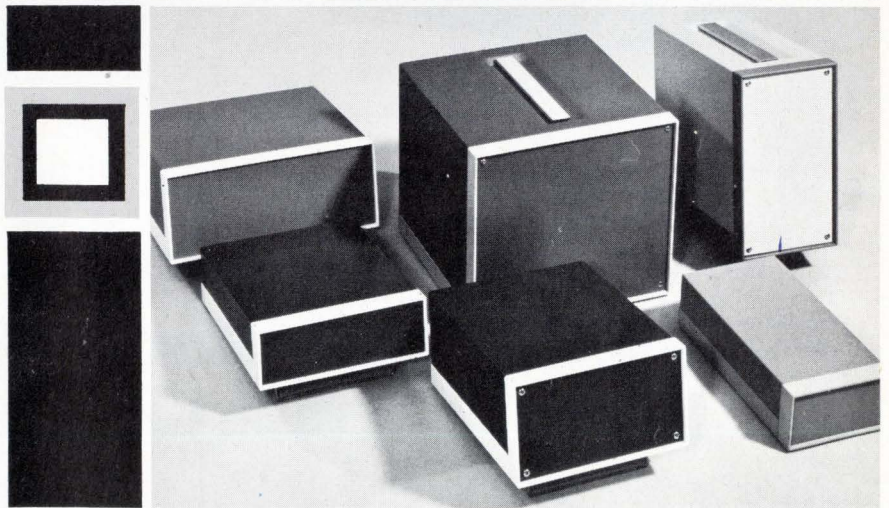
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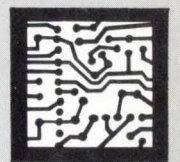
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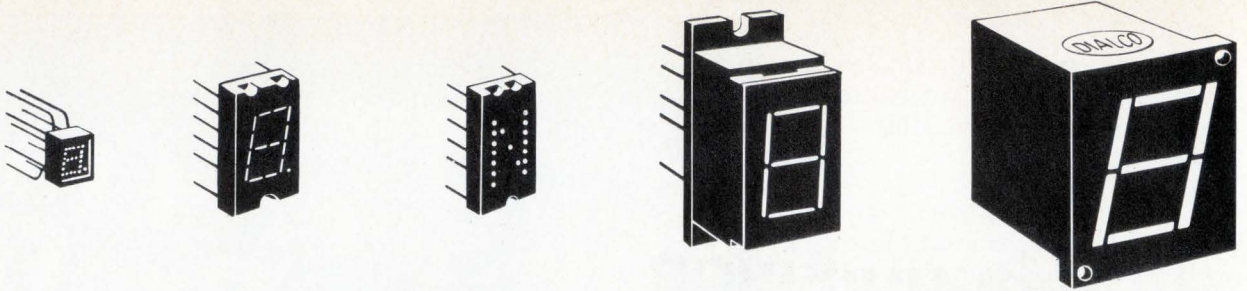


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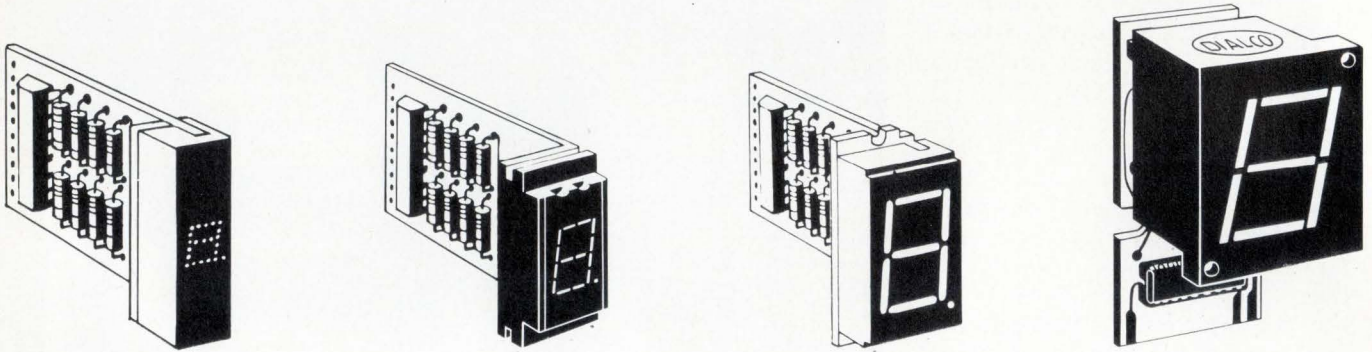
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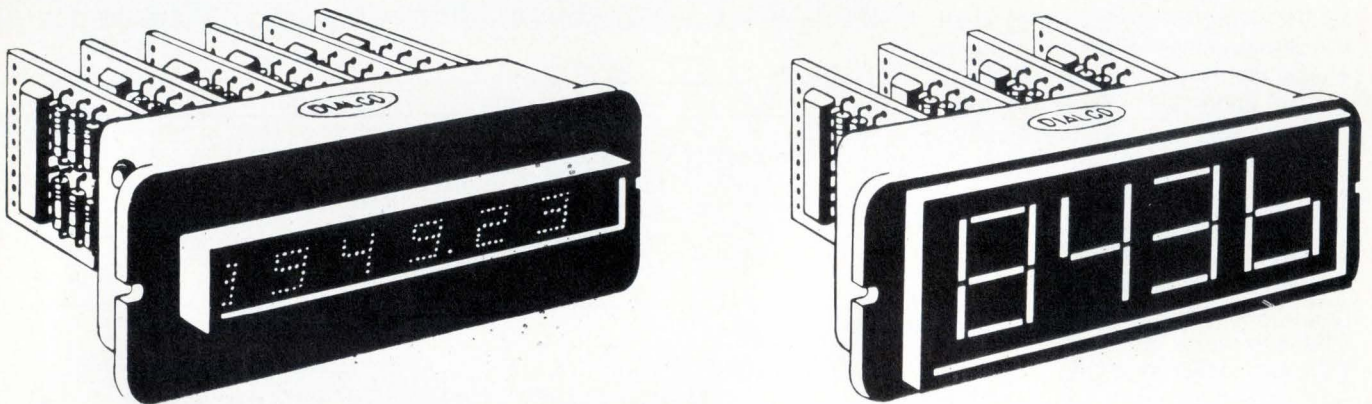
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Data acquisition instruments shrink to circuit-card size

Modular system combines digital and analog inputs for computerized control of industrial processes

There's a growing market for a type of computerized data acquisition and control system that can best be characterized as sensor-based. It has many analog and digital inputs and outputs, but may not need the greatest speed or the highest precision. Most industrial data-acquisition and control applications (such as engine testing) and many scientific R&D applications fall into this category.

The analog inputs are usually low-level and come from transducers, such as thermocouples and strain gages; digital inputs come from sensing contact closures on equipment or operator panels. Analog outputs provide for data display or control of power supplies. Digital outputs are for stepper motor control, control-panel lights, and display and relay solenoid control.

For this kind of application, systems built out of programable lab instruments are too good and too expensive. Yet the only alternative in the past has been a piecemeal approach, applying independent solutions to different parts of a customer's problem.

But Hewlett-Packard has developed another solution. The company has two new systems interface boxes—one analog and one digital—which combine into single subsystems all the analog and digital input and output needs of sensor-based data acquisition systems. The subsystems based on these interface

boxes are put together with H-P computers, peripherals, and existing subsystems in various combinations to form the 9600 series of computer-based industrial data acquisition and control systems.

The analog subsystem for the 9600 series accepts low- and high-level analog signals. It also can time these signals under program control and, if needed, time output analog signals for signal display and process control. This single subsystem, with its plug-in functional components, will replace four separate subsystems in H-P's product line. With an H-P computer as system controller, it is a complete modular analog data-acquisition system.

The basic version consists of an analog-to-digital interface box, control card, computer interface card, 12-bit a-d converter with sample and hold, cables, and software drivers. The interface box is actually a combining case that has a unique backplane for interconnecting the plug-in modules. The backplane has both an analog and a digital bus

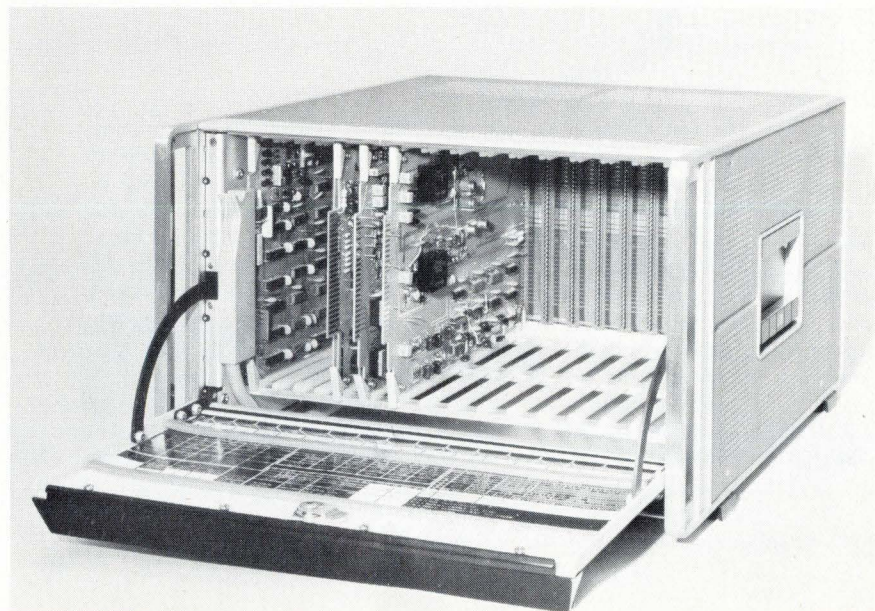
through which the functional modules communicate with each other. Control of the subsystem is derived from the computer and interpreted by the analog control card. This card uses microprogramming with semiconductor ROMs to generate the control and timing signals.

The initial analog subsystem will be offered with from 16 to 2,048 high-level input channels, which can be either differential or single-ended, and from eight to 2,048 low-level inputs, with programable gain. Also available are d-a converters at the output.

The unusual feature of the subsystem is that all functions, along with future capabilities, can be placed together in the same box. This enables the box to perform low- and high-level scanning at different speeds and voltage levels, while also putting out analog information with its d-a converters.

The digital subsystem is based on the new H-P multiprogrammer and multiprogrammer extender. The multiprogrammer provides 15 channels of

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- Telephone relay monitor card: monitors 12 lines of TTL, DTL, or RTL or contact closure logic, and can withstand transients up to 1,500 volts without damage.
- TTL output card: provides 12 bits at TTL and DTL logic levels.
- Relay output card: provides 12 independent spst contact pairs.
- Relay output with read-back card: provides same capability as relay output card, but with lines monitoring the status (energized/not energized) of the relays.

The multiprogrammer subsystem can also be used for analog output control. Analog outputs may be voltages or resistances, the latter primarily for controlling power-supply voltages and currents.

Chips show the way. Until recently the 9600 system couldn't have been built. In concept, the plug-in cards are instrument subsystems or modules—they result from shrinking an instrument as much as possible and removing all knobs and switches, which couldn't have been done without the availability of LSI circuits.

Three software packages are available for the 9600 system. The simplest of these is the Basic control system, which provides the utility service of relocation and linking of the user's program with interrupt processing, output buffering, and a library of subroutines. Next is the data acquisition and control executive, which includes a core-resident, real-time scheduler. This is supplied along with the Basic control system. The third, and most complex, is the real-time executive operating system.

The 9600 systems start at \$22,350 including the computer, and typical systems cost between \$32,000 and \$60,000. Deliveries are expected to begin in April.

Hewlett-Packard Co., 1501 Page Mill Road,
Palo Alto, Calif 94304 [338]

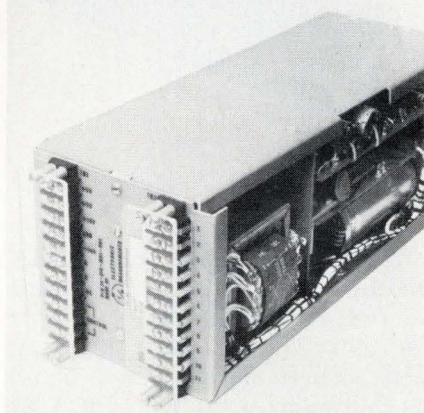
Electronics/January 3, 1972

Components

Custom supply is shelf item

Line of power equipment provides up to 3 separate outputs, choice of package

When an electronics designer needs multiple power supplies for his equipment, he usually specifies either individual off-the-shelf units or, if space and power are at a premium, he negotiates for a custom



design. But Electronic Measurements Inc., Neptune, N.J., is now combining the alternatives by offering what are virtually custom designs that are available off-the-shelf. And by relying on high-frequency magnetic circuitry, the new units are one-half to one-third the size of conventional series-regulated packages.

The new supplies, called Multi-Module, provide up to three separate outputs in any of three standard packages. These can furnish power maximums of 100, 200, or 400 watts. And the customer may choose the voltage and current ratings of each output from among a range of specified values.

With this approach, says Electronic Measurements, a customer can satisfy special requirements without incurring any extra engineering charges.

The Multi-Module units are aimed particularly at applications requiring small size and weight and

high efficiency. Size is held down by operating the supply's magnetics—the transformer, inductors, and magnetic amplifiers in the ac and dc regulating loops—at 20 kHz, rather than at 60 Hz. For example, a 400-w unit with three outputs measures 4 by 6 by 10 inches, about one-third the size of conventional series-regulated units. Efficiency can be 65% to 70% instead of 40%.

The voltage ranges for the Multi-Module series are 4 to 6.2, 12 to 16, 12 to -16, 24 to 32, and -24 to -32 v. Input voltage can swing rather widely between 80 and 130 v ac at 47 to 1,000 Hz. Regulation is $\pm 0.5\%$ overall, line and load combined. Stability is 0.1% for eight hours after warmup. Ambient temperature range is 0 to 50°C, and the adjustment range is ± 0.5 v for all outputs.

Prices are \$350 for the 100-w MM 100, \$450 for the 200-w MM 200, and \$600 for the 400-w MM 400.

Electronic Measurements Inc., 405 Essex Rd., Neptune, N.J. 07753 [341]

Versatile miniature trimmer offers high resolution

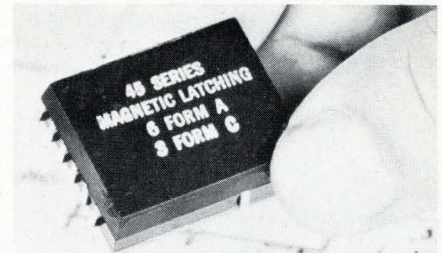
Designed to interchange with any of the 1/4-inch wirewound trimmers on the market, the model 901 developed by TRW Electronic Components has unity resolution at 10 ohms. A resolution of 0.15% is available at 20 kilohms. Offered in a resistance range from 10 ohms to 50 kilohms, the 901 has a power rating of one watt at 70°C. Minimum resistance is 0.2% or 1.0 ohm, whichever is greater. Priced as low as \$1.68 in quantity, the unit is housed in a plastic case one inch long.

TRW Electronic Components, IRC Potentiometer Div., 2801 72nd St., North, St. Petersburg, Fla. 33733 [349]

'Memory' keeps relay in position without current

A line of magnetic latching reed relays is set to operate at 5, 6, or 12 v dc nominal. The relays are furnished with six form-A or three

form-C contacts that will transfer from a 5.5 ms pulse. The contacts remain in a set open or closed position without requiring any holding current. Because of the magnetic circuit, the relays require only 75 mw of power—13 mw per pole. The devices are suitable for pc board installation or in any assembly where space is at a premium; maximum

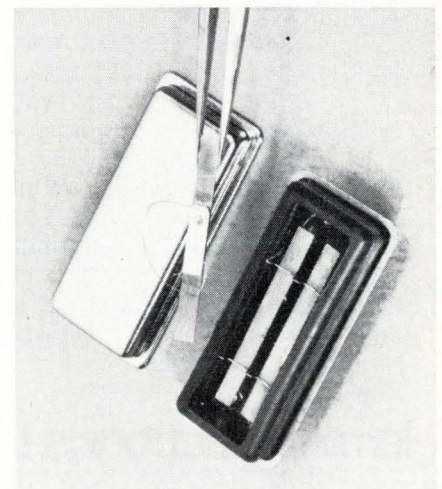


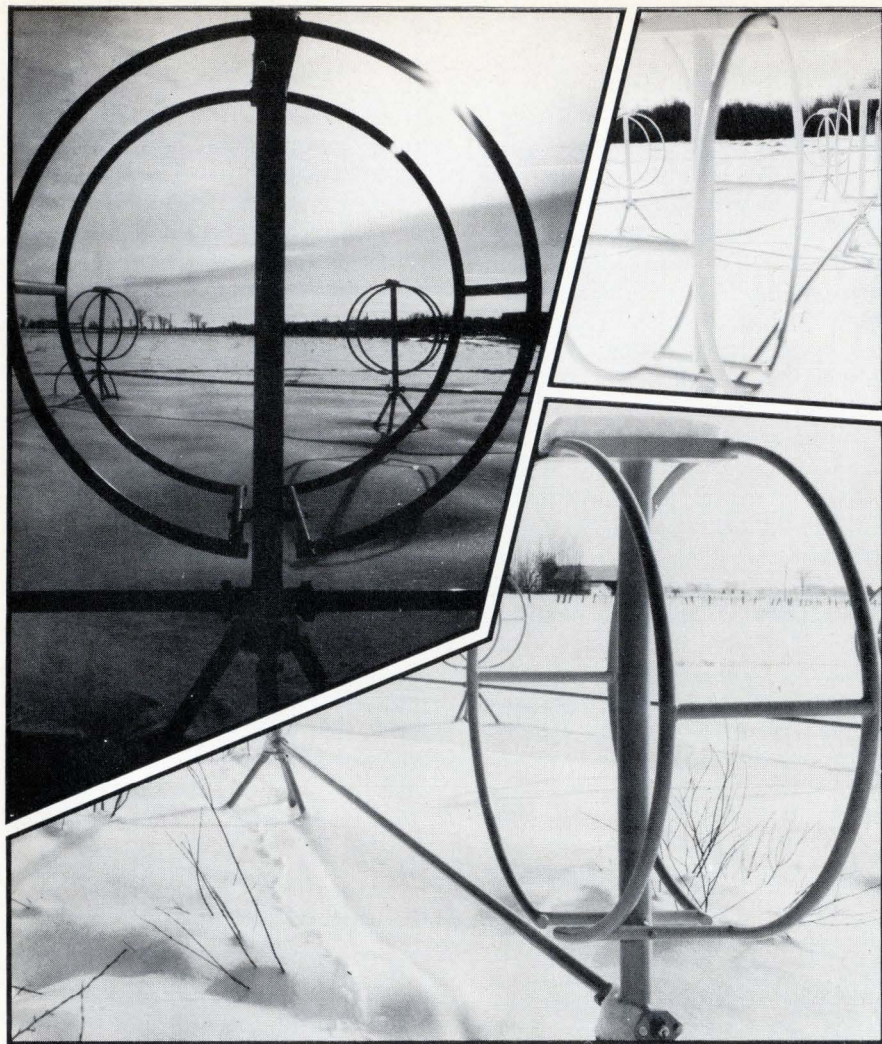
height is 3/8-in. Contacts are hermetically sealed and are encapsulated in mineral-filled epoxy.

Frederick Controls Div., North American Philips Corp., Frederick, Md. 21701 [343]

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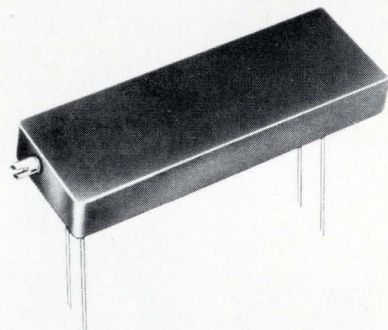
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Collins Radio Co., Component Marketing Dept. 600, Newport Beach, Calif. 92663 [344]

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Compatible with dual-in-line packaging, the Series 900 miniature, continuously variable delay line offers a delay range from 5 ns to 50 ns with corresponding maximum rise time

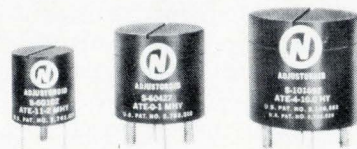


of 2.5 ns to 15.0 ns, covering bandwidths up to 150 MHz. The single control shaft varies the delay over the entire range. Other specifications include an attenuation of 0.5 dB maximum, a resolution of 0.001 of total delay, and impedance tolerance of $\pm 10\%$.

ESC Electronics Inc., 534 Bergen Blvd., Palisades Pk., N.J. 07650 [345]

High-Q variable toroid has inductance to 12 henries

Developed specially for printed circuits and similar lightweight applications, a fully shielded, high-Q variable toroid has inductance to 12 henries. The epoxy-encapsulated device, called the Adjustoroid, offers stepless adjustment, and there is no physical contact between the adjusting screw and toroid winding.



Inductance adjustment is achieved through magnetic coupling.
Nytronics Inc., Orange St., Darlington, S.C.
[347]

Multithrow rf switches are available with 2 to 50 outputs

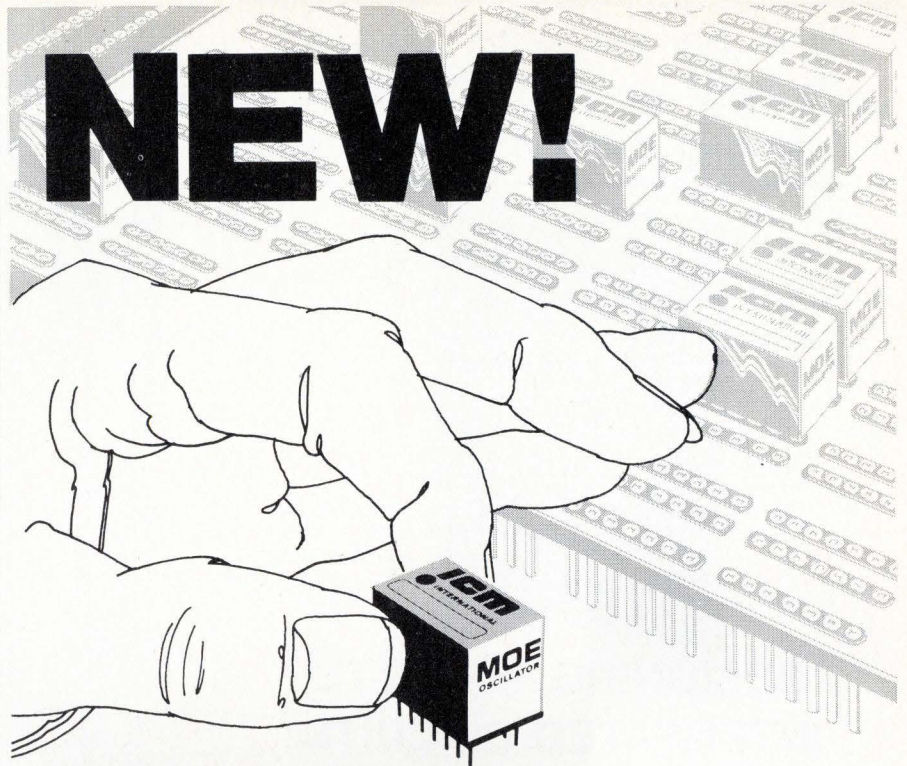
A line of self-contained, passive rf reed switches, called the SWR series, in multithrow configurations, is available with two to 50 outputs in a single package. The rf performance range is from dc to 1 GHz. The signal circuit is isolated from the control circuit, making the switch efficient where shielding, rfi integrity, and induced noise are critical. Isolation is up to 100 dB and insertion loss is 0.2 dB, achieved by using multiple reeds in a broadband matching structure. Contact rating is 10 w, and switching speed is 2 ms.
Integral Data Devices Inc., 46 S. Bayles Ave., Port Washington, N.Y. 11050 [346]

Four-pole filter design is housed in TO-5 can

Aimed at miniature receivers and paging systems, two two-pole filters are contained in one TO-5 package. The result is four-pole design, small size, and light weight. Specifications include a center frequency of 20 MHz, a 3 dB bandwidth of 16 kHz minimum, ripple of less than 0.5 dB, and an insertion loss of 3 1/2 dB maximum.
McCoy Electronics Co., Mount Holly Springs, Pa. [348]

1.5-watt zeners made with double-pin bonded design

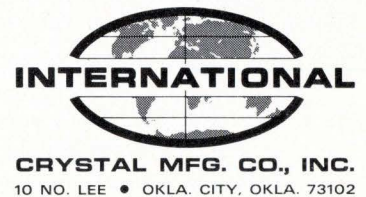
Military-type 1.5-watt zeners, series 1N4461-89, offer high reliability resulting from their double-pin bonded design. The chip is bonded between terminal pins and then fused with a hard glass sleeve to the exposed silicon surface and pins.
Unitrode Corp., 580 Pleasant St. Watertown, Mass. 02172 [350]



NEW!

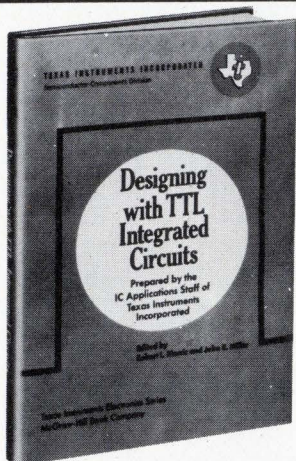
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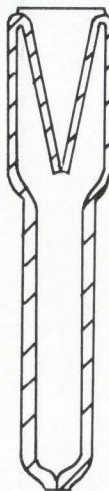
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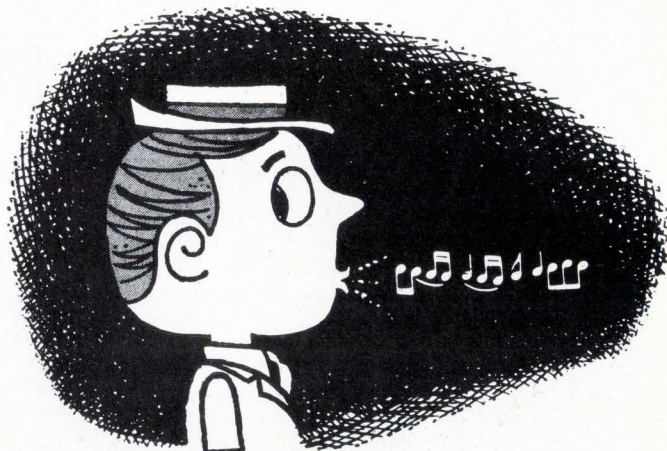
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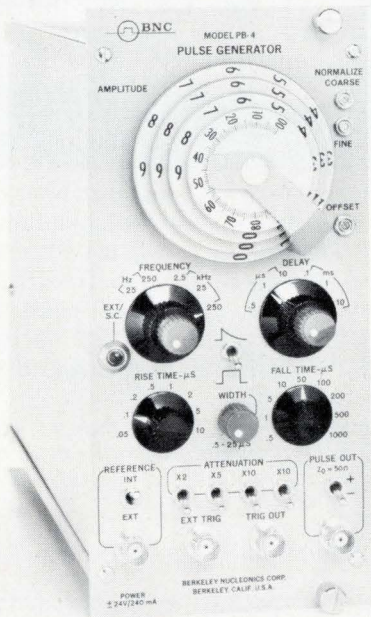
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Instruments

Stable, versatile pulse generator

Oven, op amp, chopper provide specs that aren't affected by 50-ohm hookup

Engineers in the nuclear instrumentation field have become accustomed to working with pulse generators that provide extremely stable, linear pulses. But these instruments cannot be employed in general elec-



tronics testing because they lack versatility—their repetition rates are slow and they can be used only with small output loads. On the other hand, the versatile precision pulse generators that are available with independent rise and fall times and a 50-ohm output impedance cannot provide the extremely stable pulse tops sometimes needed, for example, in amplifier calibration.

With the introduction of its model PB-4 precision pulse generator, Berkeley Nucleonics Corp. has satisfied both the stability and the versatility requirements. By using a solid state chopper, a proportional-control oven, and a specially designed,

high-gain, fast-slew-rate operational amplifier, the PB-4 attains a temperature stability better than ± 5 ppm/ $^{\circ}$ C, and a linearity of 50 ppm. According to Mel Brown, Berkeley Nucleonics' president, "These specs won't be affected by connecting the instrument to a 50-ohm load."

Other features of the PB-4 include the ability to select either flat-top or long-tail pulses with a fast rise and a long exponential fall, and independently adjustable rise and fall times. Repetition rate is continuously variable from 1 hertz to 250 kilohertz, and the pulse amplitude is variable from 0 to 10 volts.

Brown says that the repetition rate of 250 kHz is about 1,000 times faster than the nearest competitor, which is the mercury-relay pulse generator. He explains that to get the very stable pulses, previous units used relays to chop up a dc signal, producing pulses at about 100 to 200 chops per second. Solid state choppers, which would offer a higher repetition rate, could not be used because they degraded the signal too much. "But we put a specially designed op amp along with a precise zener reference and a chopper in a proportional-control oven, Brown says. "This allows us to go to 250 kHz and still maintain the precise pulse characteristics."

Applications for the PB-4 include testing the stability, resolution, and linearity of amplifiers, the integral linearity of analog-to-digital converters, and the differential linearity of pulse-height analyzers, and measuring the threshold stability of amplitude discriminators.

The PB-4 is available from stock to 30 days and is priced at \$1,450. A companion carrying case and power supply, the AP-1, sells for \$375.

Berkeley Nucleonics Corp., 1198 Tenth St., Berkeley, Calif. 94710 [351]

FET-input multimeter has high, low voltage resistance

An FET-input multimeter called the model FE160 provides both high and low voltage resistance ranges. This means that 1.5 volts is used for

conventional measurements while 0.08 volt is used for measuring resistance in-circuit without causing the semiconductors to conduct and



upset the readings. The meter also has a voltage range of 0.1 v full scale for transistor bias measurements, and a scale of 30 microamperes for base current measurements. Accuracy is 1.5% dc, 2.5% ac. Sencore Inc., 3200 Sencore Dr., Sioux Falls, S.D. [355]

Charger-stabilizer processes wide range of structures

The model 580 Magnetreater/Charger is capable of charging and stabilizing permanent magnet materials and assemblies, including

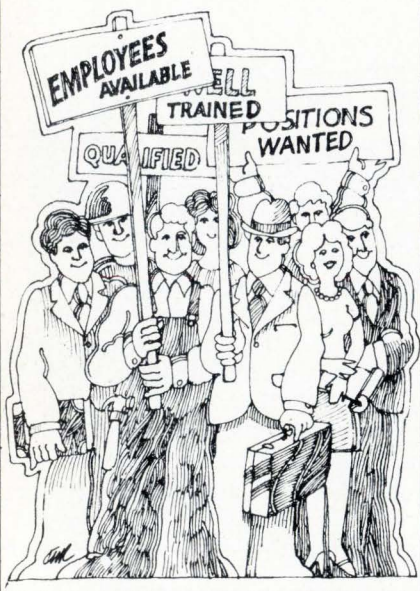


accelerometers, traveling-wave-tube magnets, and magnetron structures. A common fixture may be used for both charging and treating, enabling the assembly being processed to be magnetically saturated and stabilized without removing it from the fixture. The unit uses an SCR circuit instead of ignitrons, and energy storage at 650 v is 105 joules. Mate-

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New products

materials which may be processed range from the low-coercive-force chrome and tungsten magnets up to high-energy barium ferrite. Price of the model 580 is \$1,100.

RFL Industries Inc., Boonton, N.J. 07005 [353]

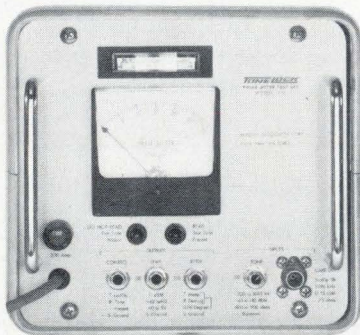
Pulse generator features output of 50 MHz, 10 V

A pulse generator, the model 135A, designed as a stimulus source for laboratory or production-line applications, has a 50-MHz, 10-v output. Variable rise and fall times are from 3 nanoseconds to greater than 8 milliseconds, and width and delay are variable from 10 ns to 50 ms. Baseline offset is 0 to ± 5 V into 50 ohms. Synchronous output gating and external triggering permit flexible operation under external control. Price is \$1,595.

E-H Research Laboratories Inc., P.O. Box 1289, Oakland, Calif. 94604 [358]

Phase jitter tester checks data communications lines

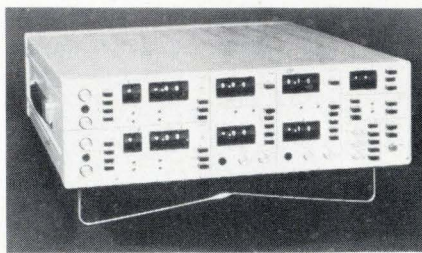
A new test instrument measures high-speed data communications systems that use standard telephone lines. Designated the Tonelock Model 75L, the instrument also tests the level of a carrier tone. Any single pilot frequency may be specified for checking pilot jitter. Phase jitter accuracy is $0.2^\circ \pm 5\%$ of reading, and level accuracy is 1 dBm. Applications include testing of



modems. Price of the 75L is \$950. Bradley Assoc. Corp., 9 Dash Place, Bronx, N.Y. 10463 [357]

Transient recorder uses high-speed a-d converter

A transient recorder, called the model 8100, uses an eight-bit a-d converter with a maximum word conversion rate of 100 MHz, combined with an eight-bit 2,000-word memory. The digital information can be fed to printers and tape punchers, or on-line to minicom-



puters. Also, a repetitive analog reproduction of the stored signal may be used with CRT displays or plotters, and signals may be recorded. Measurement rates are selectable and they allow the 2,000 data points to be obtained in 20 microseconds. Price is \$9,500.

Biomation Corp., 1070 East Meadow Circle, Palo Alto, Calif. 94306 [354]

Counters feature direct frequency display to 550 MHz

A line of five counters includes three models that can make rf measurements to 550 MHz and two models that measure to 150 MHz. All of the models in the series 8000B have wideband automatic gain control that provides constant performance, even when the signal fluctuates between 50 and 1,000 millivolts. Accuracy is maintained up to 99% amplitude modulation on the rf signal. Price ranges from \$1,195 to \$2,375, depending on frequency and time interval capability. Offered as an option is a TTL-compatible systems interface.

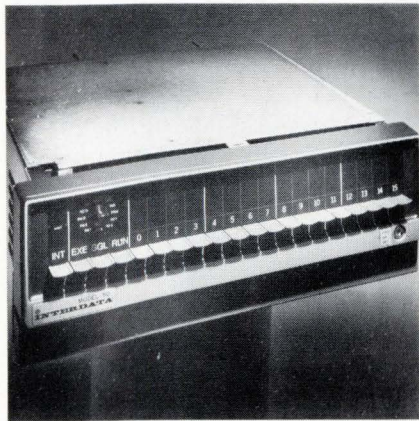
Dana Laboratories Inc., 2401 Campus Dr., Irvine, Calif. 92664 [356]

Data handling

Mini adapted to communications

Software and ROM match slower remote terminals to fast central processor

The fastest-growing area for minicomputers is in such data communications applications as terminal controllers, remote data concentrators, programable communications front-ends to large data



processing machines, and free-standing teleprocessing systems. Jon Gould, director of the data communications systems department at Interdata, Oceanport, N.J., says that 25% of his company's revenue now comes from data communications usage of minicomputers and that by 1975 this share will increase to 40% of a larger revenue base.

This trend is evident in the design of two new minicomputers, models 50 and 55, that Interdata is offering in both OEM and user configurations. The two machines are efficient in the data processing and data communications modes simultaneously. Up to now, says Gould, processing-oriented minicomputers, operating only under software control, had to idle while handling communications tasks such as receiving inputs from a slow teletypewriter or other terminal.

Interdata has added firmware, in the form of a read-only memory

with a microinstruction time of 250 nanoseconds, and extended the software package to include 26 instructions dedicated strictly to data communications and 88 instructions devoted to the usual processing activities. Thus, for example, the data communications instruction RDHS inputted to the ROM is all that's needed to have the computer read data at high speed.

Price of the model 50 is \$6,800 for one, \$4,760 each for 20. Included are 8,000 bytes of core memory and a built-in interface for a teletypewriter. The memory, a 4,096-by-16-bit ferrite core module, can be expanded up to 65,000 bytes. Memory access time is 300 ns, with a cycle time of 1.0 μ s. Of the 16 hardware general registers, 15 can be used for indexing. The minicomputer's I/O bus handles up to 255 peripheral-device controllers, and the interrupt time is 10.5 μ s.

Model 55, a dual processor selling for \$15,900, serves for larger communications applications where the computational loads are heavy, and where faster throughput and faster response are necessary. The main memory of one processor can be partitioned to provide a shared memory that can serve either processor without degradation due to memory contention.

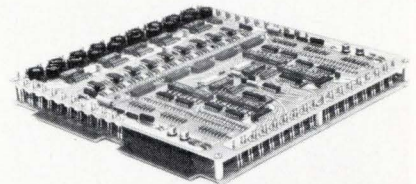
For the dual processor, data length is 8, 16, or 32 bits, and instruction word length may be 16 or 32 bits. Total instruction set, including a data communications subset and a data processing subset, is 277. Effective instruction execution time is 500 nanoseconds. The communications processor in the model 55 can support a programed I/O rate of more than 50,000 characters a second.

Interdata, 2 Crescent Pl., Oceanport, N.J. 07757 [361]

Kit allows user to make his own memory system

A core memory unit with a cycle time of 900 ns and an access time of 325 ns consists of one control card and as many storage cards as re-

quired (up to eight), each with 4,096 18-bit words. The Mesa 1400 series can be purchased as a complete ready-to-use unit or in do-it-yourself kits that contain all the necessary drawings and core stacks. The kit is aimed at firms having their own



electronic manufacturing capabilities and needing only the design drawings. The manufacturing cost, using the kit approach, will be about 0.8 cent per bit.

United Telecontrol Electronics Inc., 3500 Sunset Ave., Asbury Park, N.J. 07712 [365]

Disk-oriented computers use plated-wire memory

A series of disk-oriented computers includes processor, card reader, printer, card punch, and disk subsystem. Each of the 9000 series D units, the 9210, 9211, 9214, 9311, and 9314, is compatible with other 9000 computer peripherals and software, and each uses a plated-wire memory. Peripheral equipment available includes additional disk units for a total capacity of up to 248 million bytes, magnetic tape units, printers, card readers with



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New products

speeds of up to 1,000 cards per minute, and console-inquiry units. Price is \$131,040. Rental for one year is \$3941 monthly; for three years, \$3,450; and for five years, \$3,122.

Sperry Rand Corp., Univac Div., P.O. Box 500, Blue Bell, Pa. 19422 [367]

Remote intelligent terminal scans at 10 in. per second

A remote intelligent terminal, a desktop or floor-model optical character reader, is designed for use in decentralized systems of terminal devices for source-document automation. The transport mechanism moves documents past the scanner at a constant rate of 10 inches per second, and power requirements are 60 Hz, 115 v ac, single-phase fused for 10 amperes. Price of the model RIT 200 is about \$5,000 each for 50 machines, and rental for end users is \$250.

Input Business Machines Inc., 12111 Parklawn Dr., Rockville, Md. 20852 [364]

Microfiche recorder has internal film processor

Chemical plumbing, conventional film processing, and darkroom labs for microfiche processing are eliminated with Quantor Corp.'s model 105 microfiche production system, which has an internal automatic film processor. The system includes software for file indexing, titling, and formatting.

The 105 delivers cut, dried microfiche at a typical rate of one microfiche a minute, or 12,000 computer pages per hour. And since the film is processed inside the recorder, the unit can be used in the computer room. Operation is off-line on magnetic tape prepared by the host computer with software supplied. Two packages have been developed so far. They are the AME microfiche editor, and FAME, a formatting version of AME. Both are compatible with operating and disk operating systems of IBM 360 and 370 computers, and can be written in Cobol or

other generally used languages.

The same film roll can be used for several production runs. The first fiche of a run is ready for viewing or



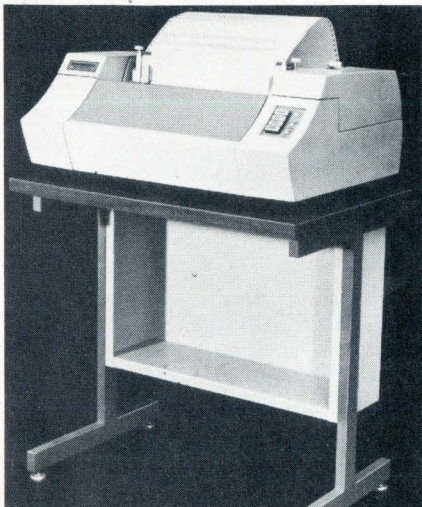
duplicating within four minutes, and the rest are produced at the rate of one a minute at average computer page densities of 5,000 to 6,000 characters. The microfiches are standard 4-by-5-in. positives or negatives containing 208 pages each at a 42x reduction, settable to 24x reduction.

Quantor Corp., Cupertino, Calif. [363]

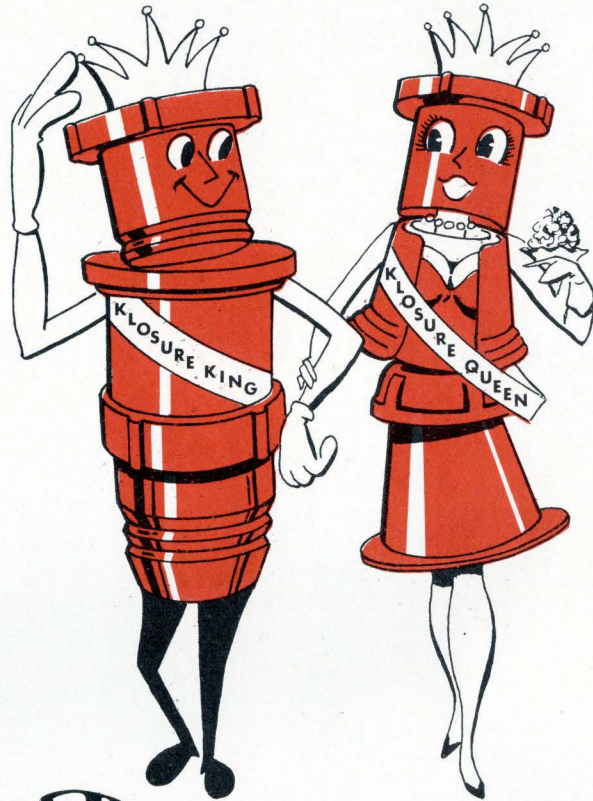
Terminal prints at speed of 165 characters a second

A line printer designated the model 101A prints a 9-by-7 dot matrix at speeds of up to 165 characters per second. A 64-character set is produced by the matrix arrangement, and transmission rate (serial) is 4,800 baud; for parallel, it is 75,000 characters per second. Options for the 101A include line drivers, character set configurations, and an elapsed-time indicator. Price is \$4,130 in single units.

Centronics Data Computer Corp., 1 Wall St., Hudson, N.H. 30351 [368]



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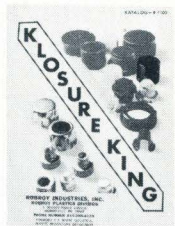
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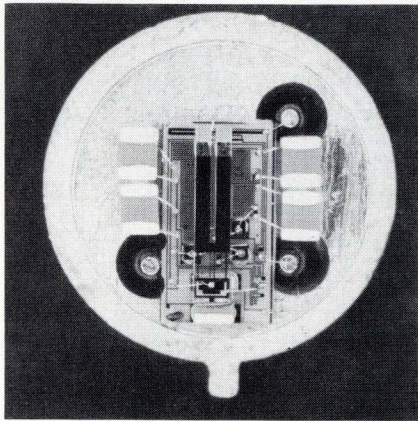
ELECTRONIC COUNTERS

Semiconductors

Logic clock built for TTL

Statek puts low-frequency crystal oscillator in TO-5 can for 5-V circuit

In their unending game of tradeoff, designers of systems using transistor-transistor logic have had only two ways to go when specifying the required 5-volt logic clock. They could use relatively large (2-by-1-by



½ inch) digital oscillator modules containing quartz crystals, or else higher-frequency (up to 5 megahertz) AT-cut crystals requiring relatively expensive TTL dividers to get down to 10 kilohertz. However, engineers at Statek Corp., Orange, Calif., have come up with what they think will be an attractive alternative—a low-frequency crystal TTL clock oscillator specifically designed for 5-v logic circuitry, and housed in a TO-5 can [*Electronics*, Dec. 20, p. 18].

The SQXO-2 has a frequency range from 10 to 100 kHz, and is characterized by Statek president Juergen Staudte as having hybrid-type reliability. The unit can be made to meet Mil Spec requirements in temperature, shock, and vibration: it can operate over the full military temperature range of -55°C to $+125^{\circ}\text{C}$, with a stability over that range of $\pm 0.1\%$. It will withstand more than 1,000g in

shock, and more than 50g of vibration from 10 hertz to 2 kHz.

Says Staudte, "You just plug it in, hook it to a gate, and it goes." He knows of no other low-frequency TTL clock available in a TO-5 can. Inside the can are Statek's photolithographically produced quartz crystals, mounted on a thin film substrate incorporating resistors. The unit also contains three chip capacitors and three transistors in a hybrid design.

Besides hybrid reliability in a hermetically sealed can, the SQXO-2 offers substantial size reduction and lower price in quantity over the module or AT-cut crystal competitors, Staudte claims. The competitors often have no shock or vibration specifications, he points out, adding that other low-frequency quartz crystals can't be operated at 125°C , because their solder mounts won't withstand that temperature, and a frequency shift results.

Staudte notes that Statek has accumulated more than 1,000 hours of operation on the quartz crystals alone at 125°C . The device can be used in any TTL system that requires an accurate clock.

The units are available in three centigrade temperature ranges: 0 to 70, -40 to $+85$, and -55 to $+125$. The 1-to-9 quantity price for the military temperature version is \$84, dropping to \$14 in quantities above 1,000, and to \$11 for 5,000 or more. Delivery for standard-frequency units is four weeks.

Statek Corp., 1200 Alvarez Ave., Orange, Calif. 92668 [411]

Metal oxide varistor protects against transients

Based on a recently developed polycrystalline technology, the GE-MOV line of metal oxide resistors introduced by General Electric Co. provides protection against voltage transients while reducing the need for expensive higher-voltage semiconductors.

The varistors are voltage-dependent, symmetrical resistors that perform in a manner similar to inverse

series zener diodes. When a power surge occurs, the varistor impedance changes from a high standby value to a low conducting value. This clamps the line voltage in the safety zone, and the energy of the incoming high voltage is prevented from passing through the circuit components.

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Alpha values range up to 70, with a guaranteed minimum of 25. Nineteen models for use in ac circuitry range in maximum energy-handling capability from 10 to 160 watt-seconds. Maximum peak current rating is 1,250 amperes, and ac voltage ratings range from 130 to 1,000 v rms.

Prices start at \$1.08 for low-energy-rated types and go to \$18.09 for the 160 watt-second models in 1,000-lots.

General Electric Co., Semiconductor Products Dept., Building 7, Electronics Park, Syracuse, N.Y. 13201 [419]

3,072-bit static ROM generates ASCII code

A 3,072-bit MOS static read-only memory that generates the ASCII alphabet font is intended for use in vertical-scan column-output CRTs, print character generators, panel displays and billboards for code conversion and microprogramming applications. Organization of the model 2516 is based on 64 characters, each consisting of eight 6-bit columns. Typical access time is 450 nanoseconds and since all inputs operate at 5 volts, the model can be driven directly by TTL or DTL circuits. Price is \$19.50 for quantities between 100 and 249 units.

Signetics, 811 E. Arques Ave., Sunnyvale, Calif. 94086 [416]

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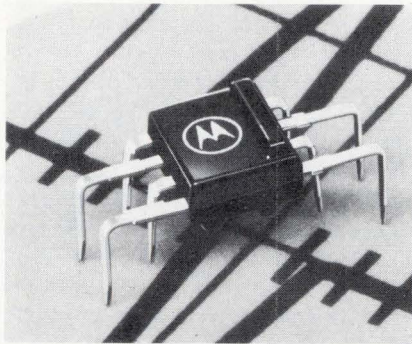
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New products



control applications, especially for driving resistive loads in noise-sensitive environments, and for voltage switching applications in heating controls, photo and valve control, lamp and relay driving, and flasher circuits. The units are designed for use in zero-voltage gating of triacs, and they provide their own input short- or open-circuit protection. Price for 1 to 99 units is \$2.55; 100 to 999, \$2.00; and 1,000 to 4,000, \$1.75.

Motorola Semiconductor Products Div., P.O.
Box 20924, Phoenix, Arizona 85036 [418]

Diode emitters provide green and yellow displays

Semiconductor-type multiple-color displays and indicator lamps are practical now that light-emitting diodes in colors other than red are commercially available. Monsanto Commercial Products Co. is marketing two alphanumeric displays, one green and one yellow, and green and yellow individual diodes for indicator lights.

The green display, the MAN 5, is a seven-segment diode array with a 0.27-inch character height and made from seven gallium phosphide segments. Housed in a 14-pin, dual in-line package, it sells for \$10 each in quantities of 1,000.

The yellow display, the MAN 8, is mechanically similar to the MAN 5, but the emitting material is gallium arsenide phosphide. Price is \$18.75 each in lots of 1,000.

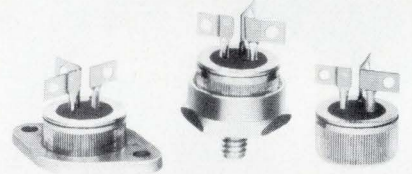
The discrete devices, indicator lamps for panel mounting, are the green MV5222 and the yellow MV5322. Both have a typical brightness of 300 foot-lamberts at 50 mil-

liamperes of rated current. The green unit sells for \$1.95 each in 1,000-unit quantities, and the yellow diode for \$3.95.

Monsanto Commercial Products Co., Elec-
tronic Special Products, 10131 Bubb Rd.,
Cupertino, Calif. 95014 [413]

Center-gate triacs are glass-passivated

A 3/4-in. press-fit series of 30- and 40-ampere electrically isolated triacs incorporate center-gate geometry and glass-passivated, dual-mesa construction. The chips are passi-



vated with a dense, void-free and sodium-free glass that provides a hermetic seal and eliminates punch-through and burn-through problems. The method also prevents fractures that can occur as a result of dicing. The units are available in chip form as well.

Hutson Industries, 2019 W. Valley View
Lane, Dallas, Texas 75234 [415]

Dual-input sense amplifier aimed at core-memory jobs

Two differential-input amplifiers, a second stage amplifier, a dc restorer circuit, and an output logic gate comprise the CA3541D dual-input sense amplifier, intended for core memory applications. The monolithic silicon device converts low-level core-memory "1" pulses to saturated-logic-level output pulses. Either of the input amplifiers may be gated ON with a saturated logic signal so that the incoming plus or minus pulse can be distinguished from either of two sense lines. Price in 1,000-lots is \$6.

RCA Solid State Div., Route 202, Somerville,
N.J. 08876 [417]

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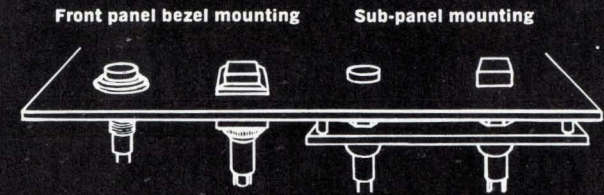
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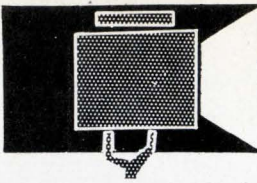
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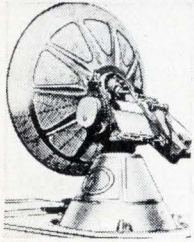
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New books

Digital Design, R. K. Richards, John Wiley & Sons Inc., pp. 577, \$22.50

Digital Design is readable, lucid, and an almost ideal text on digital machine design or reference book for the practicing designer. It is free from encumbering mathematics and dependence on specific component technologies, except when necessary, and affords an excellent intuitional grasp of the various concepts.

This is not a book solely on computers, and should not be compared to previous books in the computer area. Instead, it is intended to inform the reader about the building blocks used to construct various types of digital machines, including the digital computer.

Coverage includes Boolean algebra and minimization techniques, sequential network theory, digital coding, binary and decimal operations, and the general-purpose digital computer. As an introductory text, it seems thin in such areas as information theory and general-purpose computers. Some confusion also results from the order of presentation: the author makes reference in Chapter 7 to "variable instruction length" and an ADD instruction without providing a proper base of understanding for the student reader (the computer is not discussed until Chapter 9).

Not all topics discussed are clearly pertinent to digital design. In Chapter 8, the author discusses sort-merge techniques, in which context it is not obvious what digital electronics design methodology is being explained. Conversely, some pertinent topics are not presented: the author concludes Chapter 8 with a comparison of arithmetic checking schemes, but omits one of the best-known techniques of logic design, two-rail logic. There are also a few typographical errors.

Nonetheless, this is a fine introduction to digital logic design, and includes many techniques not previously treated in textbooks.

Donald C. Jessep, Jr., IBM Corp., Yorktown Heights, N.Y.

New literature

Engineering reports. McGraw-Hill's 1972 Catalog of Scientific, Engineering and Business Reports is available from Information Services, McGraw-Hill Publications Company, Box 812, Times Square Station, New York, N.Y. 10036. The catalog lists for sale more than 400 reports prepared by McGraw-Hill's 40 specialized publications and newsletters, and covers a wide range of subjects from engineering fundamentals, industrial service equipment, and applied technology to computers, industry and market analyses, and managerial controls. Circle 421 on reader service card.

Marketing manuals. In a 16-page catalog, Schoonmaker Associates, P.O. Box 35, Larchmont, N.Y. 10538, lists handbooks for the guidance of engineering and marketing managers in electronics industries. The manuals stress marketing of technical products and include information on sales management, use of manufacturers' representatives, and market research. [422]

Control products. A 154-page catalog from Airpax Electronics, Controls Div., P.O. Box 8488, Fort Lauderdale, Fla. 33310, gives descriptions, application information, and specifications for more than 70 industrial measurement and control products. They include digital process monitors, switches, relays, and converters. [423]

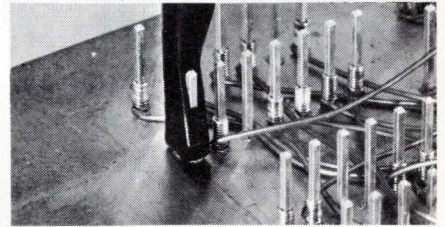
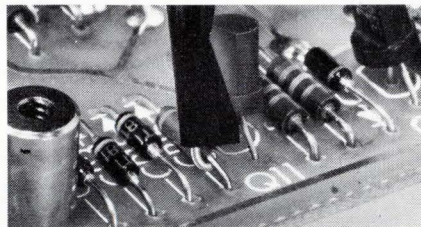
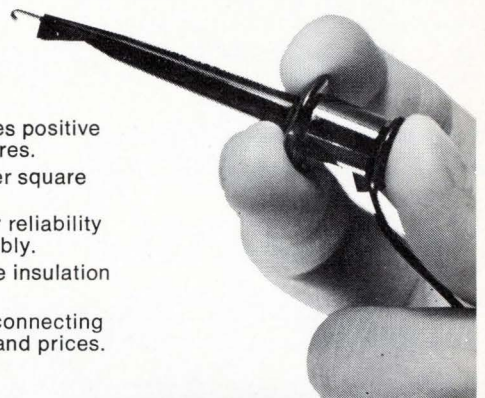
Optical components. Baird-Atomic Inc., System Components Div., 125 Middlesex Turnpike, Bedford, Mass. 01730, describes optical components and accessories in a 36-page bulletin that includes information on optical interface and exciter filters. [424]

Card edge connectors. Elco Corp., Willow Grove, Pa. 19090, has made available a 31-page guide to card edge connectors. Four new series of connectors are listed, with descriptions, specs, and drawings. Two new types are discrete connectors for wire-wrapping applications, and the other two result from the new press-fit technology. [425]

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Circle 139 on reader service card

Roll Out the Red Carpet — For Toko's New Low Cost High-Speed Memory System

Here's a real eye-opener for computer designers—Toko's new 65K byte memory system, HS-400L. It's constructed with two basic sub-assemblies—woven-plated-wire memory stacks and electronics packages. Designed for medium and large scale computers, the HS-400L offers high reliability, easy maintenance and a flexible arrangement of word lengths.

General Specifications: ● Memory Capacity: 32,768 words—18 bits (Internal Organization is 8K words—72 bits) ● Access Time: 220 ns Random Access ● Cycle Time: Clear/Write 450 ns Read/Restore 450 ns ● Operating Mode: Destructive Read-Out ● Temperature Range: 0° C to 50° C (Operating) ● Measurement: 16.5(H) x 19.0(W) x 10.0(D) ● Interface Level: TTL compatible ● Power Dissipation: 0.3 m W/bit max.

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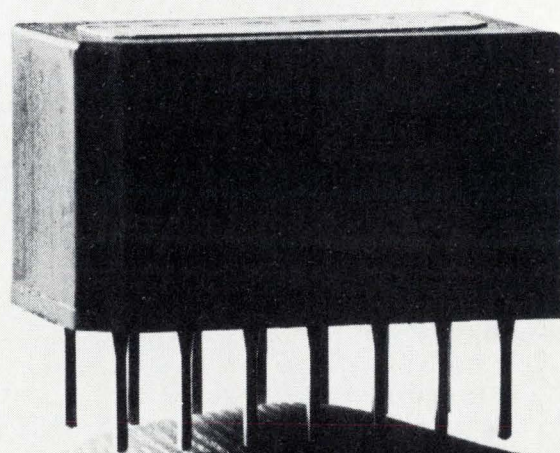
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International Newsletter

January 3, 1972

Ferranti lands CDI contract

Ferranti Ltd. has made a good start in its effort to make a success of high-density bipolar integrated circuits based on collector diffusion isolation (CDI) processing. The company will develop and supply a custom LSI CDI chip to the leading British calculator maker, Sumlock Anita Ltd. for a new single-chip calculator. Ferranti men are jubilant because they figure that the work will be worth well over \$1 million. Neither company will disclose details, but the major reasons for choosing a CDI bipolar chip instead of MOS are the lower voltage requirements of CDI—leading to longer battery life—and its superior speed/power product for the calculator application.

All-color network moves closer in France

France's broadcasting monopoly, the Office de Radiodiffusion Television Francaise (ORTF), will be investing about \$35 million in studio and transmission equipment this year, nearly double the 1971 investment. The big budget should enable ORTF to launch its third nationwide network, an all-color venture, by the end of the year. About 80% of the budget will go for transmission hardware, including more than 100 transmitters to carry the new programs. ORTF is also expanding its currently meager facilities to beam programs to foreign countries. Thomson-CSF, a world leader in high-powered transmitters, is supplying all eight 500-kilowatt transmitters in the program.

Computerized phone center in Rotterdam finally goes on line

Almost two years behind schedule, a pioneering computer-controlled telephone trunk-line switching center has been put into operation in Rotterdam. Built by Sweden's L M Ericsson, it is the first multicomputer center and has an initial capacity of 2,400 incoming and 2,400 outgoing trunk-lines. It can handle a half-million national and international calls per day. Even though Ericsson has had long delays before it managed to get the station working properly, it has received orders for at least 15 similar centers for installation in a half-dozen countries.

Franco-German airbus passes a funding hurdle

Rumors to the contrary, continued work on the French-German Airbus A-300B, a medium-range transport, is assured. In its last session before the Christmas recess, Bonn's coalition cabinet approved continued financing of the project and gave the go-ahead for the production of the plane's first series. It also approved the development of special versions with either greater range capabilities or higher seating capacities. Earlier, it was feared that production of the aircraft was in serious jeopardy because of differing customer requirements for range and passenger-carrying capabilities.

British company cuts the bulk of low-light tubes

Britain's military authorities are looking at a new, small, low-light-level TV camera tube. The tube, with a 2 1/8-inch-diameter faceplate, performs as well as established 3-in. isocons, says its maker, English Electric Valve Co. The smaller diameter and a 33% reduction in length—down to 10 in.—means yokes are very much smaller. Total assembled weight is, therefore, only one fifth that of the bigger tube. And, since power requirements are less, total TV system size is reduced. The tube gives 300-line resolu-

International Newsletter

tion and a 24-decibel signal-to-noise ratio with 10^{-5} foot-candles incident on the photocathode. The key to the tube's performance is its relatively large target—1.44 in. compared with the 1.77 in. target in the 3-in. tube.

Japan revises industrial growth estimate downward

The revaluation of the yen—together with a domestic downturn in the economy and a disruption of trading patterns—has slowed the growth in Japan's industrial and commercial sector. In a revised long-term forecast just released, the Electronic Industries Association of Japan puts industrial and commercial production at \$4.94 billion in 1975, compared with \$1.7 billion in 1970. This works out to an average annual increase of 23.8%. Last year the group's forecast put 1975 production at \$6.21 billion, an average yearly growth of 29.3%. The fastest growing category is computers and related equipment. Production is expected to rise from \$1.7 billion in 1970 to \$3.9 billion in 1975, for a whopping 30% gain annually.

AEG-Telefunken trims entertainment product operation

The changing structure of West Germany's entertainment electronics market—declining profits and rising Japanese competition—has forced AEG-Telefunken to an agonizing reappraisal. And, as a first step, the company has decided to concentrate on high-quality TV, radio, phonograph, and recorder manufacturing and centralize control over that production area in one subsidiary headquartered in Hanover. At the same time, production at some of the company's far-flung plants will be sharply curtailed.

Company marketers figure that by 1980 Japanese-made portable black-and-white TV sets, for example, will account for 90% of sales in West Germany. In color TV, where imports now claim 6%, they expect the foreign share to reach 30% by the end of the decade. Foreign made portable radios, now accounting for roughly 58% of the West German market, will have a 75% share by 1980. And foreign "pocketables" have already reached 100%.

Japanese makers cut calculator export prices

The 23 companies in the Japan Machinery Exporters Association that export electronic calculators have reduced the minimum FOB price to about \$65 during the first six months of 1972. This price is about \$20 below the current minimum price—and actually represents a bigger reduction because it has been extended to apply to all calculators without memories regardless of the number of digits. The earlier minimum was for eight-digit no-memory calculators only. Extensive use of LSI circuits has eliminated much of the price differential anyway, and the increasing use of multidigit displays will further reduce the differential.

Addenda

Canada may become an assembly station for Japanese consumer electronics products. Matsushita is thinking of assembling knocked-down color TV sets in a building in Toronto that it bought two years ago as a warehouse. . . . And Sanyo Electric Co. has just received Japanese government approval to set up a 50-50 joint venture with Magnasonic Canada Ltd. to manufacture TV and stereo sets. . . . Honeywell-Bull has won a contract to install a central computer for the Norwegian government, which is setting up a central agency to handle the data processing needs of Norway's public institutions.

Liquid crystal, C/MOS watch gets market date

Seiko, first to market quartz crystal watch, will have all-electronic model available by later this year

The Seiko group of companies has just shown the prototype of an all-electronic wrist watch with a liquid crystal display, and it plans to start sales of commercial versions this autumn, priced in the \$300 to \$400 range in Japan. That timetable should help the company maintain the lead it gained when it put the world's first quartz crystal electronic watch on the market in 1969.

The new watch starts out with the same 16,384-hertz crystal oscillator as present electronic watches. It also uses standard C/MOS MSI 14-step scale-of-two divider circuits to obtain 1-second pulses. A simple driving circuit for the stepping motor or other electromechanical transducer completes the electronics in present electronic watches. But the new watch requires about five times as many electronic circuits.

Circuits. The all-electronic watch requires a scale-of-60 counter for the seconds indication, another scale-of-60 counter for the minutes indication, and a scale-of-12 or -24 counter for the hour indication. It also needs decoders and driver circuits for driving the liquid crystal display digits. A dc-to-dc converter is needed to raise the 3 volts from the two silver oxide cells to the 15 v required by the display. With C/MOS circuits, a total of about 1,500 individual transistor and diode elements are required.

Thus, in addition to the 14-step

divider designed for its other electronic watches, Seiko uses about 15 commercially available C/MOS chips including counters and decoder-drivers.

Despite all the electronic circuits in the new watch, power consumption does not increase proportionally. The complementary MOS circuits require power only when changing state, so that the power consumption of the slower speed dividers is negligible. The biggest power drain is the liquid crystal display, which uses seven-segment digits, with each segment drawing less than 0.1 microampere at 15 v when turned on. This translates into about 15mA input to the dc-to-dc converter. The crystal oscillator draws about 1 μ A and the 14-step divider another 0.5 μ A. Total current drain is roughly 20 μ A.

Replaceable. The display has a lifetime of several years, but it is quite inexpensive and could be stocked for replacement. The liquid crystal material itself is a proprietary compound that can be used over the range from -10° to +50°C.

To reset the prototype, the user pushes a reset button, then pushes hour and minute buttons to reset these displays. The numbers advance by one for each push. When hour and minute displays have been reset, the user waits for the precise second for which watch is set and pushes the start button. The second display changes at 1-second intervals, both to enable the user to time down to 1 second and to give a quick indication that watch is operating. The liquid crystal's response time is measured in tens of milliseconds and is fast enough to follow 1-second changes.



Numerals. Seiko's all-electronic watch drives liquid crystals with C/MOS circuits.

Key to commercial production of the watch is fabricating all circuits on one or two LSI chips with good yield. Seiko hopes to be able to fabricate the chips itself and is setting up fabrication facilities at two of its Japanese watch manufacturing plants. Seiko executives feel that two competing groups give them twice the chance for success, especially since the same approach enabled it to be the first company in the world to produce an electronic watch.

Japan

Analog IC builds compact pushbutton phone

Japan's telephone company has built a compact prototype telephone made possible by an analog-type in-

tegrated circuit that can survive the high voltage and demanding conditions of telephone service. The compact handset contains the transmitter, receiver, and pushbutton keyboard. Mounted in the base are a speaker, a tone ringer, and a visual indicator to signal that a call is waiting.

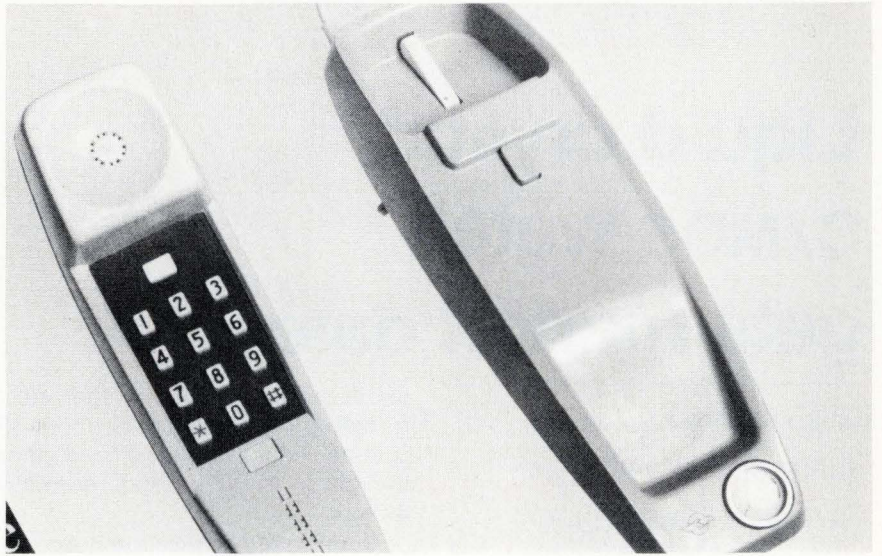
The Mushashino Electrical Communication Laboratory of the Nippon Telegraph & Telephone Corp. has designed most of the circuitry on a chip that falls between small-scale and medium-scale integration. The chip, the speech IC, contains 23 transistors, two of which are field-effect devices; seven diodes, of which three are zeners; and 33 resistors.

On line. The speech IC can operate under the unique telephone conditions of high dc voltage for the signaling circuit that must be transmitted over the same wires used to transmit speech. The speech IC contains constant-current and constant-voltage power supplies to compensate for variations on the line.

The constant-current power supply has a high impedance that prevents shorting the signal voltages. The constant current it receives from the telephone line is also optimum for holding the speech-path relays at the exchange. The constant-current regulator supplies the current-dependent circuits and delivers the remainder to a constant-voltage regulator that supplies current-dependent circuits. Variations in supply voltage are absorbed by the regular circuits. Total power input and dissipation of the IC can vary from 0.3 watts to 1 w.

The speech IC has an anti-side-tone circuit, which is essentially a two-transistor amplifier with a voltage gain of one. It has a balanced network, with impedance proportional to the telephone line in the coupling circuit between the two transistors.

Sidetone is suppressed because the voltage difference between the circuit terminals is nearly zero, and the input terminals of the receiver amplifier are connected between these two terminals. The caller's voice or outside noise thus sends only a small input to the receiver,



Extra features NTT's pushbutton phone not only uses integrated circuits, but has a light showing a call is waiting, a speaker in its base, and a tone ringer instead of a bell.

providing him with a muted sound of his own voice.

By including two voltage-controlled attenuators, the need for setting the 3-dB attenuation pad at installation, as in present telephones, is eliminated. The new phone attenuators are FET transistors connected across the transmitter and receiver. The gates of the transistors are connected to a voltage proportional to the dc voltage at the telephone line terminals. These FETs are used as voltage-variable resistors, whose resistance is inversely proportional to gate voltage.

The highest voltage normally applied to the IC is about 40 v. Transients in excess of 50 v are bypassed to ground by zener diodes external to the IC, but three zener diodes are included on the chip in the power-supply circuit.

Mikes. Identical small magnetic microphones are used for both transmitting and receiving, thus providing production economies. When used as a transmitter, the mike has an output about 50 dB lower than the standard carbon transmitter. This reduced output is made up by an amplifier on the speech IC chip with a 50 dB gain. The amplifier is designed with a gain characteristic that decreases as a function of frequency because the output of the magnetic transmitter rises with frequency. Another im-

portant characteristic required of this amplifier is a very low output impedance.

As a receiver, the mike is basically similar to those used in conventional telephones, but its sensitivity is 5 dB lower because of its smaller size. Thus, a 5-dB amplifier is used.

No hands. For using the speaker, an IC amplifier mounted on the hybrid IC used to generate tones for pushbutton dialing amplifies the signal, and a magnetic microphone much larger than the one used in the handset is the speaker.

The telephone is also designed so that a projection on the base depresses the No. 2 pushbutton when the handset is rested on the base. This sets the oscillator to the 1,366-hertz position. When the 16-Hz ringing signal is received from the exchange, it is modulated by the oscillator and fed to the speaker. This "tone ringer" replaces the bell.

France

Three simple sensors monitor premature babies

Premature babies in a few Paris hospitals are breathing easier these days—and it's all being monitored by a compact machine developed by a Polish immigrant named Rom-

uald Plaszczynski. Thomson Medical Telco, where Plaszczynski works, hopes the Neo-Natal system will make life easier for the incubator set—and their concerned mothers—around the world after the machine is launched commercially early this year.

Plaszczynski has borrowed space-age medical techniques to monitor breathing, heartbeat, and body temperature with two stick-on electrodes and one temperature sensor, instead of the usual array of nasal thermistor, anal thermometer, and sensors for chest expansion and heartbeat.

Alarm system. Neo-Natal, which will sell for around \$1,500, enables an untrained nurse to give intensive care to a ward of premature babies without neglecting any of them. The system is equipped with visual and audible alarms that signal whenever any of the three parameters vary outside of pre-set levels.

"It's easier to operate than a television set," says Plaszczynski. "A mother could easily handle it at home." It is aimed mainly for use in hospitals, however, and it has been undergoing a test program in Paris for the past six months. The developers say the system's main advantages are the capturing of three essential body functions with a minimum of equipment and automatic processing by a small, inexpensive instrument.

The breathing and heartbeat readings are recorded by a 0.1 milliamper electric signal put out by Neo-Natal's 50-kilohertz oscillator. The resistance encountered by the current as it passes from one side of the body to the other varies as the lungs inhale and expel air. The receiving electrode picks up a signal with rhythmic ups and downs in impedance that correspond to the respiratory cycle.

Curve. At the same time, the heart is producing a regular electric pulse that is picked up by the same electrode. The readout thus contains both heartbeat and respiration superimposed on a single curve.

Plaszczynski says he is especially gratified to see hospitals satisfied with the instrument. "When I see

the doctors, and they tell me they have saved two lives this week, I feel I have done something useful," he says.

Great Britain

UK space effort boasts technology improvements

Although the United Kingdom is spending only about \$8 million a year on its own spacecraft, officials contend that in some ways they are getting more mileage for their money than the Americans with their more ambitious programs. The Royal Aircraft Establishment (RAE) has been spending on satellites that try to improve on NASA's methods where possible. Component specifications have been increased above American standards.

Seven up. The British have launched four satellites in a scientific series. The last, called UK-4, went up with five ionosphere probing experiments—one American—on Dec. 11, propelled by an American Scout rocket. Three have been launched in a technology proving series. Last of these was X-3, launched on Oct. 28 by a British Black Arrow rocket. The only definite successors will be UK-5 and X-4. The former will carry six X-ray experiments, including an American one, and go up in two years.

Though this program may seem extremely modest, British space technologists get hot under the collar if it's suggested that all they've done is repeat American work. "I can list half-a-dozen ways in which we've improved on U.S. methods," says Dennis Allen, RAE project officer for X-4 and partly responsible for development of the data handling facilities on UK-5. Allen's list includes these sectors: the albedo horizon sensor, the star sensor, and control of the stabilization jets in X-4; the data storage and handling system on UK-5; and, on the two spacecraft just put into orbit, a higher degree of component reliability than U.S. space technology normally achieves.

Allen has no faith in the U.S. practice of accepting highest grade Mil-Spec components for satellites. "Even though they're highest grade, you still get components being replaced in U.S. satellites right up to the launch-pad stage" he maintains. "Consequently it seems to me that when a U.S. satellite has trouble in orbit, component failure may be at the root of it."

Until the last two spacecraft, British satellites followed U.S. practice. But Allen said that 0.8% of the transistors used in the data handling system of UK-3 failed after test, usually during equipment assembly. Hence, RAE has developed its own specifications, and, according to Allen, the component failure rate for X-3 was less than 0.1%. Allen says that neither X-3 nor UK-4 needed to be touched after leaving England for launch in Australia and California, respectively.

To develop its specifications, RAE gets a semiconductor manufacturer to make devices he thinks will do the job, then RAE tests them extensively until the weakest points show up. The components are sent back to the maker with instructions to strengthen those weak points. After more testing, the strengthened devices form the basis of the spec.

Thick-film hybrids. Also to increase reliability, from X-3 onwards, British satellites contain complete subsystems built with thick-film hybrid technology. For instance, in X-3, the successive-approximation analog-to-digital converter for the pulse-code modulation data system is on five substrates. In X-4, the star sensor, albedo horizon sensor, and infrared sensor are built with thick film technology.

Instead of the usual tape recorder, UK-5 will use two core stores to hold data from the experiments prior to transmission to earth. According to Julian Robinson, of Marconi Space and Defence Systems Ltd., prime contractor for the satellite, this reduces considerably the amount of data to be stored and transmitted.

The experiments look for and classify X-ray photons. If tape were used, the capacity required would

be vast. In UK-5, the angle of approach, energy band and other characteristics of the photon are categorized, and for each category there is a location in a store. For every event in that category, the location is incremented by one.

X-4 will use an albedo horizon sensor that uses a strip of 100 photo-diodes. The sensor always faces the horizon between earth and space, and because space is black and the earth is brighter from the sun's light, the brightness can be used to maintain the satellite's position relative to the horizon for one axis. For the other two axes, the satellite is locked on the sun. Total field of view is 25°, with about 5° normally above the horizon, giving a nominal resolution of ¼° per diode. On X-4, the integration time of the array will be variable in order to determine the optimum operational threshold of the diodes. The array, integrated with MOS scanning circuitry is made by Integrated Photmatrix Ltd.

Star orientation. The star sensor on X-4 will lock onto the star Canopus. Instead of relying on very accurate scanning of the image in a dissector tube, as is usual, the image is split into two by a prism, and both light inputs are fed into the tube. When the light inputs are equal, the star is aligned on the optical axis.

Hawker Siddeley Dynamics Ltd., main contractor for X-4, is giving a new twist to methods of turning on and off the propane gas jets of the three-axis stabilization system. The jet controller models the response of the satellite to the jet pulse simultaneously with the real response. The model controls the "off" signal, which is the most important, and partially controls the "on" signal. Using the model is more accurate than using real feedback, which is subject to lag and noise distortion.

The model signal is essentially a constant voltage, pre-calculated to represent the constant acceleration force of the jet. The voltage goes into a rate integrator, which reproduces a rising voltage proportional to the increasing rotational speed of the satellite, caused by the constant acceleration. When this voltage crosses a threshold, the jet switches

off. To switch it on, the rate output combines with the direct output from the gyro platform to produce a voltage that has to cross a threshold.

West Germany

How to generate a complex waveform

A new electromagnetic device that generates voltage patterns of irregular but uniform shape has been developed at the Philips Research Laboratory, Hamburg, Germany, by Klaus Renniecke and Reinhard von Hacht. The generator, which uses the principle that magnetic flux between two coils can be made to change by a tiny copper disk rotating between them, is expected to be of value to designers of control engineering equipment.

Although common voltage waveforms that follow sawtooth, sinusoidal, or square-wave patterns can be generated by electrical means, a mechanical function generator is required to generate precise waveforms of irregular shape. Previous mechanical generators have been plagued by heavy wear and often have output oscillations.

The Philips generator produces voltage forms that vary precisely as a function of the masking of magnetic flux lines by a copper disk, 0.2 millimeters thick, which rotates between two electromagnets. Its periphery is cut to produce the voltage and waveform desired. Any wave shape—even with abrupt voltage changes—can be generated with an accuracy of better than 0.5%, the developers say.

Spin. The copper foil disk—only 18 mm in diameter—rotates, typically at 24 revolutions per minute, between two ferrite plates, each 22 by 15 by 0.4 mm thick, wrapped as electromagnets. The irregular periphery interrupts the magnetic lines of flux in the air gaps between the electromagnets. When no foil is between them, the voltage at the secondary coil is maximum. When the foil cuts all the lines of flux, voltage drops virtually to zero.

At optimum values, the voltage between the electromagnets ranges from 20 to 140 millivolts peak-to-peak, at a frequency of about 200 kilohertz. The output signal at the secondary coil is 3.6 mV to 30 mV. This voltage is amplified, rectified, and again amplified so that the final output is about 19 v. The first amplifier boosts the voltage by a factor of 100, and the second provides amplification of 15 times.

The generator is built so that the edges of the electromagnets are angled with respect to the foil. The gap varies from 0.25 mm at one end to 0.7 mm at the other, corresponding to an angle of 1° to 2°. The diminishing air gap keeps deviations from linearity between output voltages to less than 0.5%, Renniecke says. Without the angle, deviations could be as high as 7%, he says, because the foil would effectively "shove" the magnetic lines of force somewhat past the magnetic plates as the lines bunch in front of the foil during rotation.

No wear. The developers say that other electromechanical function generators, such as profiled rotary capacitors, have their voltage peaks accompanied by trailing voltage values and add distortions through signal bottoming. In addition, parts of the Philips generator do not wear out because the foil rotates in a frictionless air gap.

The function generator was developed for C. H. F. Mueller GmbH, a Philips subsidiary also headquartered in Hamburg, that specializes in X-ray apparatus and other medical gear. Mueller will use the generator in special X-ray equipment to provide certain voltage functions for control purposes.

But Renniecke says principles of the generator could be applied to programmers for metal-working machinery, positioners for work benches or drawing tables, or anywhere that an accurate analog control device is needed. The machine could be used in automotive engineering to determine angular displacement of an engine piston in terms of piston travel. Measurements of revolutions per minute are also possible.

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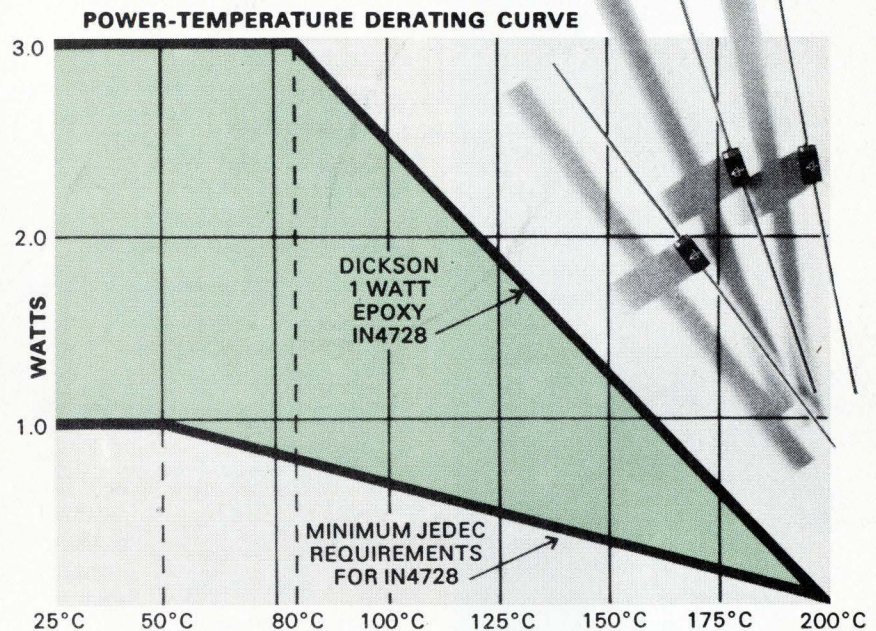
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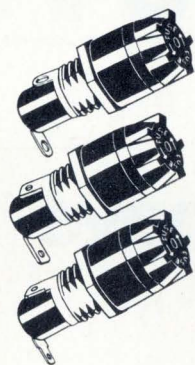
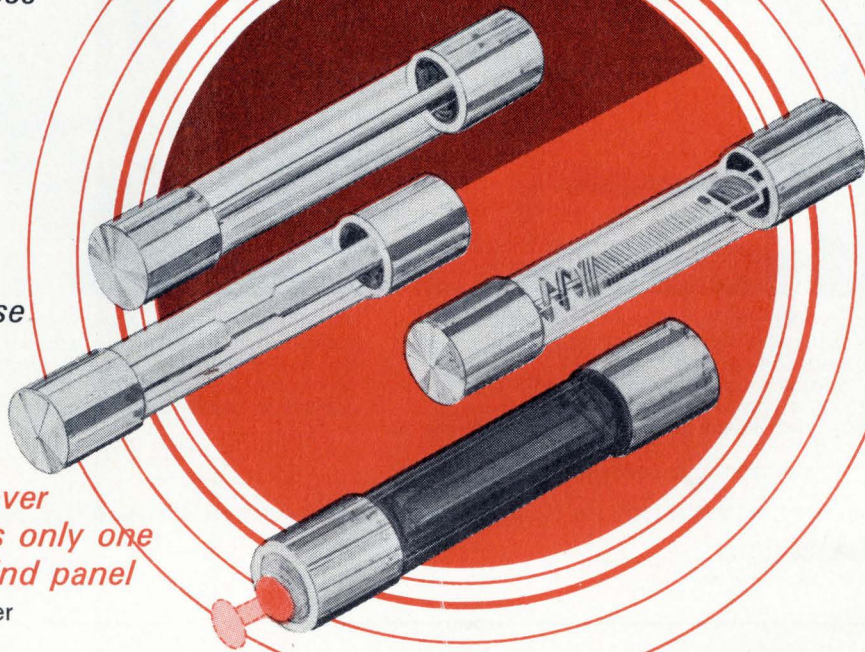
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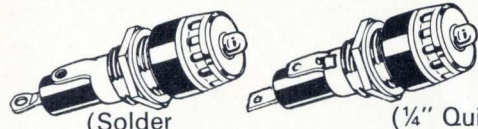
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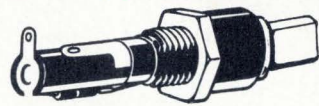
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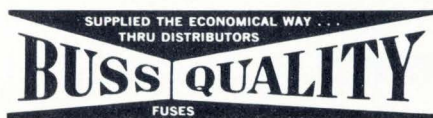
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