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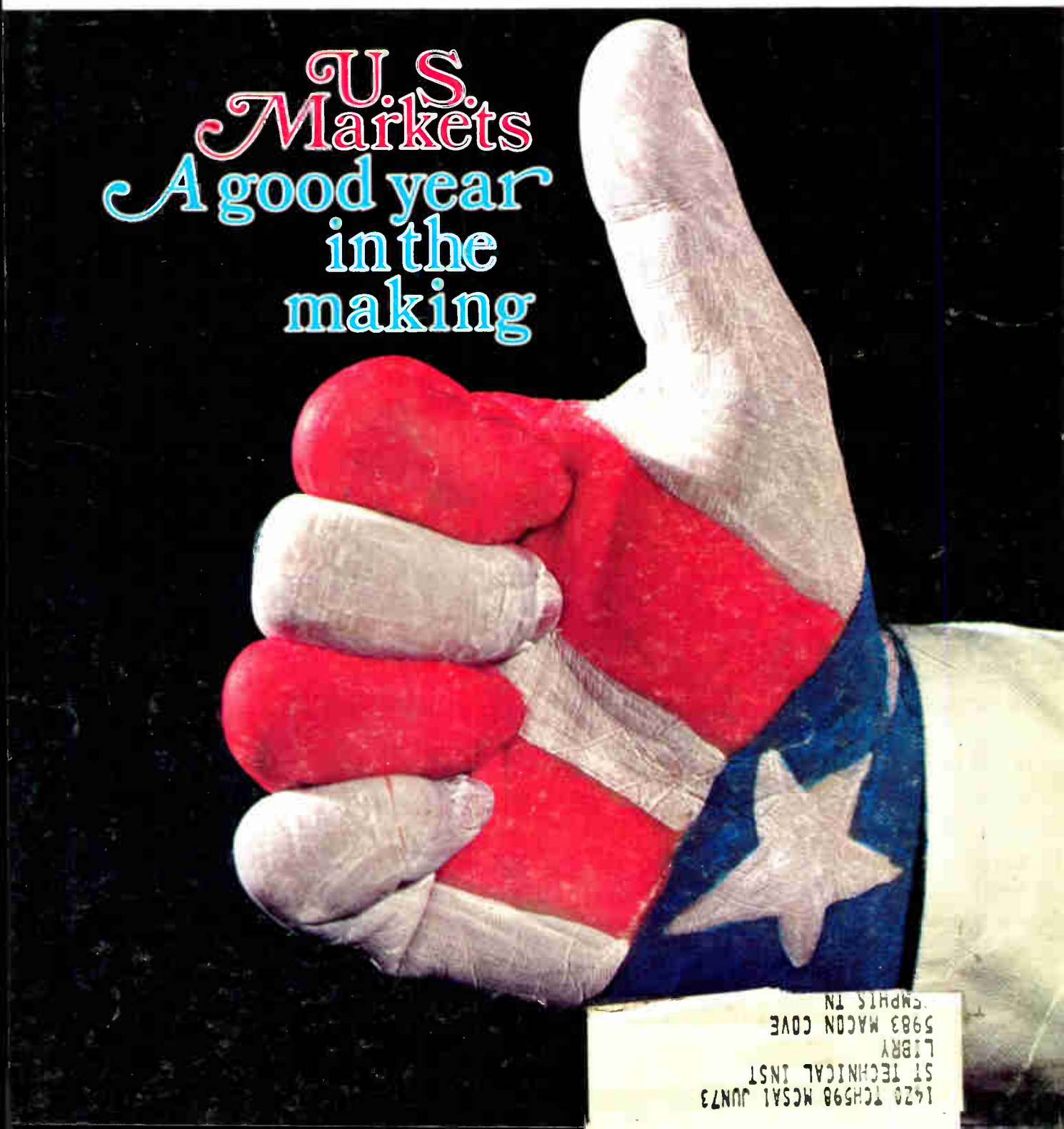
Electronics



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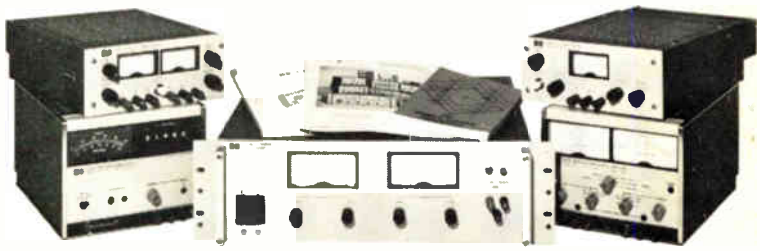

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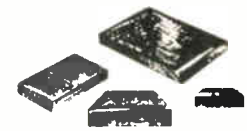

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Electronics
The International Magazine of Electronics Technology
Vol. 46, No. 1•January 4, 1973

Highlights

Rubles by the billion for air traffic control, 50
The USSR, looking to exploit western R&D in "reconstructing" its air-traffic-control system, aims to spend possibly $1 billion with a single nation. This week it's the U.S.A.'s turn to receive a visit from team of Soviet technicians and administrators.

1974: the return of the good times, 69
That's the consensus of *Electronics*' 15th annual forecast of the electronics equipment and components markets in the U.S. An in-depth analysis of business and technological trends, it tells where the action is liveliest (color TV, calculators, computers, and industrial equipment generally) and where the different markets are heading.

Figures for the future, 93
Detailed chart summarizes dollar sales in electronics for 1971, 1972, and 1973, market by market, besides indicating the most likely estimates for 1976.

Programable memories win many new friends, 115
With the arrival of the 2,048-bit products, programable read-only memories seem set to dominate the ROM market. Buyers like their design flexibility, as well as the reduced inventories and lead times that they allow.

And in the next issue . . .
Image-sensing with charge-coupled devices . . . a color tube for industrial displays . . . progress in packaging: the leadless IC.

The cover
With the electronics industries' sales expected to reach $33 billion, Art Director Fred Sklenar seized on the "thumbs up" gesture to describe the outlook for 1973.

Electronics

We are often asked why *Electronics*, a magazine devoted to keeping electronics engineers and engineering managers informed of technological advances and current industry news, publishes an extensive market report every year.

One reason is tradition. Our report is unique because no one else presents such a close-in marketing forecast. We feel that our report contributes something of continuity to the chronicling of electronics.

But, more important, the 24 pages of text and four pages of tables pinpoint where the action is, right now and for the immediate future. That's the kind of information that is of value to our readers, especially in these times of changing engineering priorities. So our annual market report falls right in with our mandate: keeping you informed—about technology and the many events and trends that impact your job.

The Japanese and Americans are battling over what videotape recording system will become standard—and hence open up the vast consumer market. For the details on the incompatibility of present systems, see page 47.

Standards may slow market development, but the variety of programs already available on videotape points to a broad market when it does come. Here's a sampling, compiled by Marilyn Offenheiser, Assistant Editor, as she put together the story.

- Gadabout Gaddis at Atoka Lake: how to pull in big bass.
- Two Wheels to Eternity, describing the growth of motorcycling.
- Thallassa Cruso on Forcing Bulbs.
- The History of the Blue Movie.

The index of articles published in *Electronics* in 1972 will be available shortly. For a copy, circle 340 on the reader service card inside the back cover.

January 4, 1973 Volume 46 Number 1
89,881 copies of this issue printed

Published every other Monday by McGraw-Hill Inc. Founder: James H. McGraw 1860-1948. Publication office: 1221 Avenue of the Americas, N.Y., N.Y. 10020 second class postage paid at New York, N.Y. and additional mailing offices.

Executive, editorial, circulation and advertising addresses: Electronics, McGraw-Hill Building, 1221 Avenue of the Americas, New York, N.Y. 10020. Telephone (212) 997-1221. Teletype TWX N.Y. 710-581-5234. Cable address: M C G R A W H I L L N Y.

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Readers comment

Court decision quote denied

To the Editor: In your article dealing with the Supreme Court's decision on the patentability of software, "Software patent hot potato winds up in Congress' lap," [Dec. 4, 1972, p.39], you attribute an erroneous quote to me.

The Supreme Court clearly did not decide on the basis of one case before it "that all programing is mathematical and therefore not patentable." It is difficult to determine the precise scope of the decision; all we can say is that a program that involves nothing more than the steps embodied in a mathematical formula cannot be protected. But an application program, especially if in a real-time environment requiring peripheral equipment and which has for its object something other than the mere computation of a mathematical formula, would apparently still be protectable.

It will probably be many months until the Court of Customs and Patent Appeals develops rules, within the framework of the Supreme Court decision, that will distinguish between patentable and unpatentable software inventions.

Michael I. Rackman
Gottlieb, Rackman & Reisman
New York, N. Y.

Software door remains ajar

To the Editor: The Supreme Court has not decided that all computer programing is unpatentable, a conclusion that you attribute to Mr. Rackman [Dec. 4, p.39]. In fact, your article elsewhere correctly quotes the Court as negating that conclusion.

The question of patentability of computer programs (as distinguished from "generalized formulations," which may form the bases for such programs and which are not specific as to end use or apparatus employed) was expressly not decided and is still open.

Edward F. McKie Jr.
Schuyler, Birch, Swindler, McKie, and Beckett
Washington, D. C.

■ *Unquestionably, the Court has not decided that all programs are unpatentable.*

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Circle 7 on reader service card

40 years ago

From the pages of Electronics, January 1933

The year 1933 is a year of new horizons in electronics. Steadily, persistently, the usefulness and variety of electronic-tube applications widen out. Meanwhile, the installations of a few years or months ago rapidly shake themselves down into regular, dependable operating routine.

It is in the ultrashort waves and in television that romance still abounds; the impossible today may always be the possible tomorrow. The photocell and all its works have largely simmered down into mechanical ingenuities of use and application, while the roster of different uses endlessly expand. And the electronic tube in power and control applications, constantly finds new fields to conquer as great power currents and motor equipments rush to do the bidding of their tiny electronic commanders.

As 1933 opens, television is temporarily outside the center of public attention; yet perverse child that she is, television today gives more promise of performance than at any time since her theoretical discovery by Nipkow in 1888.

Development of the cathode-ray tube goes on, and several extremely satisfactory images are now regularly produced. The wizards at Camden continue to refine the equipment used with the Empire State Tower job, but have essayed no further public demonstration. At Philadelphia, Farnsworth is working on electronic scanning for Philco. At Purdue, in Indiana, George has developed excellent detail of cathode-ray-tube reception in co-operation with Grigsby-Grunow.

In the scanning-dish receiver field, Garner of Western Television is producing a receiver to sell at $75, and is offering this in Kansas City in connection with a studio service which KMBC, the Columbia outlet in Kansas City, is putting on locally. This picture is of a special character, with successive scanning of numbered alternate lines, which does not lend itself to being picked up by other standard receivers.

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Circle 9 on reader service card

ECL

European production of ECL10,000 has started

First in the field is Philips with a pin-for-pin compatib e family. Twenty devices are currently available, more are coming throughout 1973. Including a 256-bit RAM and 1024-bit PROM.

As well as being the first and only European produced ECL range, Philips GX family has other advantages.

Small, but significant, is the convenient type numbering. Philips GXB 10102 is equivalent to the ECL 10102, for example. And although they are compatible, Philips GXB 10,000 does not suffer from spurious oscillations. A special network is built into every logic input to ensure that the real part of the input impedance stays positive.

The table shows you what's available (we're already delivering) plus what's coming through 1973.

For price, delivery, technical and uality control information contact:

Philips Industries,
Electronic Components an
Materials Division,
Eindhoven - The Netherlands.

In USA contact: Amperex Electronic Corporation, 230 Duffy Avenue, Hicksville, N.Y. 11802.

GXB 10101	Quad OR/NOR Gate with Strobe
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GXB 10105	Triple 2-3-2 OR/NOR Gate
GXB 10106	Triple 4-3-3 NOR Gate
GXB 10107	Triple Exclusive OR/NOR Gate
GXB 10109	Dual 4-5 OR/NOR Gate
GXB 10110	Dual 3-Input/3-Output OR Gate
GXB 10111	Dual 3-Input/3-Output NOR Gate
GXB 10115	Quad Line Receiver
GXB 10117	Dual 2-Wide O-A/O-A-I Gate
GXB 10118	Dual 2-Wide OR-AND Gate
GXB 10119	4-Wide OR-AND Gate
GXB 10121	4-Wide O-A/O-A-I Gate
*GXB 10124	Quad TTL to ECL Translator
*GXB 10125	Quad ECL to TTL Translator
GXB 10130	Dual D Latch
GXB 10131	Dual D Master-Slave Flip-Flop
*GXB 10132	Dual Multiplexer with Latch
*GXB 10133	Quad Latch with Output Enable
*GXB 10136	Universal Up/Down Binary Counter
GXB 10160	12-Bit Parity Generator/Checker
GXB 10161	Binary 1 of 8 LOW Decoder
GXB 10162	Binary 1 of 8 HIGH Decoder
GXB 10164	8 Line Multiplexer
*GXB 10173	Quad Multiplexer with Latch
*GXB 10174	Dual 4-1 Multiplexer
*GXB 10175	Quint Latch
*GXB 10179	Look Ahead Carry Block
*GXB 10181	4-Bit Arithmetic Logic Unit
*GXB 10149	1024-Bit PROM (256 x 4)
*GXB 95410	256-Bit RAM (256 x 1)

* To be introduced through 1973.

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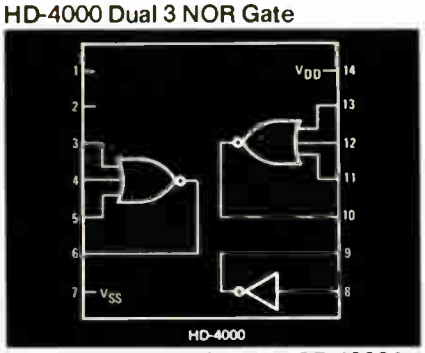
All of the new devices are available in 14-pin dual in-line packages except the HD-4009 and HD-4010, which come in 16-pin packages. Because of their compatible pin-out configurations these circuits will replace or interface with the CD 4000A series. For details see your Harris distributor or representative.

1

HD-4000 Dual 3 NOR Gate



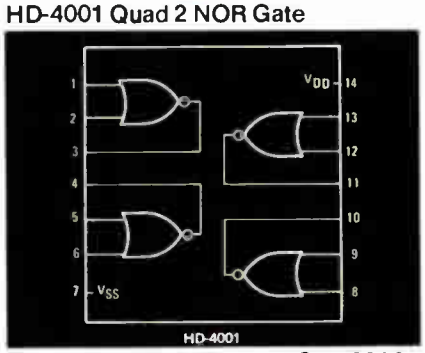
Pin for pin compatible with CD 4000A.

High speed	10ns
Low power	1nW

	100-999 units
−40°C to +85°C	$1.00
−55°C to +125°C	$3.10

2

HD-4001 Quad 2 NOR Gate



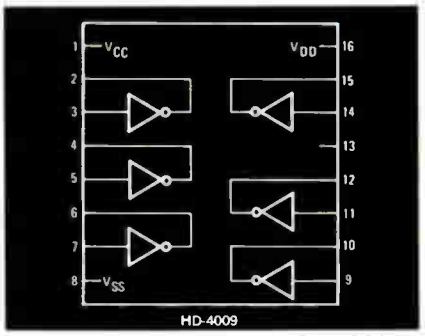
Pin for pin compatible with CD 4001A.

High speed	10ns
Low power	1nW

	100-999 units
−40°C to +85°C	$1.00
−55°C to +125°C	$3.30

3

HD-4009 HEX Inverter



Pin for pin compatible with CD 4009A.

High speed	10ns
Low power	50nW

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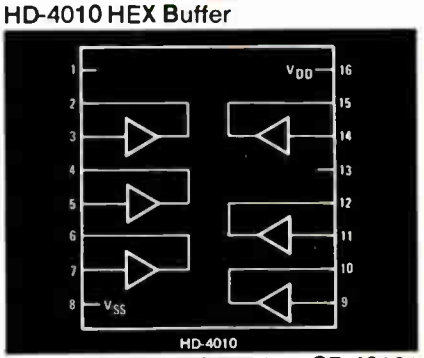
4

HD-4010 HEX Buffer



Pin for pin compatible with CD 4010A.

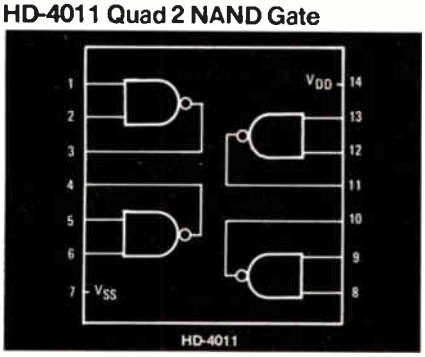
High speed	10ns
Low power	50nW

	100-999 units
−40°C to +85°C	$2.20
−55°C to +125°C	$5.25

CMOS:

5

HD-4011 Quad 2 NAND Gate



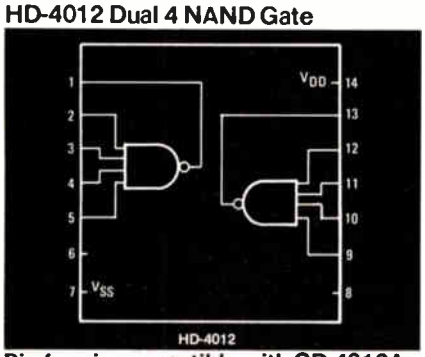
Pin for pin compatible with CD 4011A.

High speed	**10ns**
Low power	**1nW**

	100-999 units
−40°C to +85°C	**$1.00**
−55°C to +125°C	**$3.30**

6

HD-4012 Dual 4 NAND Gate



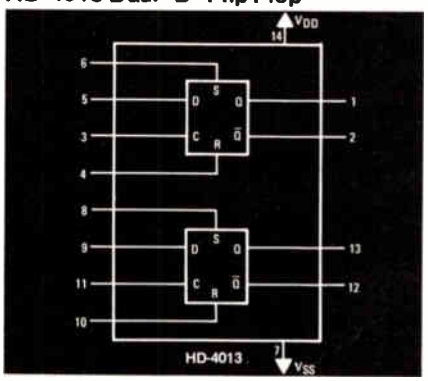
Pin for pin compatible with CD 4012A.

High speed	**10ns**
Low power	**1nW**

	100-999 units
−40°C to +85°C	**$1.00**
−55°C to +125°C	**$3.45**

7

HD-4013 Dual "D" Flip Flop



Pin for pin compatible with CD 4013A.

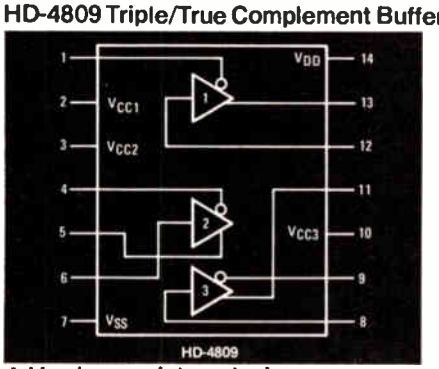
High speed 18MHz typical toggle rate

Low power	**50nW**

	100-999 units
−40°C to +85°C	**$2.10**
−55°C to +125°C	**$4.75**

8

HD-4809 Triple/True Complement Buffer



A Harris proprietary device.

High speed	**10ns**
Low power	**50nW**

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People

Gunn, the racer, wins another award

Gunn: Semiconductors and motorcycles.

The man who just won another award for his discovery of the Gunn effect would sometimes prefer to be seated on either his Kawasaki or Ducati motorcycle, tasting the dust at Watkins Glen or Bridgehampton. "I've been messing about with motorcycles since I was 17," says IBM Fellow John B. (Ian) Gunn, who has just won the Valdemar Poulsen Gold Medal, presented by the Danish Academy of Technical Science.

The award, recognizing Gunn's discovery of spontaneous oscillations of current in certain semiconductors when a steady voltage is applied to them, is the 10th to be given since the medal was instituted in 1939. Gunn-effect devices—the first solid-state source of microwaves—are beginning to come into wide use in radar and high-frequency-radio communications, where they replace vacuum tubes.

Gunn, 44, who describes himself as a "cross between an engineer and a physicist," is more interested today in technology than in science. Why focus on engineering? "Maybe it's time for a change," he says. "After all, I spent 15 years experimenting in the same field, and now that it's paid off, I don't see much sense in continuing. But I might well some day drift back into physics." His experimental study for IBM of the mobility of hot electrons in gallium arsenide is considered a classic.

As for his interest in wheels, Gunn has been racing motorcycles since his early days in Britain. Although he hasn't raced lately, he enjoys "playing at being a mechanical engineer" and has a dynamometer at home and hopes to get into engine development.

Besides his Kawasakis and Ducatis, his latest racing machine is a 1953 357-MM Ferrari. Gunn had expected difficulty in finding the car; he wrote to dealers in Italy, France, and Britain and placed ads in auto-racing magazines. "Then," he says, "I heard from a chap in Poughkeepsie who had just what I was looking for—and you can probably guess who he worked for."

Gunn, who still has a trace of British accent, was born in Egypt, where his English parents were doing archeological research. Today he lives in a rambling house with an ambitious home workshop that sometimes creates the need to "make a tool to make a tool to make a tool to do a job."

O'Green takes over a troubled Litton

Fred O'Green has been getting bad news and a little good news. The bad news for O'Green, at 51 the new president of Litton Industries, begins with the huge conglomerate's dismal record last year: earnings dropped to $1.1 million from $50 million in 1971, even though sales increased $134 million to $2.5 billion. Not only that, there's the ongoing controversy surrounding Litton's shipbuilding activities at Pascagoula, Miss. As for the good news, says O'Green, "1973 will be much better than '72."

The new president, who succeeds

O'Green: New man handling Litton's tiller.

ONE CENT ...
it'll buy you 20 bytes on a DIVA disc

with a minicomputer controller that fits on this page!

If you've got to cram more memory into your mini system, the DD-14 lets you add discs at a price your customers can afford and with reliability they demand. DIVA has made such disc add-ons practical.

The DD-14 is an IBM 2314 type single spindle drive. Transfer rate is 312,000 bytes/sec. and capacity is 29 million bytes. Total system price is $12,800! At this price/performance, why even consider a limited 10 million byte 2310/5440 type system for your customers?

TOTAL SYSTEM FEATURES

Controller:

It's small enough to fit inside any mini! Reliability of this controller? 38,000 hours MTBF.

Software:

DOS compatible I/O drivers for almost any mainframe are available as an option.

Dual Word Buffers:

You can transfer one word at a time or two at a time. This gives you up to 8 microseconds latency in the CPU for Direct Memory Access. You can use today's high performance discs with older minis. Impossible without the DIVA controller!

29 million bytes not enough? Then add another drive at $7,600. It gives you 58 million bytes. The total price is $20,400. We call it the DD-14/p.

If you need up to 4 drives per controller, these can be easily added in the field. DIVA's Overlap Seek feature means that you can increase throughput by accessing multiple drives simultaneously.

Where do you get the most bytes for your buck? You can buy this 2314 type system from DIVA. You can pay twice as much for the same system from Data General. You can pay three times as much for the same system from DEC. The same system!

Do your customers need still larger drives? DIVA delivers, and supports, IBM type drives as well. They are priced just as competitively as the DD-14 we've been talking about, and they're IBM media compatible, too! This means that for the first time your customers can freely interchange disc packs between their DIVA systems and IBM 360 systems.

Let's look at track records. DIVA has delivered more large disc controllers for more minis than any other manufacturer. DIVA disc systems are used for credit checking and medical data processing and text editing and batch processing and graphic design and point of sale terminals and . . . we're just getting started!

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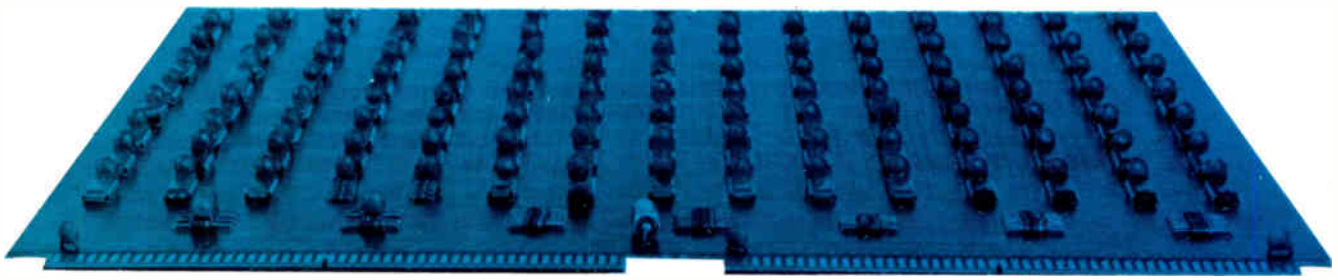

People

Roy Ash, President Nixon's new director of the Office of Management and Budget, should be quite familiar with the shipbuilding problem. He was put in charge of the marine activities less than a year ago to try to straighten them out, and he feels that considerable progress has been made.

The work in question involves five landing-helicopter-assault ships and a number of the new Spruance class of destroyers for the Navy. O'Green says Litton has run into many problems with hiring skilled personnel in the area and with the new technologies of building the ships: "we're the first company to even have a contract for the total design and fabrication of ships, and both we and the Navy have had to learn."

Litton has grown in 20 years from a small electronics company into a major conglomerate. In the past year, the company has been trying to get back on the high-technology track where it has excelled—for instance, it has sold its Stouffer Foods division.

Many observers, in fact, see O'Green's appointment as signaling increased determination to grow internally with present operations, rather than seek acquisitions. The company is still very diversified, however, and O'Green says one of his first jobs will be finding out about the many areas of the company he hasn't been working in: he has been an executive vice-president with responsibility for defense electronics (guidance and control, communications, and data systems) and electronic components, as well as the shipbuilding activities.

An Iowa native, O'Green received a BSEE from Iowa State after service in the Navy in World War II, and he also has an MSEE from the University of Maryland. He joined Litton 10 years ago after serving as technical director of space programs and assistant general manager of Lockheed's Space division. His father is from Sweden, despite what his name might suggest, and his hobbies include golf, woodworking, water-skiing, and motorcycle trail-riding with his two sons.

Fluke problem solvers

The new multimeter with advanced L.S.I. for more function power. 26 ranges, 5 functions.

$299... Fluke's new 8000A, Try one for fifteen days, no obligation.

Now you can put the unmatched quality of Fluke instrumentation to work for you at the price of an ordinary multimeter.

Here's the DMM with more function power. Its got 26 ranges, including five ranges of ac and dc volts, five ranges of ac and dc current, and six ranges of resistance. Push button control gives you the simplest most reliable error-free operation possible. The new Fluke 8000A is the only multimeter using an A-to-D converter with inherent self-zeroing to completely eliminate offset uncertainty.

More details are on the next page, but we think you'll want to try this low-priced measurement system now. Fill in the coupon; we'll do the rest.

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For even more convenience, let your nearby Fluke sales office handle the details. For location, dial toll-free 800-426-0361.

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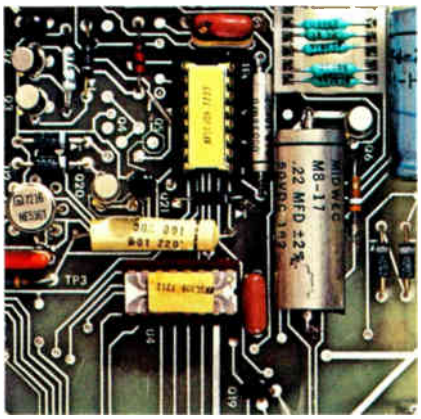
When you look inside you'll find the same high technology and quality we put in our $3000 DVM's.

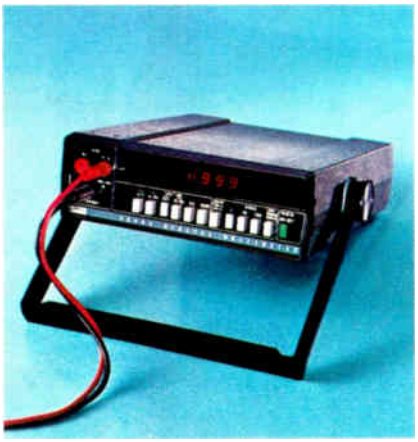
Take a look inside. The LSI chips, equivalent to over 3,000 circuit elements, are the most advanced proven semiconductor devices on the market today. Fluke is the only manufacturer using **both analog LSI and digital LSI** to give you increased reliability at lower cost with fewer parts. The Fluke 8000A has only ⅓ the number of parts used in a typical 3½ digit multimeter.



A simple guarantee
You can understand our 12-month guarantee. It's straightforward and honest. And you can believe we live up to it. If anything happens to your 8000A, take it or send it to your nearest factory service center. We'll give you 48-hour turnaround service in the U.S., Canada, Europe and the Far East.

Specs to work by
The new Fluke 8000A has a dc accuracy of 0.1% when you buy it. We guarantee it will still measure within that accuracy without recalibration a year later.
The case is rugged and tough. Drop this multimeter from a bench. Nothing happens to the works inside. We guarantee it.

Wide range of measurements
Measurement flexibility is broad enough to meet all the situations you're likely to encounter. The Fluke 8000A gives you 26 ranges to measure ac and dc voltages from 100 microvolts to 1200 volts, currents from 100 nanoamps to 2 amperes; and resistance from 100 milliohms to 20 megohms.



Wide choice of options
For a few dollars more, you can add a rechargeable battery pack to give you completely portable operation for over eight hours. And when you're back on the line, the batteries will recharge automatically. Other options include digital printer output, deluxe test leads, high voltage probe, rf probe, 200-amp ac probe, carrying case and rack mount kits.

A complete digital multimeter
But with or without options, the Fluke 8000A comes complete with test leads and spare fuses. It all adds up to an instrument you can count on day after day, year after year. Isn't this what you want in a digital multimeter at any price? Fluke thinks so.

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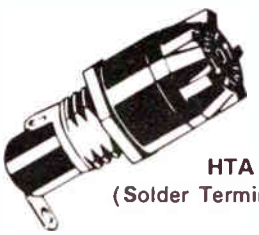
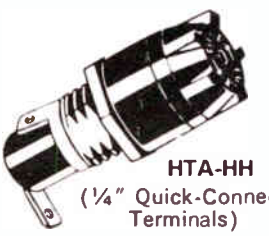
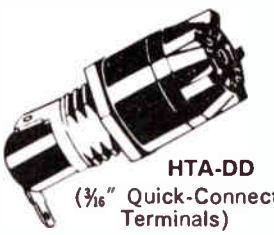


HTA
(Solder Terminals)



HTA-HH
(¼" Quick-Connect Terminals)



HTA-DD
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ALL FUSE HOLDERS HAVE THESE FEATURES IN COMMON

■ Rated for 15 amps at 250 volts ■ Dielectrically capable of withstanding 1500 volts a.c. between terminals and between terminals and panel ■ Bayonet-type knob grips fuse so that fuse is withdrawn when knob is removed; strong compression spring assures good contact ■ Made for installation in D-hole to prevent turning in panel ■ Terminals are mechanically secured as well as soldered in holder.

The BUSS line of small dimension fuses and mounting hardware covers the complete spectrum of electronic applications. Use the coupon at right to order the complete catalog.

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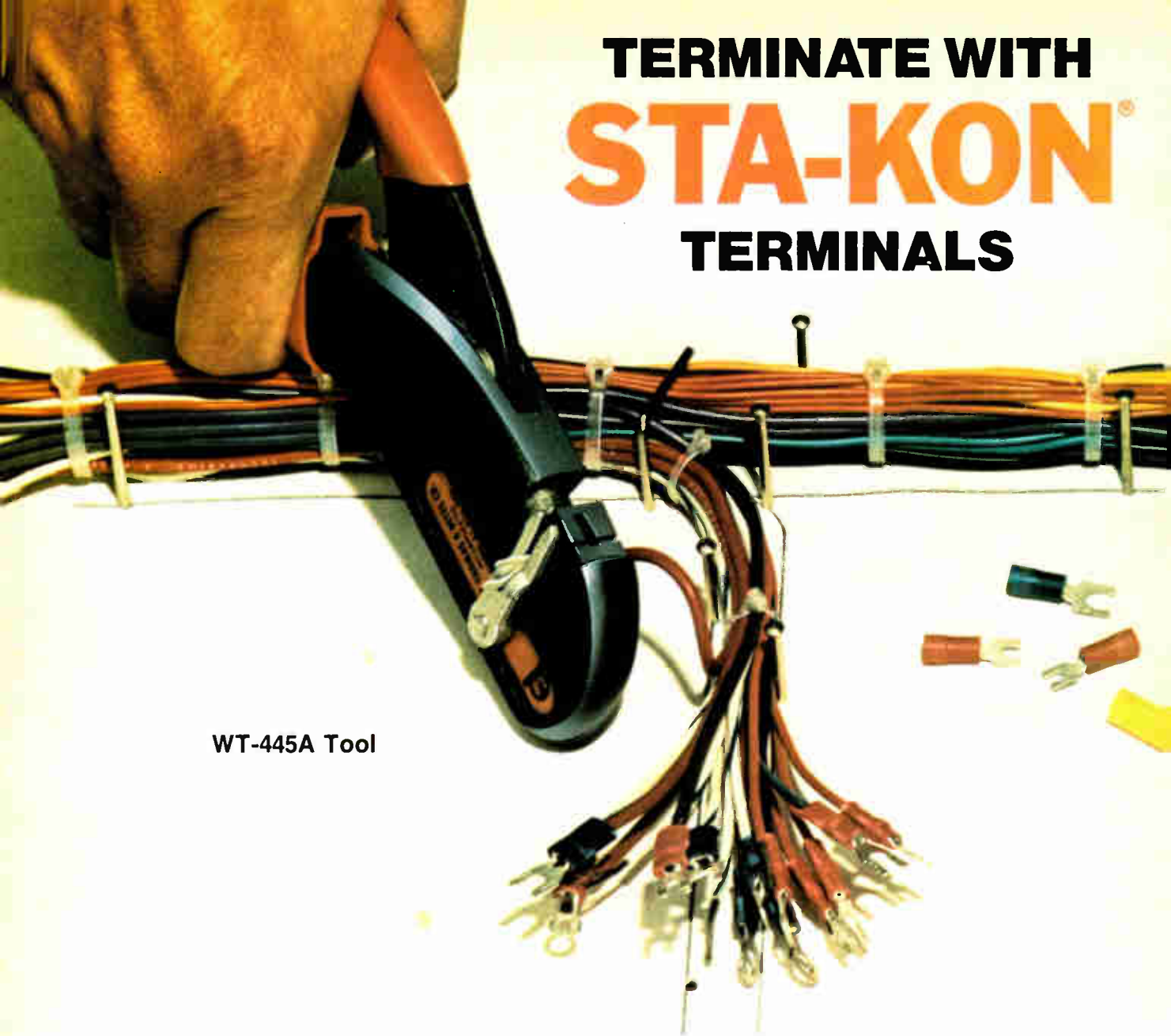

WT-445A Tool

From beginning to end and every place in between, our goal is to make your wiring more reliable.

The STA-KON Terminal Method reduces the chance of human error . . . increases the level of reliability. Our exclusive Shure-Stake® principle makes the tool responsible (not the installer) for the compression connection. Once the tool's compression stroke has started, the tool will not release the terminal until the proper compression has been made.

Another benefit of the STA-KON Method is the solderless terminal design. Take for example, the problems of high density wiring in terminal blocks. Our new mini-locking fork terminals and mini-ring types are considerably smaller than conventional terminals. They prevent overlapping of terminals at the block. They fit all kinds of restricted spaces . . . both in depth and width.

This configuration of the spring-like locking fork terminal itself, is another new idea from T&B. The terminal snaps on like a fork tongue and stays on like a ring tongue. No need to remove screws or nuts to install the terminal.

Our insulated ring, fork and locking fork terminals are now available tape mounted for use with high speed automatic installing tools . . . you can crimp over 3600 per hour with our new #11908 tool.

When you specify STA-KON, you get extras at no extra cost — long serrated barrels give positive contact and maximum pullout resistance — and precision tools are matched to the terminals. Write for catalog.

BUNDLE WITH TY-RAP® CABLE TIES

Cut Costs at Each Step of Harness Fabrication

1. Tying a large variety of bundle diameters? The new WT-193 tool gives you an improved level of control and convenience. The accurate preset tension control makes tying uniformity the responsibility of the tool rather than of the installer. The narrow nose and long slim body reaches in, cinches the TY-RAP® tie to a preset tension and trims it evenly . . . even in those tough high-density areas.

2. Repetitious tying in large quantities? The new TR-300 high-speed tool gives you several benefits. In 8/10th of a second, it installs a TY-RAP tie around a bundle up to 5/8" diameter, cinches and trims evenly.

3. Here's the most important reduction benefit! The ultimate key to savings is the locking device in the cable tie. Only TY-RAP ties give you a "grip of steel." A patented, non-magnetic, stainless steel locking wedge is embedded in the nylon cable tie. It's in every self-locking tie, from the miniature 3 inch for 1/16" dia. to the 30 inch tie for 9 inch bundles. It is used in virtually every modern aircraft, communicaiton, business machine and electrical equipment application... in general wherever wire is used.

4. Tired of the recurring costs of harness boards?

Our new modular harness board is designed to substantially reduce costs while providing convenience. It is constructed of polyethylene foam sandwiched between two metal screens — the nails can be pushed in by hand. It's reusable. It's reversible. It's modular — boards interlock in seconds to produce any size board needed.

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Meetings

International Solid State Circuits Conference: IEEE, Marriott, Philadelphia, Feb. 14–16.

Aerospace and Electronic Systems (Wincon): IEEE, Sheraton, U. of Pa., Philadelphia, Feb. 13–15.

IEEE International Convention (Intercon): IEEE, Coliseum and New York Hilton, March 26–29.

Reliability Physics Symposium: IEEE, Dunes, Las Vegas, Nev., April 3–5.

Southwestern IEEE Conference and Exhibition (Swieeeco): IEEE, Houston, Texas, April 4–6.

International Symposium on Circuit Theory: IEEE, Four Seasons Sheraton, Toronto, Canada, April 9–11.

International Magnetics Conference (Intermag): IEEE, Washington Hilton Hotel, Washington, D.C., April 24–27.

Carnahan Conference on Electronic Crime Countermeasures: IEEE, U. of Kentucky, Carnahan House, Lexington, Ky., April 25-27.

Electron Device Techniques Conference: IEEE, United Engineering Center, New York, May 1–2.

Electronic Components Conference: IEEE, EIA, Statler-Hilton, Washington, D.C., May 14–16.

Naecon: IEEE, Sheraton, Dayton, Ohio, May 14–16.

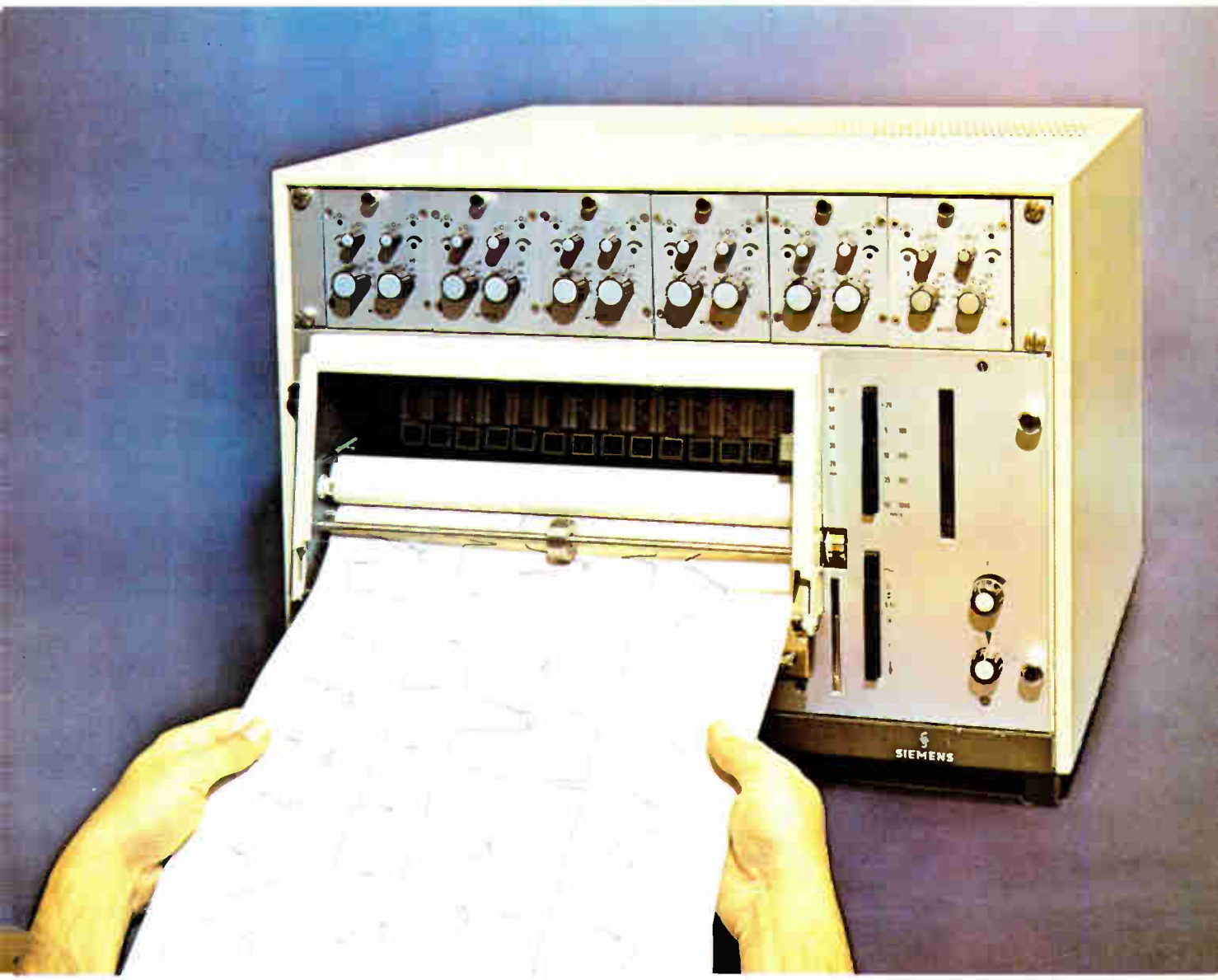
International Symposium: SID, Statler-Hilton, New York, May 15–17.

Measurement and Test Instrument Conference: IEEE, Skyline Hotel, Ottawa, Ont., Canada, May 15–17.

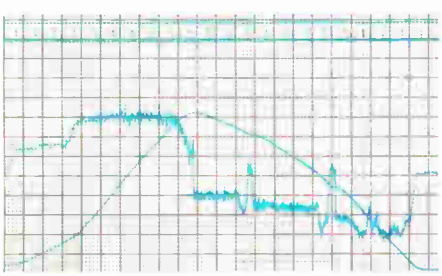
Conference on Laser Engineering and Applications: IEEE, OSA, Hilton, Washington, D.C., May 30–June 1.

National Computer Conference and Exposition: Afips, New York Coliseum, New York City, June 4-8.

Siemens



This new ink jet system does the work of more expensive pen arms and light beams.



Actual ink-jet recording of overlapping traces.

Like pen arm recorders, Siemens new jet recorders write with ink on low-cost Z-fold paper. Like light beam recorders, they write fast. Up to 3,000 inches a second.

They easily record time-synchronized overlapping traces (such as the one at left) at frequencies from dc to 1,000 Hz.

Four basic models provide for 2, 6, 12 or 16 channel recording. To learn more, send for our comprehensive brochure describing these new low-cost recording systems. Write to Siemens Corporation, 186 Wood Ave., So., Iselin, N.J. 08830. Call 201-494-1000.

SIEMENS

Circle 23 on reader service card

SCHOTTKY ON

One-stop TTL shopping for 74S MSI, SSI...

At last. Available now, all in one place. The whole mix in Schottky logic-to match every high speed TTL function in demand today. Signetics broad line of 74S circuits. Plus our compatible 82S series of enhanced MSI devices that help Schottky give you a competitive step-up in speed, in design-ease, in versatility... and of course, in MSI complexity.

And you get it where you want it, when you want it. Fast service directly from distributor stock. Signetics knocks off the waiting list tie-ups, the multi-stop shopping. After all, how can we encourage you to boost system speed by replacing TTL with Schottky equivalents, if you can't get the circuits to work with? All the parts you need—without delays, without runarounds, without making six calls when one should do the job.

Here's where Signetics makes the difference. One call does the job. Completely.

SSI Schottky to cover full function range:

SSI SCHOTTKY 74S TTL	
74S00	Quad 2-Input NAND Gate
74S03	Quad 2-Input NAND Gate (Open Collector)
74S04	Hex-Inverter
74S05	Hex-Inverter (Open Collector)
74S10	Triple 3-Input NAND Gate
74S11	Triple 3-Input Positive AND Gate
74S15	Triple 3-Input Positive AND Gate (Open Collector)
74S20	Dual 4-Input NAND Gate
74S64	4-2-3-2-Input AND/OR/INVERT Gate
74S65	4-2-3-2-Input AND/OR/INVERT Gate
74S74	Dual D-Type Edge-Triggered Flip-Flop
74S112	Dual J-K Edge-Triggered Flip-Flop
74S113	Dual J-K Edge-Triggered Flip-Flop
74S114	Dual J-K Edge-Triggered Flip-Flop
74S40	Dual 4-Input NAND Buffer
74S140	Dual 4-Input NAND Line Driver

You can make the same call encompass MSI too. Signetics 74S MSI circuits offer the same volume availability as SSI, as well as the same total TTL compatibility—pin-for-pin fits with standard TTL and low-power Schottky. Ten MSI devices in stock now, with more to be announced in the next few months.

MSI SCHOTTKY 74S TTL	
74S151	8-Input Data Selector/Multiplexer
74S153	Dual 4-Input-to-1-Line Selector/Multiplexer
74S157	Quad 2-Line-to-1-Line Data Selector/Multiplexer
74S158	Quad 2-Line-to-1-Line Selector/Multiplexer (Inverting)
74S174	Hex D-Type Flip-Flop w/Clear
74S175	Quad D-Type Flip-Flop w/Clear
*74S181	Arithmetic Logic
*74S194	4-Bit Bidirectional Shift Register
*74S195	4-Bit Parallel Access Shift Register
74S251	8-Input Data Selector/Multiplexer w/tri-state
74S253	Dual 4-Input-to-1-Line Selector/Multiplexer w/tri-state
74S257	Quad 2-Line-to-1-Line Data Selector/Multiplexer w/tri-state outputs
74S258	Quad 2-Line-to-1-Line Selector/Multiplexer (Inverting) w/tri-state

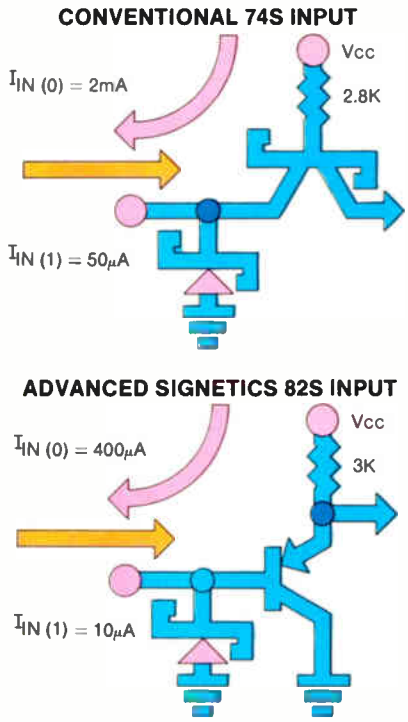
*January-February announcement

Complementing 74S, Signetics 82S series MSI circuits offer significant advantages in sophisticated Schottky systems designs. The conventional TTL input circuit found in all Schottky logic, other than Signetics 82S, suffers from low input impedance.

Signetics advanced PNP structure produces significantly higher input impedance. You can drive far more devices from one output since input current is one-fifth that of standard Schottky inputs. With Signetics 82S MSI you need not worry about noise when driving long lines since, in addition to 10 PNP loads, a termination resistor can be accommodated when needed without fan-out reduction.

THE DOUBLE.

...and now optimized 82S MSI too.



The growing line of 82S includes ultra high speed pin-for-pin replacements for the popular 8200 series MSI. In addition, the 82S90/91 100 MHz counter will replace the 74196/197, and the 82S70/71 70 MHz shift register will replace the 74178/179 in systems requiring improved speed performance.

The BCD arithmetic unit 82S82 replaces at least six MSI packages previously needed for the same function while at the same time operating speed is improved by a factor of 3. For BCD applications that only require addition, the 82S83 adder will replace three MSI circuits, and double operating speed. The 82S62 parity generator/checker is unsurpassed in speed.

Of course the 82S MSI line interfaces with 74S logic directly, operating in the same design environment as all 7400 circuitry but with the added advantage of direct replacement without violating fan-out rules.

MSI SCHOTTKY 82S TTL		SPEED
82S30/31/32	8-Input Digital Multiplexer	15 ns
82S33/34	2-Input, 4-Bit Digital Multiplexer	15 ns
82S41/42	Quad Exclusive-OR/Quad Exclusive-NOR	5 ns
82S50/52	Binary-to-Octal/BCD-to-Decimal Decoder	12 ns
82S62	9-Bit Parity Generator/Checker	17 ns
82S66/67	2-Input, 4-Bit Digital Multiplexer	15 ns
82S70/71	4-Bit Shift Register	70 MHz
82S82	BCD Arithmetic Unit	20 ns
82S83	BCD Adder	20 ns
82S90/91	Presettable Decade/Binary Counter	100 MHz

74S/82S Schottky TTL. Just one call to one of our distributors, reps or salesmen. And Signetics puts it on the line. Your line.

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High speed response requested on Schottky TTL data, specs, applications and delivery for 74S SSI, 74S MSI and 82S MSI.

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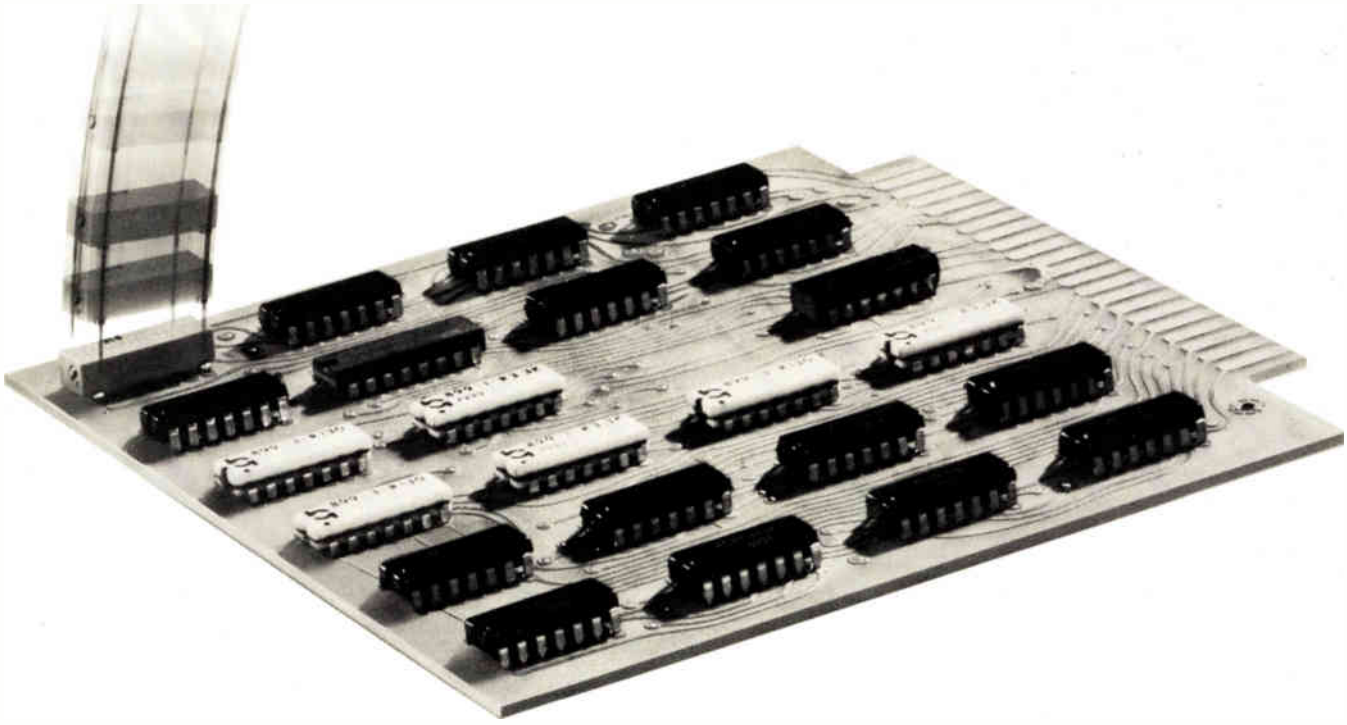
The dependable Helipot trimmer goes automatic.

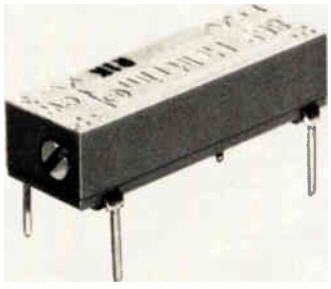


Now, the Helipot Model 86 Trimmer comes in standard DIP configuration (TO-116) for compatible, fast insertion by automatic equipment.

Our Model 86 line features cermet resistance elements, essentially infinite resolution, and 19 standard resistance values from 10 ohms to 2 megohms. Sealed for board washing, they're leak-tested with 70°C water for one minute.

And temperature coefficient is a low ±100 ppm/°C.

These trimmers are made for both industrial and commercial applications, and their price is really right: just $1.61 each in the 1,000 quantity, $2.30 each for one to nine.



Your local Beckman/Helipot distributor stocks the Model 86 in depth. To order or to request technical data, call him today. Or write to Helipot Division, 2500 Harbor Boulevard, Fullerton, California 92634.

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new, pocket-size Tri-Phasic™ multimeter

MODEL 245, ACTUAL SIZE

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The miniature, rugged, lab-quality 4½-digit multimeter with .005% resolution, basic ±.05% accuracy, battery and line operated. Measures DC volts, AC volts, DC current, AC current and resistance.

$295
COMPLETE

The performance of Model 245 is so remarkable, the circuitry so stable we offer it on a 30-day trial.

Send me Data Precision Model 245 @ $295. I prefer the following purchase plan:

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Electronics newsletter

GR, Schneider of France form instrument firm . . .

Looking for a way to get onto the low-cost instrument bandwagon while simultaneously increasing its penetration of European markets, **General Radio Co., of Concord, Mass., is joining with France's Schneider Electronique to form an as yet unnamed Paris-based independent company.** The new firm, in which GR has taken a strong minority position, will have as its initial goals the **increased importation of low-cost French digital test gear into the United States and the increased exportation of GR's more expensive equipment into Europe**—particularly France.

Capitalized at $1 million, the new company is expected to gross about $3 million in its first year of business, which should begin this spring given French government approval. Peter J. Macalka, GR vice-president, predicts that **about $2 million in sales should come from GR's more effective penetration of the French market.** Another million should come from U.S. sales of Schneider digital instruments priced under $500. These would be made through GR's domestic marketing organization. Macalka ignores the rest of the European market in his estimate—sales there would be icing on the cake.

Macalka expects sales of industrial equipment, nonindustrial electronics, and automatic test systems to have about equal fractions of GR's share of the market in the beginning. However, since the automatic equipment is by far the fastest growing of the three product lines, it may well account for 40% to 50% of the new firm's sales within a year after its doors open, Macalka predicts.

. . . that may develop new products

If all goes well, the new General Radio-Schneider Electronique company is expected to go beyond the simple marketing of the product lines of the two parent companies. **New-product development is expected, as well as the melding of compatible existing products**—an example might be the combination of a complex automatic GR test system with a Schneider CRT display terminal.

RCA plans for terminal-a-day Videovoice rate

RCA's slow-scan picture telephone system, Videovoice, appears to be taking off. The system, announced in 1971 by RCA Global Communications Inc. [*Electronics*, June 21, 1971, p. 36], has more than two dozen terminals already installed in the corporate offices of such major companies as Motorola, IBM, Atlantic Richfield, and Western Union. **But now, "we are planning for the installation of one terminal per day,"** says George Shawy, project manager.

The system uses standard voice-grade telephone lines to produce a frame in about 30 seconds that RCA says is nearly of TV quality. Present leased cost is $225 per month per terminal.

621B navsat passes test

The Air Force is encouraged by initial data from a demonstration of its 621B navigation satellite concept, and plans are already under way for an on-line, real-time demonstration of the concept before mid-year. Partial results of the initial tests, done at Holloman Air Force Base, N. M., under the guidance of the Air Force Space and Missile Systems Organization, **show that the equipment used delivered the desired accu-**

racies of tens of feet, a Samso source says. The off-line tests at Holloman used transmitters made by Hazeltine Corp., plus a Hazeltine and a Magnavox Co. receiver. [*Electronics*, Dec. 20, 1971, p. 66]. The transmitters were placed on the ground in the same kind of cluster they'll form in satellites bearing them in spaceborne usage. The system concept was checked for accuracy in area navigation and instrument landing system capability, with the data taped on the ground and in overflying aircraft for later reduction.

In the next step, the same ground-based transmitter arrangement will be used, **but real-time reception will be checked** with a receiver to be supplied by TRW Systems, tied to a Singer-Kearfott digital computer and intertial platform to provide high on-line precision. TRW Systems will conduct the next tests for the Air Force Avionics Laboratory under Samso guidance.

MOS LSI finds way into control unit for range

The computer in the kitchen may be here sooner than most people had thought. **Frigidaire has developed an electronic control for electric ranges that employs three complex MOS LSI chips for complete management of both time and temperature.** The user simply touches a button for the desired temperature; for the oven, the start and stop times are programed the same way.

The MOS circuits, made by American Micro-systems Inc., Santa Clara, Calif., make up a special-purpose processor that handles all control functions. Frigidaire has been showing the range in several cities, and it may be available this year.

Dozen firms seek St. Louis air monitoring job

The prospect of building the first major automatic air-pollution monitoring system **has generated heavy competition among electronics firms trying to break into the environmental market.** The St. Louis Regional Air Monitoring System (RAMS), part of the Environmental Protection Agency's Regional Air Pollution Study, is the plum, and it's expected to cost more than $1 million.

Among the dozen bidders are Systems, Science and Software, a La Jolla, Calif., firm already involved in pollution studies, paired with Dallas-based hardware producer E-Systems (formerly LTV Electro Systems). Others include such diverse firms as IBM, GE, Westinghouse, Beckman Instruments, Computer Sciences, IRW, Standard Research Institute, and North American Rockwell. Bids are due Jan. 29.

Addenda

Texas Instruments Ltd. of Bedford, England, has invaded U.S. consumer electronics territory. **The target is a new market for its 2,200-volt, 1.5-ampere silicon transistors, which have sold well in Great Britain for television line-scan applications.** . . . Hopes of the Electronic Industries Association's Tube division that countervailing duties would provide a means of checking imports from Japan of such components as color TV picture tubes have been dashed by the U.S. Tariff Commission. The Treasury Department ruled late in September that picture tubes were being or were likely to be dumped, **but now the commission has ruled that the margin of imports was insufficient to injure U.S. producers.**

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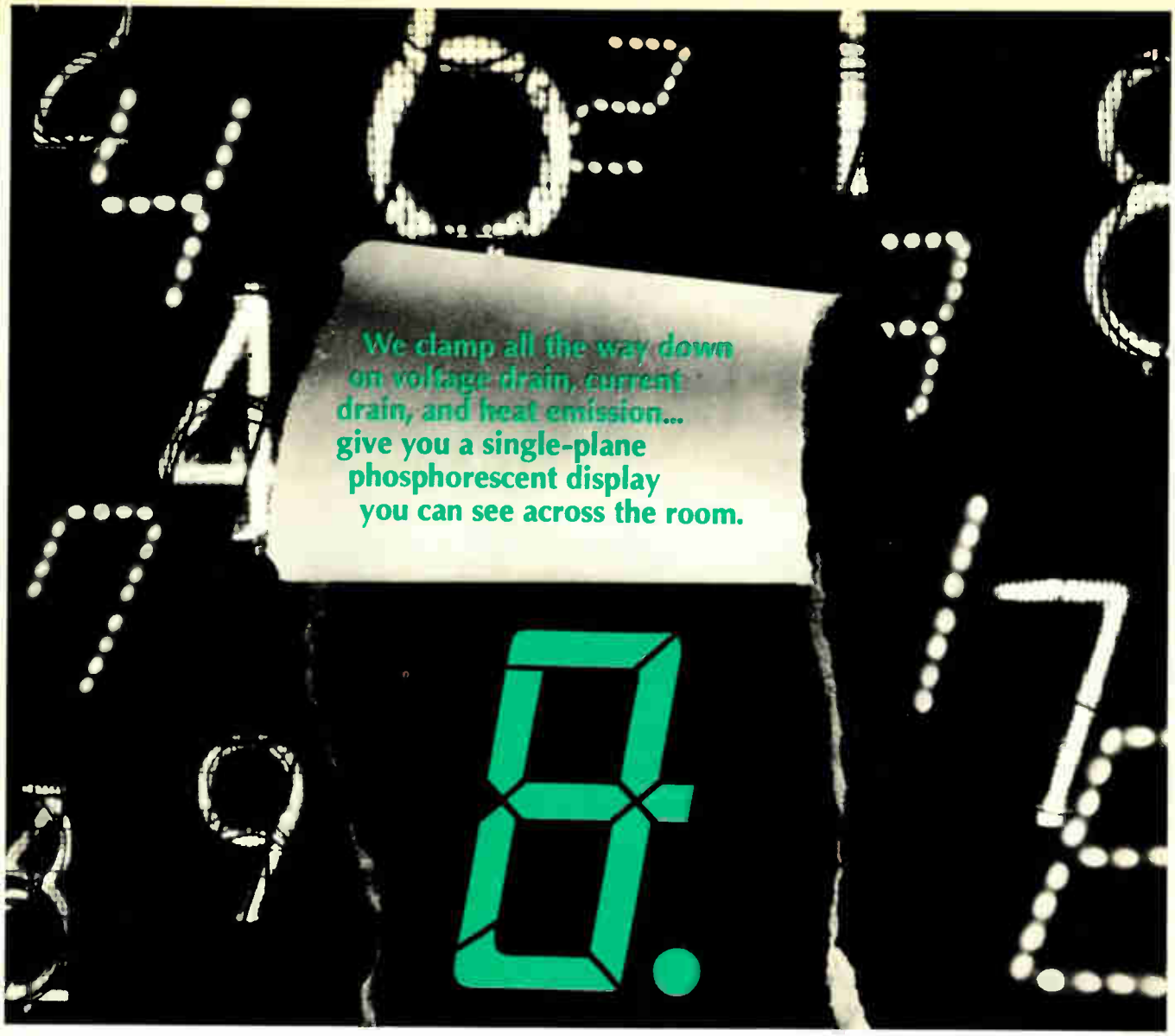

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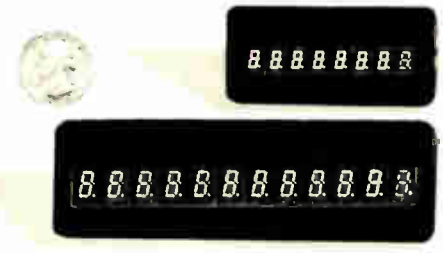

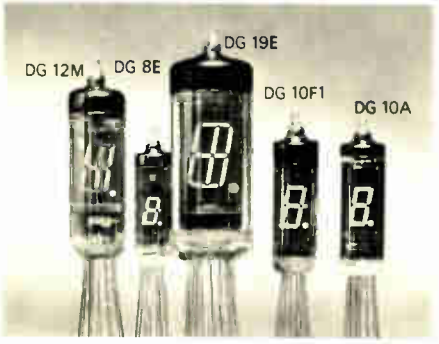

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FCC domsat decision leaves Comsat a winner

Corporation may go into both 'retail' and 'wholesale' domestic satellite business with MCI, Lockheed, AT&T

Ever since the Federal Communications Commission announced its policy for domestic satellite (domsat) systems last summer, [*Electronics*, July 3, 1972, p.72], the important question was how it would decide complaints by Communications Satellite Corp. (Comsat) and American Telephone & Telegraph Co. that they were being unfairly restricted. The answer came just before Christmas when the commission opened its bag of surprises to reveal its far-reaching decisions that:

- Comsat is no longer confined to choosing either a retail system or serving AT&T and other carriers as a carrier's carrier. It may team with Microwave Communications Inc. and Lockheed Aircraft Corp. to operate an end-to-end retail domsat while also operating a wholesale system for AT&T. Here, the FCC persuaded itself that it was bad to have Comsat own and operate a retail system plus one for AT&T, but it was good to have Comsat as a one-third partner with MCI-Lockheed while serving AT&T.
- To permit other companies to start up, AT&T is still restricted from offering any private-line service except to the Government for three years after the first operational domsat. But what's more, it must give up its three seats on Comsat's 15-man board and submit to the commission a plan detailing how it would divest or reduce its 29% share of Comsat stock.

Although AT&T president Robert D. Lilley grumbles that the limitation "is an artificial restriction that isn't in the public interest," others read it differently. "Score another victory for Whitehead," comments one industry executive. He alludes to persistent pressure by Clay T. Whitehead, White House Office of Telecommunications Policy chief, both behind the scenes and center-stage, for unrestricted open entry by anybody into the domestic communications satellite market.

Whitehead. The head of the White House's Office of Telecommunications Policy is called the winner again as . . .

. . . **Dean Burch,** chairman of the FCC, and the rest of the commissioners decided to let Comsat become a carrier's carrier and a partner in the operation of a domsat system.

The FCC's unanimous decision allowing Comsat to participate in two systems is a marked change from the 5-to-4 June decision, which would have forced Comsat to choose but one system. Comsat said it was "delighted" with the decision and "welcomes" the FCC's "approving both Comsat's contract with AT&T and its arrangement with MCI-Lockheed."

Now that the last policy questions have been settled, the first applicant could be approved within 60 days, but an operational domsat is still two years away, estimates Common Carrier Bureau chief Bernard Strassberg. Three applications—from Western Union International, General Telephone/Hughes, and AT&T/Comsat—are being processed now, with the Western Union International proposal (for which the company already has contracted with Hughes for satellites) furthest along. "The rest are down the road a ways," says one member of the commission staff.

As for using the Canadian Telesat system as a stepping stone for a domsat [*Electronics*, Aug. 28, 1972, p. 32], the commission said that it

would treat those applications on an individual basis.

But the answer to one big question engenders another one: How many domsats will there be, and who will operate them?

"Technically, we're fine. We can fit them all in," says an FCC staffer. "But the economics of the marketplace is the main problem. With some of them proposing smaller systems now, there may be several, after all." □

Companies

Goldmark turning vision into profit

One year after retiring from CBS Laboratories and forming Goldmark Communications Corp., Stamford, Conn., Peter C. Goldmark has put his R&D firm into the black. With 80% ownership by Warner Communications Inc., GCC has concentrated on the parent company's interest in cable television.

The company has also pursued Goldmark's major dream, the New Rural Society, via a national pilot study being conducted under a grant to Fairfield University in Connecticut to develop a new pattern for rural development. The grant is from the Department of Housing and Urban Development. The concept involves a pattern for urban living, for Goldmark dreams that a completely different community can be formed around modern communications centers, using cable-TV, facsimile, and video-recording equipment.

The idea is to relocate the population away from cities and their equally troubled suburbs and form smaller units that can deal with their own needs. The mortar for this new structure will be broadband communications that link individual households with a communications center in each community and with the outside world.

Goldmark acknowledges that this is a long-range project. Such a change will probably require a gen-

Hogan says boom is 'fantastic'

The magnitude of the current surge in semiconductor sales [p.76] is only now becoming clear, and its impact on even such a bullishly effusive executive as C. Lester Hogan is remarkable. Hogan, president of Fairchild Camera and Instrument Corp., Mountain View, Calif., speaks both emphatically and with some awe about the outlook for the semiconductor industry and Fairchild Semiconductor.

"This isn't a boomlet—it's a boom," he says. "It's just fantastic. There may be some buying for inventory, but if all that quits, we still won't be able to keep up." Hogan sees two reasons for the breakneck sales pace, which brought three successive profitable quarters for Fairchild through the first nine months of last year and undoubtedly produced a fourth in the period ended Jan. 1. The profits are welcome after Hogan's prolonged, frustrating struggle with red ink.

The obvious reason Hogan cites for renewed strength in semiconductors is a boost in the over-all economy. He predicts that 1973 will be the best year for U.S. business in the last 20. Less readily apparent is the difference in this boom from previous cyclical hikes in semiconductors, in Hogan's view. Says he, "Applications for semiconductors are coming on-stream that people predicted 10 years ago, and we're even stunned at the pace."

Two lucrative business opportunities that Hogan expects for Fairchild Semiconductor are in cameras and automobiles. Fairchild is under contract to Polaroid Corp. to produce what Hogan calls "the most complex linear ICs ever built in the world" for the SX-70 camera. And he's convinced that Fairchild Semiconductor has the inside track for an electronic-ignition system in General Motors cars after recently winning a development contract worth about $500,000.

Hogan says the Polaroid and GM efforts are typical of the contracyclical nature of the volatile semiconductor business. Both are in markets that Fairchild Semiconductor, with its earlier heavy emphasis on the computer mainframe business, hasn't been in before. Polaroid is "likely to be the largest customer of Fairchild in 1973," Hogan notes.

He looks for auto makers to be "large customers" for semiconductor houses this year, and while he cautions that Fairchild Semiconductor is nowhere near a production order for the GM electronic-ignition system, he understatedly admits to being "a little bit excited about it because it will be big business if we perform well in development."

The FC&I president further admits to having sacrificed some of Fairchild Semiconductor's ability to supply some of its standard products in order to serve those two big customers. "They soaked up a lot of resources," Hogan says, "but a lot of that development is behind us now, and some of those resources are ready to be turned back to standard products."

Regarding the steam in the present surge, Hogan foresees no chance of an overcapacity in semiconductors for at least two years. "There's no way there can be a downturn in '73 or '74. Cameras, watches, and calculators are all new on top of the base business that was highly computer-oriented."

Hogan looks for a good 1973 among large-mainframe houses, and any new business generated as a result "will come on top of everything else we have," he opines. He adds further that Fairchild Semiconductor's backlog is too great for current capacity to meet. Additional facilities are being added.

Meanwhile, Fairchild customers, like those of most other semiconductor manufacturers, will have to stand in line.

eration to accomplish, he points out. Nevertheless, one of the first steps next year will be creation of a community communications center, what Goldmark calls a new "village green" for the HUD project. Here rural residents will have a television theater to produce and receive shows. It will also provide experimental electronic mail and a library of educational videotapes.

GCC, which now has 50 to 65 employees, has also worked on near-term projects generated by its relations to Warner Communications. One result of this relationship has been an inexpensive videotape cassette, called Star Pak. The cassette is a means of circulating broadcast-quality programing among CATV operators for program-origination channels. The first of these cassette systems is in use by one of Warner's cable operations.

Another development by GCC is a device to improve picture quality of video cassettes by automatic skew correction. The device, which monitors video signals as the magnetic tape moves through the video player, detects timing errors caused by tape shrinkage or stretching and continually corrects the tape tension as picture images are fed to the TV screen. As part of these projects, GCC has also developed a top-quality video transfer system that reprograms all types of film and video tape into the Star Pak cassette format.

While Goldmark has become known primarily for his way-out planning for the New Rural Society, he's just as concerned with improving present-day communications. GCC will be working on means of improving picture quality of cable installations, as well as expanding services available on both one-way and two-way cable. Television broadcasting, he observes, long has been criticized for isolating people, but with cable services, TV now can play a role in bringing people together in a community.

"I hate planning," the 66-year-old researcher states. "I feel, 'let's do it and show it.' Let's use the inventions we have, instead of spending all funds on new inventions."

Asked why he passed over the opportunity for a $90,000-a-year post-CBS Labs job as the CBS corporate scientist, he remarks, "I had no lab, no people. No project can be carried out without people." □

Doer. Peter Goldmark hates planning, simply wants to do it and show it.

Government electronics

Ship projects get under way

The U. S. Maritime Administration plans to issue requests for proposals early next year for prototype L-band shipboard antennas as part of a diverse program to bring more electronics aboard ships. In churning ahead with a cargo of automation, communications, and navigation development projects, the agency is aiming for a highly automated merchant marine linked with satellite communications [*Electronics*, March 27, p. 68].

Sniffing several potential markets, industry has high interest. "We received 30 responses on requests for sources" on the antenna prototype, says Harry A. Feigleson, program manager with the advanced navigation and communications program. The project's cost cannot be told now, he says, but the agency will look at "a couple of kinds of antennas with different gains."

The Maritime Administration also plans to take a good look at the use of radar transponders on ships for better tracking. Conceptually similar to the airborne use of transponders, the prototype system would cost about $300,000, Feigleson says. Chief aim of the program would be to find out how to identify a ship by interrogation. Also, the agency wants to see whether the system can be used "to send very limited messages" over the radar system, he adds.

An ongoing program to improve vhf communications on the Great Lakes will enter its prototype phase next year. The $400,000 digital system will give ships a push-button dialing capability to talk with anyone through a single shore station, Feigleson explains.

Development of collision avoidance systems will continue with work on logic and threat analyses. This concept digitizes information on a ship's radar scope, and transmits it to a shore station where a computer assesses dangers from many ships' inputs. "The major problem is to reduce the data flow to something reasonable," Feigleson says, noting that raw video needs 12 megahertz though there's only 7.5 MHz in the whole maritime frequency allocation. The problem will use a shore simulation and a test ship. Applied Information Industries has a development contract.

An integrated conning system is being built into a U. S. merchant ship, says Gene St. Germaine, senior project engineer. The "centralized, one-man bridge" will use the Navy's Transit navigational satellite to perform collision avoidance and navigation. Designed by Marine Digital Systems, Plymouth, Mass., the $400,000 prototype uses two Digital Equipment Corp. PDP-8 computers. "We're pleased with the experience," says St. Germaine. The system could become "a module for a potential fully automated ship."

Also to be installed on a merchant ship next year is the vibration and deviation concept, known as Videc, built by Raytheon's Submarine Sig-

nal division and designed at the State University of New York. The $750,000 system will monitor the ship's performance by sensing vibration, temperature, and efficiency of the propulsion system. □

Management

EIA eyes structure as Fairchild quits

While the New Year begins for the Electronic Industries Association as one of over-all organizational reappraisal, most of the agonizing will be limited to the Solid State Products division (SSPD). It is SSPD that has been hardest hit by the resignation of Fairchild Camera and Instrument Corp., effective Jan. 1, the second major semiconductor house to quit. Texas Instruments was the first [*Electronics*, Sept. 11, 1972, p. 25).

With the loss of both Fairchild and TI, accounting for 35% to 40% of the U.S. domestic IC output, EIA "cannot possibly continue to issue industry reports" on production in the market, says division staff vice-president James Conway. "It is a major blow to our statistical base."

The loss is also a major blow to SSPD's dues base, since both companies were paying the maximum—about $16,000 a year—plus additional fees for services. They also contributed free services of a large number of professionals to EIA committee staffs. In addition to contributing the services of Tom Hinkelman, its Microwave and Optoelectronics division marketing chief, as SSPD chairman, Fairchild had "significant representation at all levels of activity," says Conway. He is now drawing up alternatives for a division meeting, to be chaired by Hinkelman's successor, former vice-chairman Frank E. Jaumot Jr. of General Motors Corp.'s Delco Electronics division.

The Fairchild decision, announced by C. Lester Hogan, president and chief executive, came as a shock at all levels of EIA. The trade group viewed the statement as a reversal of Fairchild's position at the EIA November meeting at Beverly Hills, Calif.

Issues. Ironically, neither Fairchild nor TI resigned because of dissatisfaction with EIA's successful statistics program. Both companies cited EIA's inability to take a strong stand on free trade because of the diversity of members' interests. The EIA has, in Hogan's view, "evolved into an organization representing different segments of electronics, with varying objectives. We, therefore, feel it does not effectively represent the views and interests of high-technology industries in the U.S., particularly with regard to such issues as free trade." Hogan's statement is remarkably similar to TI's, issued when it left.

The departure of two of the semiconductor industry's "big three" from EIA leaves Motorola Semiconductor as the top member of SSPD, along with 34 others. Although Motorola is sure to remain loyal to the association because of the strong ties to the group of its chairman, Robert W. Galvin, other manufacturers are expected to drop out, say EIA insiders. National Semiconductor, though not a member company, has participated in the statistical program, but has reappraised its position.

Reappraisal. But the toughest assessment of EIA's future makeup now falls on Motorola president William Weisz's ad hoc committee set up at the EIA Beverly Hills meeting "to investigate the present makeup and relationship of the board of governors and the officers' structure within the association." Serving with Weisz as chairman are EIA vice-presidents from member companies, representing each of the association's divisions.

Specifically, the Weisz committee will examine the possibility of keeping top industry executives in EIA leadership roles for three years by creating a vice-chairman of the board. By limiting the chairman's role to one year, instead of two, the vice-chairman could then succeed to the chairmanship, while the chairman moves on to become chairman of the executive committee.

Fundamentally, what Weisz's group must address are complaints that EIA's management structure is too unwieldy with its 54-man board and 18-man executive committee; that there are too many "at-large" members and that they, representing old-line EIA members, serve too long and come to exercise too much influence over association policies.

Rumbles that solid-state-product makers would form a new association get short shrift from most manufacturers. □

Reorganizing. EIA committee under Motorola's Weisz is looking at top structure.

Industrial electronics

IR systems may enter machine shop

Two new applications for passive infrared sensing could mean more reliable, and perhaps less costly, automobile engines. As a result, machine shops and machine tools may be among the newest important markets for IR systems.

Riccardo Vanzetti, president of Vanzetti Infrared and Computer Systems Inc. of Canton, Mass., says the reason is the ability of IR sensors to "look" where other temperature sensors cannot. In one application, after camshafts have been ground to specifications, they are hardened for improved wear in an induction furnace. In another, the temperature at the very edge of a metal lathe's cutting tool is monitored to cut wear and boost output.

An induction furnace is a coil

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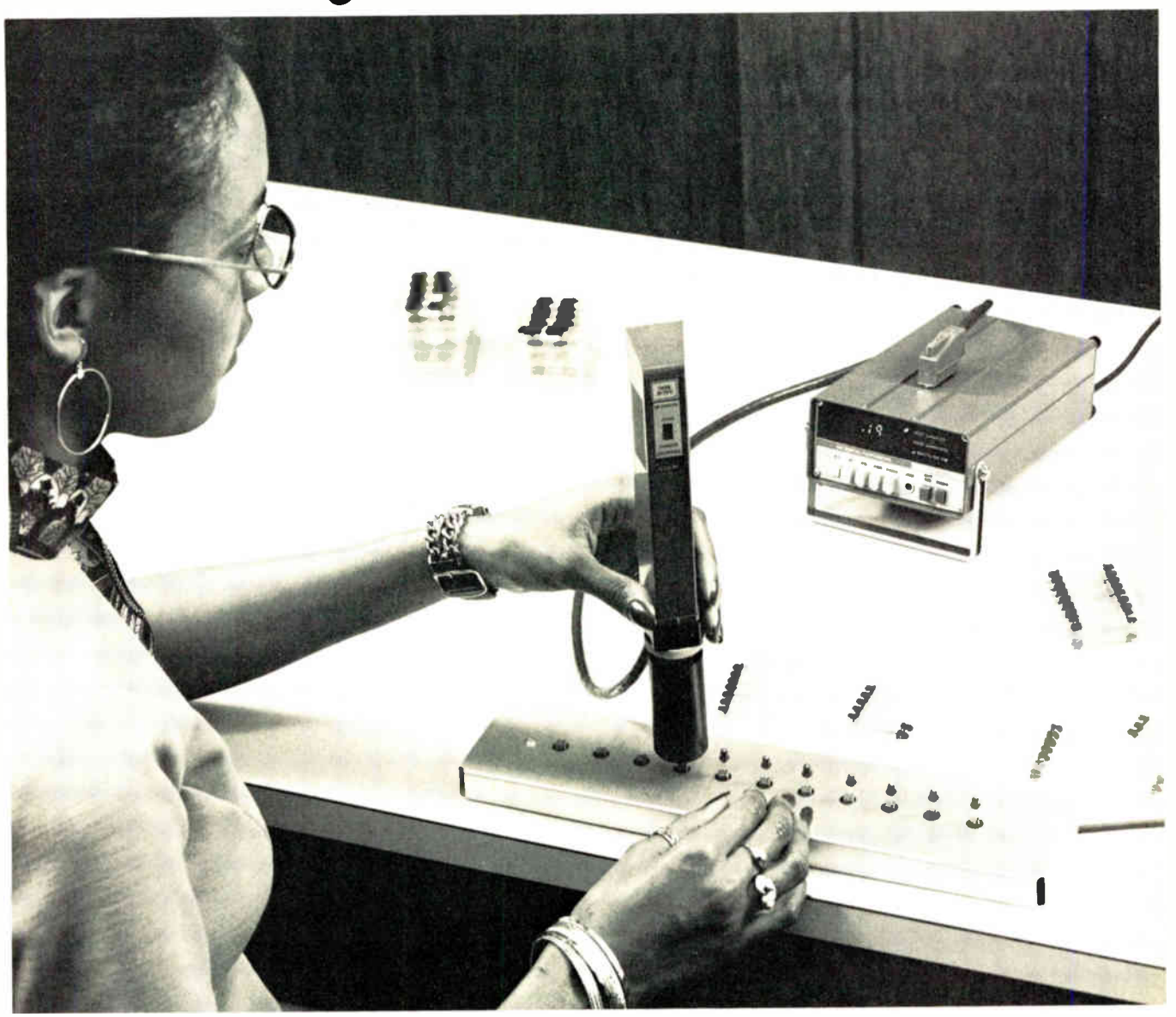

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through which high-frequency electromagnetic alternating current is passed, and its electromagnetic field heats metal moving through the coil. But temperature is hard to monitor. Because thermometers and thermocouples are themselves heated by the 10-kilohertz field, they can give inaccurate temperature readings. And in the camshaft operation, the relatively small size and the movement of the shaft about its axis and through the coil makes use of a pyrometer difficult if not impossible.

Together with the Atlas Crankshaft Co., a Detroit subcontractor, Vanzetti Infrared has developed a system to monitor temperature to within a few degrees and at the same time to act as a sensor, supplying a servo error signal to the furnace controller.

The cams rotate at 30 revolutions per minute as they pass through the field, and their temperature rises in 21 seconds from ambient levels to about 1,750°. It's held at that level for a minute; then, after a short pause, it's quenched in 19 seconds.

Long reach. To avoid the problems encountered by previous temperature sensors, the new system places a detector diode at a distance from the furnace and extends a ceramic-sheathed fiber-optic bundle into key locations. The combination of glass and ceramic isn't affected by the field; thus it can reach into areas where temperature-monitoring hasn't been possible before. The remote-sensing unit can be calibrated to high accuracy.

The result is a camshaft with its surface hardened to depths from 1/80,000 to 0.25 inch, as required for maximum durability. Heretofore, the line between hardness and brittleness has been a fine one, and heat treatment is almost an art. But with their system, both Atlas and Vanzetti expect more accurate production control and lower reject rates.

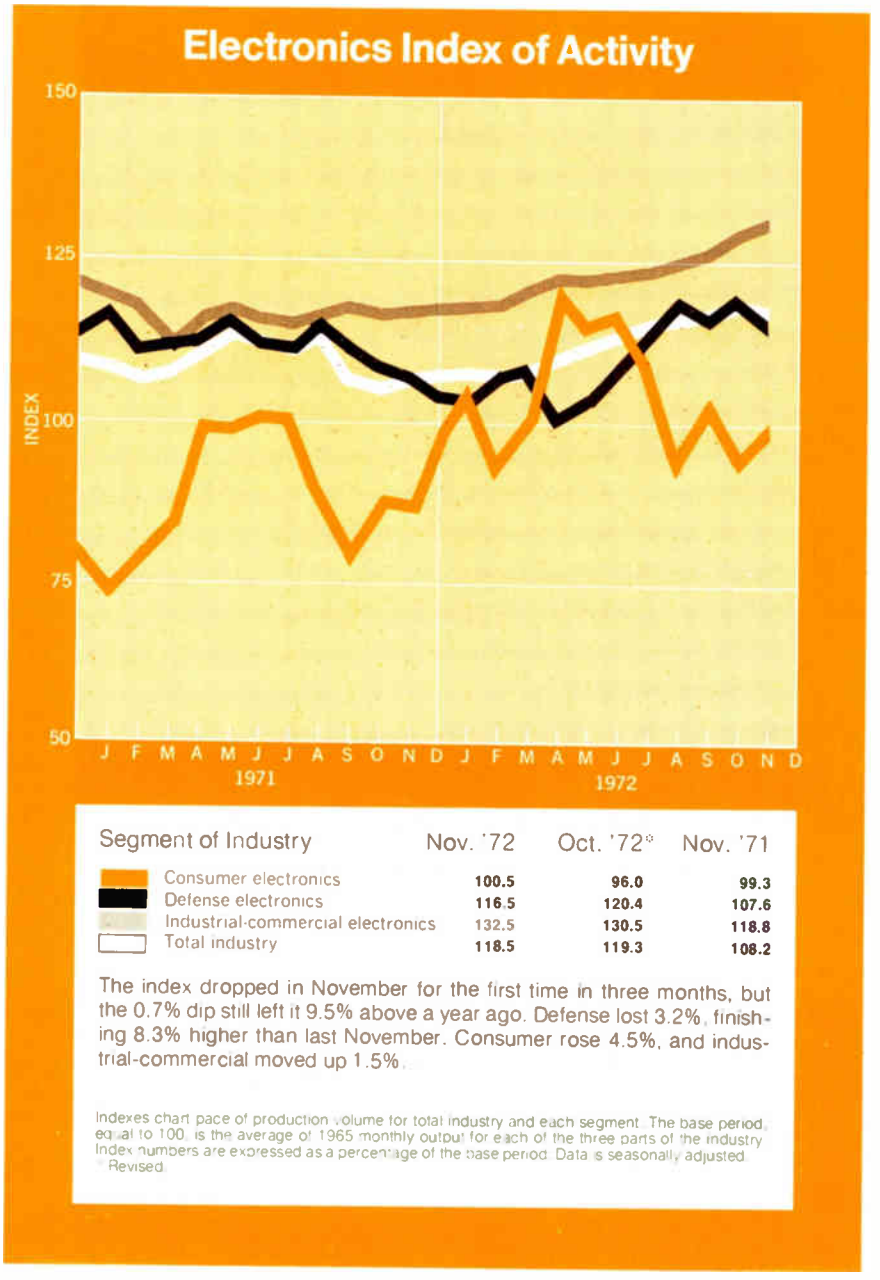
But before hardening, a piece of metal must be machined. In any machine shop, a controlling output factor is the edge temperature of metal cutting tools. If the temperature is too low, the machine should be operating faster, and throughput is artifically low. If the temperature is too high, the tool will quickly dull, and it must be removed and be resharpened, which again lowers shop throughput. Between the extremes there is an optimum temperature for any given combination of metals and cutting speeds; the trick is to hit it and stay there.

With some new lens-equipped fiber-optic bundles, or with other bundles aimed right at the cutting edge, real-time temperature measurement is simple and perhaps realistically possible for the first time. Firms as large as General Motors now are said to be logging data to determine best tool temperature for various metals, lathe speeds, and cutting rates. □

Commercial electronics

LEAA charts development plan

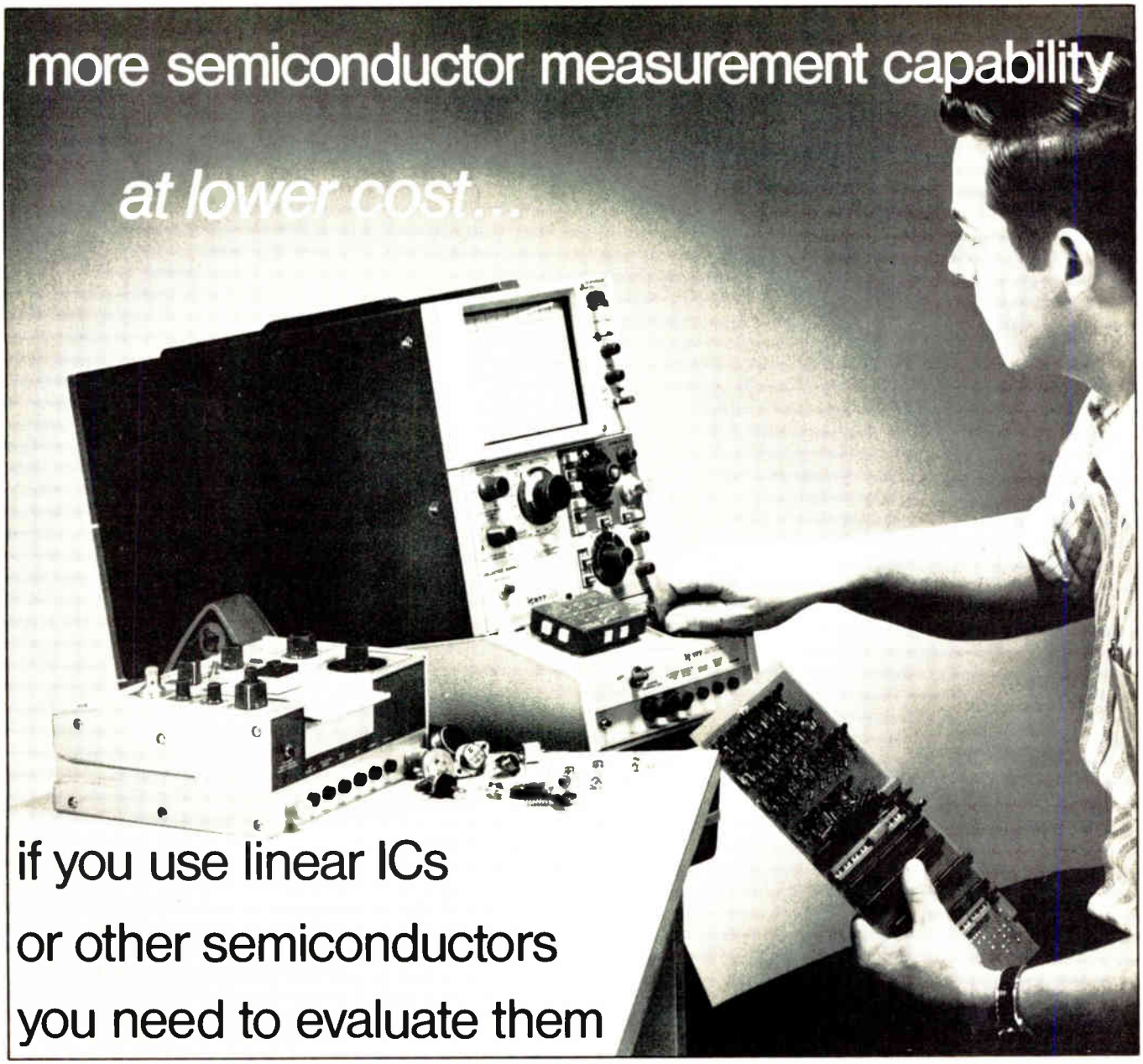
It took the Law Enforcement Assistance Administration (LEAA) a little while to draw up its shopping list of hardware development [*Electronics,*



Segment of Industry	Nov. '72	Oct. '72*	Nov. '71
Consumer electronics	100.5	96.0	99.3
Defense electronics	116.5	120.4	107.6
Industrial-commercial electronics	132.5	130.5	118.8
Total industry	118.5	119.3	108.2

The index dropped in November for the first time in three months, but the 0.7% dip still left it 9.5% above a year ago. Defense lost 3.2%, finishing 8.3% higher than last November. Consumer rose 4.5%, and industrial-commercial moved up 1.5%.

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.



The new TEKTRONIX 577 Curve Tracer offers a better way . . . Measurements of both linear ICs and discrete semiconductor devices can now be made with this single, versatile, self-contained system.

This extended capability is contained in a small, modular package consisting of storage or non-storage display modules, easy to use mainframe and versatile plug-in test units.

Many previously difficult measurements become convenient to make with split screen storage display capability. For instance, you can compare the characteristics of one device with another, or view changes in a device's characteristics while varying operating conditions or temperature.

The 177 Standard Test Fixture plug-in adapts the 577 mainframe to display characteristic curves of devices such as: transistors, FETs, tunnel diodes, SCRs and Zener diodes.

Measuring parameters of linear ICs such as op-amps, diff-amps, comparators and regulators becomes an inexpensive, simple task when using the plug-in 178 Linear IC Test Fixture.

Think about the value of IC characteristic curves, quickly plotted over a range of inputs, not just one point. These curves with their thermal effects, phase-shift and noise are dynamically pictured on the CRT; not hidden from you as with metered testers, digital readouts or go, no-go indicators. System prices; from $1850 to $3200.

For technical data and measurements information contact Tektronix, Inc., Box 500, Beaverton, Oregon 97005 or call 503-644-0161.

TEKTRONIX®
committed to technical excellence

For a demonstration circle 38 on reader service card

Circle 39 on reader service card

Aug. 14, p. 42], but now armed with new fiscal 1973 funds, the agency's research and development arm is speeding ahead with top-priority electronics projects. The results promise new technological markets here and abroad as well, according to George D. Shollenberger, program manager in the Equipment Development group of the National Institute for Law Enforcement and Criminal Justice (NILECJ).

LEAA soon will ask industry what companies have resources to develop a remote vehicle-disabling system to stop fleeing cars. After evaluating the responses, the agency quickly would issue requests for proposals for a first-phase $50,000 study contract, followed by a prototype-development contract.

A contract to develop a low-cost home-security system is about to be let through the Aerospace Corp., El Segundo, Calif., which manages the NILECJ hardware development. As Shollenberger describes it, the passive detection unit would use a home's existing electrical wiring to transmit the alarm to a police station. An intruder would trigger the sensor and change the electrical system's impedance, thus signaling the intrusion.

The system would consist of four elements: the sensors, the internal communications using the wiring, a controller to monitor the impedance, and a device to transmit the signal, such as an automatic telephone dialer. The contract to be let is a six-month, $60,000 effort to look at the internal communications. Another contract to study sensors will be let in the spring. LEAA wants a family of modules for the high-reliability system so that a small home or an estate can afford one.

Portable. A new project is a portable citizen's alarm. Now in a $20,000 in-house study by Aerospace Corp., the program could move into development of hardware. Other electronic devices Aerospace is charged with developing are: both automatic and simplified drug-analyzing equipment, narcotics detection equipment, body-mounted police-radio antenna, and anti-truck-hijacking equipment. A possible future project is creating window glass with a conducting surface so that burglars couldn't cut glass around alarm wires.

Voice-identification technology will be the next development area, Shollenberger says, after LEAA approves the requested $500,000 allocation, biggest in the R&D shop. Designed for home and business security systems, as well as crime prevention, the voice-identification projects would include computer-aided and holographic techniques. Development contracts would go out to industry when the programs are approved, he says.

"We'd like to get into real time," Shollenberger comments. "It would aid security systems because you could have voice-actuated locks." No one would have to carry identification cards or keys, he adds, and it would ease credit checks as well. Ultimately, LEAA would like to so refine voice characteristics that a voice-identification file, based on components of speech, similar to the FBI's fingerprint file, could be assembled. □

Lasers

Laser beam guides mine vehicle

The Bureau of Mines is evaluating a laser-based alignment system designed to keep a continuous-mining machine correctly positioned and on course as it cuts and batters its way through coal seams. Developed by Bendix Research Laboratories, Southfield, Mich., the experimental alignment system results from the bureau's three-year-old effort, dictated by the Federal Coal Mine Health and Safety Act of 1969, to make mines safer.

The system itself is "not unusual in terms of technology," points out Louis C. Paine, Bendix's program manager. Rather, the design exemplifies how technology developed to solve problems in space can be applied to industrial problems.

A continuous-mining machine employs a heavy rotating drum studded with cutting bits that smashes at the coal face. The loosened coal is then carried back behind the machine on a conveyor belt to a point where it can be taken in cars to the surface. Typically, the machine costs more than $225,000 and carries a drum that's about 10 feet long and 2½ feet in diameter.

Such machines need operators to steer them. These men must sit far enough back from the coal face not to be endangered by falling coal, or by the collapse of an undermined roof. Consequently, the mining machines may be thrust forward only about 20 feet before they must be pulled out and the roof shored and bolted securely, Paine explains.

But with the laser system helping to position the mining machine, it may be possible to place the operator so far back that the machine could be thrust forward 100 feet.

The Bendix system uses an ordinary 3-milliwatt helium-neon laser located back down the mine corridor and aimed at the coal face. It can be fastened to the roof and aligned with the aid of a transit. The visible red beam thus establishes a path along which the mining machine must travel.

On the rear of the machine is a horizontal line of seven photodetectors mounted on 2-inch centers to pick up the beam. Because the mine floor is usually far from level, the beam is elongated by lenses into a vertical ellipse that's up to 6 feet high and only 1 inch wide. This helps ensure that beam will strike the detectors, regardless of the dips in the mine floor.

The detectors, together with the electronics to compute the mining vehicle's displacement and azimuth errors from the detectors' output signals, are battery-powered. So is the laser. System accuracy is on the order of 1 in. in a distance of 1,000 ft, according to Bendix. Azimuth error is obtained because the detector output is proportional to the angle the plane of the laser beam makes with the light-detecting element, Paine points out. Both parts of the system are positively vented to keep out the omnipresent dust. □

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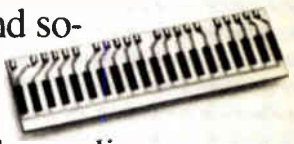
More than a couple of couplers.

We're probably best known for our top quality optical couplers — the RAYSISTOR™ line. But we offer a great deal more in high performance, special purpose commercial optoelectronics.

Almost 50 standard discrete photocells, for example. Or custom-designed photoconductive arrays with an almost limitless number of cells per substrate. Or the fact that, as a major supplier of high reliability military microelectronics, we put this experience and sophisticated production technology into our high performance commercial opto line.



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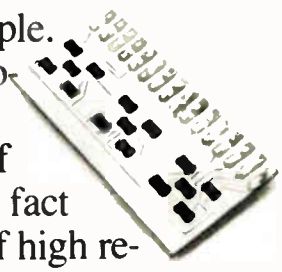

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RAYTHEON

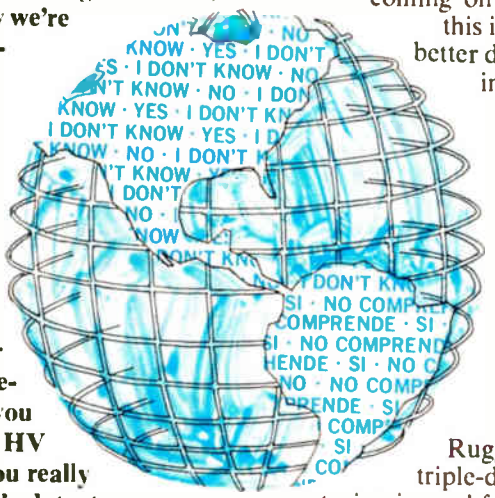
Circle 41 on reader service card

High-Voltage

...the universal answer?

We've got more power Darlingtons than anyone else. First to introduce them. First to offer complements. First to do what they said couldn't be done — single-diffused, UniBase† power Darlingtons. Now we're offering high-voltage types in state-of-the-art, triple-diffused, etch-cut technology.

Impressive, you say. "I can use high-voltage power Darlingtons right now to get a competitive edge in my equipment market."



Hold on. Maybe one of the other high-voltage techniques, in a discrete device, would be a better answer. Double-diffused or triple-diffused Annular.° And unless you understand the basics of all three HV technologies you won't get what you really want — an optimum device matched to true design needs, with the best tradeoffs in device characteristics.

Lots of designers are edueating themselves before using any process. Questioning and comparing to find out which is best for their needs. Studying. Checking. Challenging.

"Why should structure make a difference?"

"Which is best for high-speed inverters?"

"Are there SOA tradeoffs?"

"Can I get high-voltage and high-current in one?"

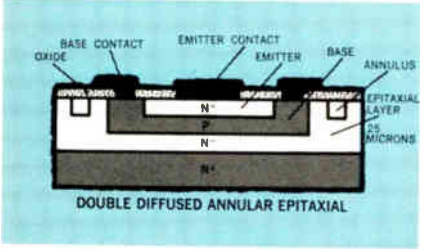
"What about complementary designs?"

If you're satisfied with your supplier's answers, your education, your design, fine. If not, listen.

YOUR POWER STRUCTURE . . .

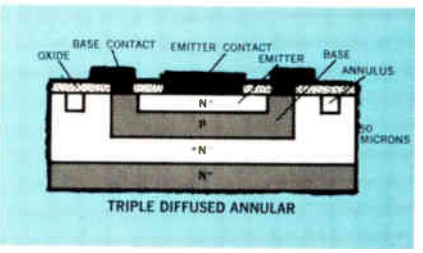
Know it before you use it.

Emitter and base on old-reliable, double-diffused Annular types are diffused into an epitaxial substrate. Devices are characterized by high frequency response, excellent switching efficiencies and complementary capability. The Annular ring retards inversion layer leakage and shapes surface electrical fields eliminating fringing field effects. But inherently narrow base width limits optimum safe operating areas. Result — devices that switch fast at high currents with excellent beta linearity . . . as long as they're not required to operate into overly reactive loads.



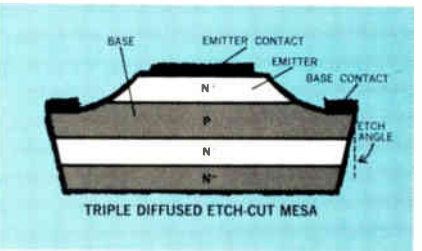
DOUBLE DIFFUSED ANNULAR EPITAXIAL

More sophistication, and more SOA, can be had with triple diffused. The Annular approach is applicable but base, emitter and collector are separately diffused. Collector layer can be ⅓ or more thicker than double-diffused with emitter and base profiles coming on proportionately deeper. Net effect of all this is allowance for wider depletion regions and better defined fringing fields (i.e. higher voltage), increased SOA and moderate f_T. One pays the price with poorer switching efficiency and lower gain.



TRIPLE DIFFUSED ANNULAR

Ruggedness with a reverse twist characterizes triple-diffused, etch-cut technology. Mesa structuring is used for ultra-deep base diffusions. But this precludes use of metal overlays to retard fringing field effects. Etch-cutting from the back side at a precise angle to define the junctions solves this problem and provides high operating voltage and SOA potential.



TRIPLE DIFFUSED ETCH-CUT MESA

TECHNOLOGY OVERVIEW . . .

If you're at home with high-speed, high-current switching, double-diffused can't be beat. Generally, gain linearity with voltage is better, too, with sat voltage coming in low because of limited epi layer thickness. In a high-speed design where most device heat stems from switch losses, it's a mistake to use super-rugged, slow types. Triple-diffused, however, is your best bet where speed and efficiency take a back seat to operating voltage and ruggedness. But the wider the base, the lower the current — and triple-diffused is basically wide-base.

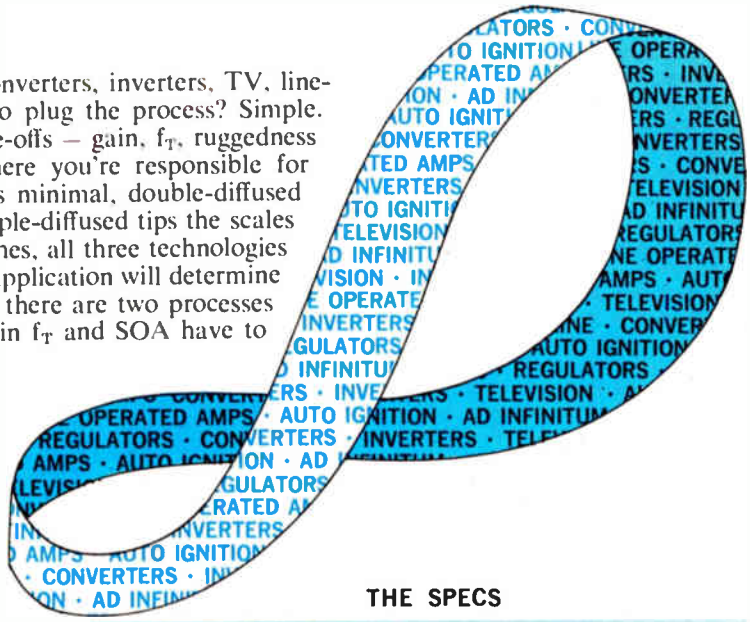
You can't have everything.

Process Characteristic	Double Diffused Annular	Triple Diffused Annular	Triple Diffused Etch Cut
fr	30-80 MHz	10-30 MHz	5-10 MHz
SOA@ 100V	7W	15W	30W
Voltage	20-300V	40-1000V	To 2000V
Current	100A	20A	20A

Power Darlingtons

THE APPLICATIONS . . .

High voltage is everywhere and more! Regulators, converters, inverters, TV, line-operated amps, auto ignition, ad infinitum. Where to plug the process? Simple. Follow our recommendations: we've factored in trade-offs – gain, f_T, ruggedness and breakdown voltage. In pulse mode designs where you're responsible for fast-changing load conditions and junction heating is minimal, double-diffused is desirable. As you go up the voltage/SOA ladder, triple-diffused tips the scales in its favor. In some cases, such as high voltage switches, all three technologies will fill the bill—and the speed/SOA demands of your application will determine your choice. HV complements can be had too – but there are two processes involved that must be matched and slight variations in f_T and SOA have to be considered.



Application	PROCESS		
	Double Diffused Annular	Triple Diffused Annular	Triple Diffused Etch Cut
Series Pass. Regulator			●
Inverter			●
TV Deflection			
Small Screen		●	
Large Screen			●
Auto Ignition		●	●
High Voltage Amplifier		●	●
High Voltage Switch	●	●	●
Power Switch			
Slow			●
Medium Speed		●	
Fast	●		

THE PACKAGING . . .

For your optimized form factor: plastic discretes, metal TO-66 and TO-3 discretes, plastic and TO-3 Darlingtons, plastic and metal discrete complements. For your optimized cost factor: HV prices start at 65¢, 100-up.

THE DARLINGTONS . . .

It's been said before – Monolithic power integrated circuits with revolutionary new levels of super-high gain, direct logic-to-Darlington interfacing, simplicity, cost-savings. It bears repeating. Now all the advantages are there in triple-diffused HV Darlingtons. Depending on your conclusions and your needs, your choice will be Darlingtons or discretes, in the technology that fits best.

Draw those conclusions now. Match your design need with an unmatched high voltage power capability. Write us at Box 20912, Phoenix, AZ 85036 – contact your Motorola distributor for prototype or production.

Motorola is the source for high-voltage power.
No question about it.

THE SPECS

. . . NEW HIGH-VOLTAGE DISCRETES

DEVICE	BREAKDOWN VOLTAGE	SAFE OPERATING AREA	FREQUENCY
2N6306-8 Triple-Diffused Etch Cut	500-700V	250V @40mA	5 MHz
MJ7160, 61 Triple-Diffused Annular	300, 400V	100V @200mA	30 MHz
2N6277, 81 Double-Diffused	150V	10V @20A	30 MHz

. . . plus a choice between these HV discretes

2N3439 40	2N5838-40	MJ701	MJ3430
2N3738, 39	2N6233-35	MJ704, 721	MJ4645-48
2N3902	2N6259, 62	MJ702, 723	MJ9000
2N4240	2N6341	MJ1800	MJE341, 344
2N5051, 52	MJ105	MJ2251, 52	MJE350
2N5157	MJ400	MJ3010-12	MJE2160
2N5241	MJ410, 411	MJ3026, 27	MJE2360
2N5344, 45	MJ413, 423, 431	MJ3028-30	MJE3439, 40
2N5555, 56, 57	MJ420	MJ3201, 02	MJE3738, 39
2N5655-57	MJ424, 425	MJ3260	MJE5655, 56,57

. . . NEW HIGH-VOLTAGE DARLINGTONS

MJ3040-42 Triple-Diffused Etch Cut	400-500V	300V @40mA	5 MHz

. . . NEW HIGH-VOLTAGE COMPLEMENTS

2N3583-85 Triple-Diffused Annular NPN MJ3583-85 Double-Diffused PNP	175-300V	70V @500mA	15 MHz 30 MHz
MJE340 Triple-Diffused Annular NPN MJE350 Double-Diffused PNP	300V	250V @15mA	15 MHz 30 MHz

MOTOROLA POWER
—Technology By Design, For Design

*Patented Process of Motorola Inc.
†Trademark of Motorola Inc.

INTEL MICRO

MAKE POINT-OF-SALE TERMINALS

Staid, Inc. of Casselberry, Florida is using Intel micro computers to build advanced point-of-sale terminals for a large chain of cafeterias in the Southeast. Operated by the cashier, the terminal automatically enters item prices, totals items, adds taxes, prints a sales slip, dispenses change, adjusts the inventory of each item as it is sold, and transmits all this information to corporate headquarters. It can handle 100 separate items and is expandable to accommodate 200.

Staid says the Intel micro computer on only two PC cards does the work of about a dozen cards of random logic, and increases estimated reliability by an order of magnitude. Cost reduction, compared to random logic, is estimated to range from 20% to 30%.

Since the micro computers are programmed by Intel PROMs, Staid can produce point-of-sale terminals for the other types of businesses that have different requirements without redesign. They simply change the PROMs to make the terminal perform according to the new customer's requirements. Obviously, this saves a lot of money and enables them to deliver systems soon after receipt of order.

MAKE COMPACT BUSINESS MACHINES

This general-purpose data processing machine for small businesses is built by Omni Electronics using an Intel micro computer as the heart of the system. Suitably programmed, this machine will tabulate accounts, type invoices, write checks, and even produce personalized form letters.

Omni says they saved about $3,000 by using an Intel micro computer in place of a mini. Moreover, the micro computer enabled them to reduce the whole system to typewriter size.

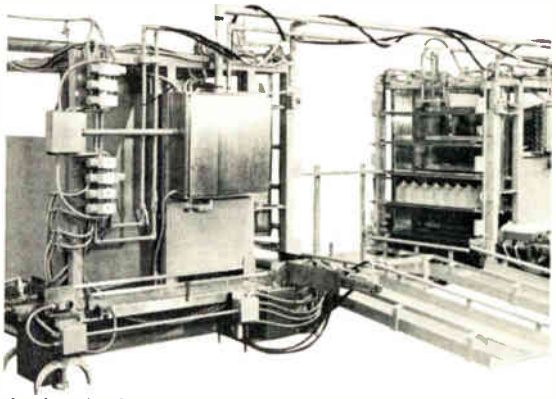
They say the micro computer has even more speed than they need, and offers the extraordinary reliability they require in this application.

In addition to the Intel integrated CPU, which does all central processing, the machine uses Intel's electrically-programmed PROMs for bootstrap programming and Intel's 2102 N-channel 1024-bit MOS RAMs as the central memory, a memory which stores up to 16K 8-bit bytes. Peripheral memory is supplied by one to eight Omni tape decks, which store 15,000,000 bits per cartridge.

THIS SUPPORT MAKES SYSTEM-BUILDING EASY.

COMPUTERS

DO PROCESS CONTROL



An Intel micro computer does all the thinking for this automatic bottle-loading machine. The micro computer, built by Comstar Corporation of Edina, Minnesota, for Conveyor Specialities, tells the machine how to load bottles of different sizes and when to perform each step in the loading process.

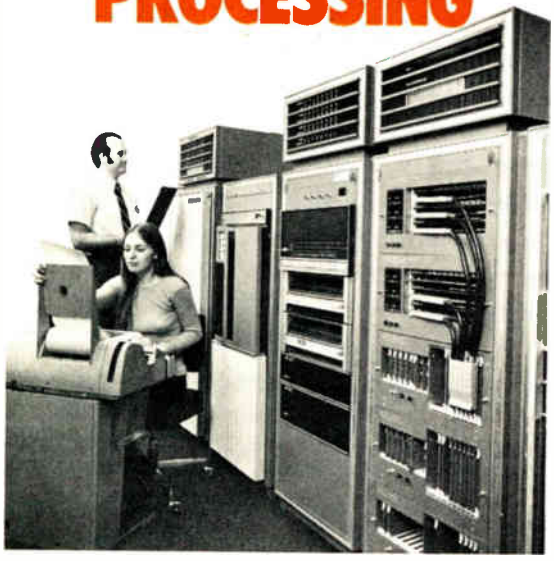
The little computer in a 6" x 6" x 1½" space replaces several racks of counters, timers and relays that would otherwise be required. According to Comstar, the computer's flexible programming is a major advantage. Programs on PROMs can be changed in half an hour.

Comstar estimates that the micro computer halved the cost of the control portion of this system, and reduced the time required to build it by a factor of two or three. The company is now building other types of systems with Intel micro computers, including an automatic meat weighing and packaging machine.

For MCS-4 systems using Intel 4004 4-bit CPU. **1.** Prototyping board that forms functioning micro computer (SIM4-01). **2.** Expanded prototyping board (SIM4-02). **3.** PROM programmer (MP7-02). **4.** Hardware assembler on PROMs. **5.** Hardware simulator on PROMs. **6.** System interface and control module (MCB4-10 or MCB4-20). **7.** Decimal addition routine on PROM. **8.** Fortran IV assembler. **9.** Fortran IV simulator. **10.** User's manual, 115-page. **11.** Library of programs.

For MCS-8 systems using Intel 8008 8-bit CPU. **1.** Protoyping board that forms functioning micro computer (SIM8-01). **2.** PROM programmer (MP7-03). **3.** Hardware assembler on PROMs. **4.** System interface and control module (MCB8-10). **5.** TTY transmit/receive test program. **6.** Chip-select and I/O test program. **7.** RAM test program. **8.** Bootstrap loader. **9.** Fortran IV assembler. **10.** Fortran IV simulator. **11.** User's manual, 76-page. **12.** Library of programs.

DO DATA COMMUNICATIONS PROCESSING



Action Communication Systems of Dallas used Intel micro computers as front-end processors in this high-speed dial-up communications controller built for The Bekins Company.

Action adopted Intel micro computers in order to save both development time and system cost. The Bekins system was fully developed and delivered *only 90 days* after Action decided to use Intel micro computers. And Action estimates they saved about $10,000 in over-all cost.

The Bekins controller, located in Glendale, California, is the heart of a nationwide multi-terminal system that carries administrative messages, financial data, shipping notices and customer inquiries. A micro computer on each of fives lines puts messages in a binary synchronous format, checks for errors, and signals for re-transmission when an error is detected.

Action used Intel's standard SIM4-02 micro computer boards in the system, and did the final programming with Intel's electrically-programmed PROMs. Intel's Micro Computer Systems Group worked very closely with Action in both the design and debugging phases of the project.

intel® delivers.

Circle 45 on reader service card

Two cables. Two minutes. That's all it takes to test a 20,000-point backplane.

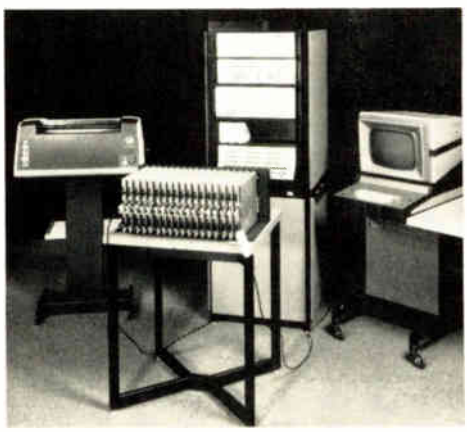
Two little cables are all that connect Teradyne's new N151 Test System to your backplane—whether your backplane has 1,000 or 100,000 points.

In the N151, the pin electronics are on "fixture cards" that plug into your backplane. With two sets of fixture cards, you can be testing one backplane while you're setting up the next one for test. With three sets of cards, you can set up one while testing another while servicing another. The test system is moved from one job to another as fast as you can plug and unplug those two cables.

Now, about the test system itself. It's computer-operated with all solid-state switching, of course. But it requires no programming. You just connect a prototype or a known good backplane and tell the system to learn what's connected to what. (If you already have your own data base, IBM-compatible magnetic tape and translation software are available.) The N151 will then give you a complete connection list to double-check against your drawings. After that, it tests your production backplanes at high speed (typically, two minutes for 20,000 points), reporting all shorts and opens in your own nomenclature on a CRT display or line printer. Programs are stored on magnetic-tape cartridges for quick call-up when you want them.

Price? Less than you might expect for a system that solves the backplane-testing problem so completely.

There's much more to tell about this unique test system, and we tell it in a detailed brochure, yours for the asking. Write: Teradyne, 183 Essex St., Boston, Mass. 02111.
In Europe, Teradyne Europe S.A., 11 bis, rue Roquépine, 75 Paris 8e, France.



TERADYNE

Standards may be key to mass VTRs

Although the Japanese deny consumers are ready for videotape recorders, their standardized approach may give them the edge over noncompatible U.S. systems

by Marilyn Offenheiser, Assistant Editor

U.S. companies say they are about to unlock the door to the consumer videotape recorder market. But the key to that door is likely to be standards, and right now no one, especially a U.S. firm, wants to standardize on anyone else's approach. And it may be premature to dictate a standard.

The major Japanese VTR manufacturers—Sony, Matsushita, and Japan Victor—insist that the mass consumer market does not yet exist. Yet they are shipping hundreds of thousands of units—which are standardized—to the U. S. for commercial, educational, and military applications.

On the other hand, the U.S. companies—RCA Corp., Indianapolis, and Cartridge TV Inc., Palo Alto, Calif.,—believe that each can capture a large segment of the mass market right now, even though their systems are incompatible. Their strategy is to license major TV receiver manufacturers (see table below). And RCA's entry in the consumer market this summer could be a crucial factor in shaking out a standard.

When the idea of home videotape recorders was born in the late 1960s, the industry was permeated by optimism, typified by the catch-phase, "a billion-dollar home industry by 1980." But as technical and marketing problems mounted, optimism waned. The gloss came off the new equipment, and it was the Japanese, led by Sony, that moved into commercial applications.

Progress slow, change inevitable. Since the genesis of the industry, two systems have dropped out of the competition, the Ampex Instavideo and the CBS EVR in the U. S. (it is still being developed in Europe and Japan). For those remaining, the matter of standards has been coupled with the rivalry between U. S. and Japanese companies. Compounding this rivalry is the fact that video disk systems are emerging as a highly favored alternative (see panel).

This squaring off has led some industry insiders to believe that the present lack of a mass consumer market, the lack of an abundance of U. S. hardware, and, above all, a lack of interest by the U. S. on the standards issue, particularly by the Electronic Industries Association, Washington, D. C., will spell defeat for American firms.

However, John Sodolski, vice-president of the EIA's Communications and Industrial Electronics division, contends that the VTR market just hasn't matured to the point where everyone is ready to agree. "We can't force the industry to accept a standard. There are too many competing ideas right now."

Confusion twice confounded. All VTR units use helical scan and magnetic tape, but manufacturers vary the tape width, the number of reading and recording heads, and the packaging format. There are three packaging options: reel-to-reel, cassette (two reels side by side or on

VIDEO TAPE RECORDERS COMPARED

Manufacturer	System name	Tape width (in.)	Tape speed and maximum play time	Type tape	Tape format	No. of heads	Scan	Compatible with:	Licensees	Price (U.S.)
Akai	VT 110 (portable) VT 700 (nonportable)	1/4	80 min	Iron oxide	Open reel	2	Helical	—	—	$940 to $1,700
Cartridge TV Inc.	Cartrivision	1/2	3.8 in./s 120 min	Iron oxide	Cartridge	3	Helical	Among licensees	Dumont Emerson Teledyne Admiral Warwick (Sears) Mont. Ward Philco-Ford	$1,700 max
Matsushita (Panasonic)	NU-5110 NU-2100	1/2 3/4	30 min 60 min	Chromium dioxide	Reel-to reel cassette	2	Helical	Sony Victor	—	$950 to $1,250 $1,100 to $1,375
N. V. Philips (Norelco)	N-1500 (Europe) Norelco VCR (U.S.)	1/2	6.75 in./s 40 min	Chromium dioxide	Cassette	2	Helical	10 European licensees	Shiba	$1,295
RCA	SelectaVision MagTape (for summer '73 intro.)	3/4	3 in./s 60 min	Chromium dioxide	Cassette	4	Helical	Magnavox Bell & Howell Westinghouse Canada	—	$700 (projected)
Shiba Electric (Hitachi)	N-1500 VCR	1/2	6.75 in./s 60 min	Chromium dioxide	Cassette	2	Helical	—	Philips	$775 to $1,650
Sony	U-Matic	1/2 3/4	30 min 60 min	Chromium dioxide	Reel-to-reel cassette	2	Helical	—	Matsushita Victor	$995 to $1,395
Victor (JVC)	U-VCR	1/2 3/4	30 min 60 min	Chromium dioxide	Reel-to-reel cassette	2	Helical	—	Matsushita Sony	$1,400 max

top of each other in the container), or cartridge (one reel in the container, the other in the VTR).

The only attempt at a formal standard was made about two years ago by Japan's EIA-J for reel-to-reel equipment, recommending ½-in. tape, helical scan, 7-in. reels, and a tape speed of 7.5 in. per second. The standard was later extended to include cartridges.

Sony, Matsushita, and Victor have reinforced this standard by recently introducing ½-in. reel-to-reel equipment. At the same time, Sony, Matsushita, Japan Victor, and Nippon Electric have set up their own standard of a ¾-in. tape width, too. Matsushita says it will push ½-in. machines, "but the two should coexist for some time." Masahiko Marizone, Sony's manager of general magnetic-recording products, explains, "Sony prefers ¾-in. tape because the angle of the helical scan and other factors allow a higher packing density of information on the tape, as well as on a more attractive cassette."

Currently, 70% of all Japanese VTRs are exported, and 70% of these come to the U. S. Sony alone has announced that it will produce 100,000 units in 1973, and Matsushita has scheduled 80,000 to 100,000, topping Japan's total 1972 industry figure of 110,000 units.

Both Cartrivision and RCA are confident that they can secure a mass consumer market now by effecting de facto standards through gathering a number of licensees (see table), and, without formalized standards, close out the Japanese. However, the Japanese may be waiting for U. S. firms to fall on their faces over the standards issue before jumping into the consumer market.

Cobalt power. Spokesmen for Sony and Matsushita, however, say that a mass consumer market will only be possible with a new generation of both machines and high-energy recording tape. The over-all trend will be toward simpler, less-expensive machines that use less tape.

Present equipment is geared to handle high-energy chromium-dioxide tapes, but many industry insiders agree that the equipment does not take advantage of high-energy tape's potential to provide denser recording capability and that the equipment is not geared to handle such newer materials as cobalt-energized tapes. "The change would not entail new circuitry," says a Matsushita spokesman," but new geometry will be needed, much like the audio industry's switch from ¼-inch reel-to-reel tape to the Philips cassette."

But RCA and Cartrivision insist that their present designs will penetrate a waiting mass consumer market. The proof of this statement, as well as the direction that the industry will take, will depend on the impact of RCA's SelectaVision on the marketplace this summer. A spokesman for RCA says, "You have to some extent create a market. We know a consumer market is out there if the price is right, and our price—$700—is right. One or two standards will emerge, and the company that sets them is the company that gets the price down first."

In Europe, the situation is not as complicated. Philips has already established a de facto standard by taking under its aegis 10 major European TV manufacturers in addition to Japan's Shiba Corp. Moreover, European governments, not anxious

Disk shakeout is also on the program

Incompatibility is also a plague on the disk variety of home video players. But whereas videotape recorders are principally the same—they are magnetic-tape systems—each disk system is electronically different, so that they will be standardized only when manufacturers agree to use the same technology.

Philips of the Netherlands and MCA Inc., Universal City, Calif., for example, are using lasers to pick up video signals from the disks, while Teldec, the German-English venture of AEG Telefunken-Decca Ltd., Berlin, is using a pressure transducer. Arvin Industries Inc., Columbus, Ind., is working on a stop-action system, Japan's Hitachi is developing a frame-grabber unit, and RCA Corp., Indianapolis, and Zenith Radio Corp., Chicago, are keeping details under wraps. Except for Teldec, the systems won't be ready for market until technically perfected—several years from now. Teldec's TED system will be introduced to German-speaking countries in Europe this August. A single-disk player with a 10-minute playing time will cost about $300, and disk retail prices will be comparable to long-playing audio albums.

Like Teldec, disk manufacturers have uniformly promised prices "comparable to those of color TV", which has prompted an industry observer to state, "this means the onus of the shakeout is on the consumer, who will make options based on performance, brand name, and other considerations not based on price." Says another spokesman, "the shakeout is a long way off yet, but until the dust settles, incompatibility won't be as devastating as it is with VTRs—hardware and software are cheap enough to scrap without shedding too many tears."

Latecomer. RCA Corp's consumer VTR, SelectaVision will debut this summer, bolstering U.S. hopes of capturing a mass market.

to promote Japanese dominance have set up import quotas. Japan now sends 30% of the VTRs it exports to Europe. Philips is also using the same strategy for video cassettes as for audio: licensees pay no royalties on the cassettes that conform to its specifications. Philips figures to triple 1973 production over the 1972 figure.

Over the dam. Gerald Citron, director of video-cassette-recorder product marketing, for Norelco, the Philips American arm, reflects, "Philips would love to standardize video cassettes as they did with audio, but a worldwide standard is impossible, due to the disparity among different television systems such as NTSC, PAL, and Secam." He adds, "The situation is too solid now; too much water has gone under the bridge for standards to evolve from a shakeout." Instead, Citron believes that the industry will settle into two camps; video disk systems for consumer applications and VTRs for commercial applications. "Incompatibility is not anathema in commercial applications because those are closed-loop systems. In other words, if you get two machines together, you can exchange programing from one to the other, and commercial institutions can do this easily," he says.

Most industry experts, however, do not think this will be the case because consumers want record capability. Robert Bitting, RCA's head of SelectaVision says, "RCA is planning a disk for playback and a VTR for recording and playback."

The success of the mass consumer market is also inhibited by expensive software, an added expense the consumer does not want to chance, particularly if he cannot play today's $30 Cartrivision cartridge on tomorrow's RCA SelectaVision. Says Sony America president, Harvey Shein, "Record capability is essential, rental of cartridges notwithstanding. Software is too expensive for the type of programing offered, and that turns the consumer off." And an industry watcher concludes, "If the hardware is cheap enough, the software won't really present that much of a problem. Eventually, the outcome of the race can't be read until all of the horses are on the track, off, and running." □

Avionics

USSR comes west to buy ATC

To upgrade its air traffic control, the USSR plans to spend up to $1 billion abroad; a team of experts now in the U.S. has already visited France, Germany, the UK

by William F. Arnold, Aerospace Editor

The Soviets are shopping for up to an estimated $1 billion worth of air-traffic-control equipment and navigation aids, and U.S. Government-industry and association teams are gearing up to persuade them to buy American [*Electronics*, Dec. 18, p. 25]. In a scheduled visit next week, the Russians are coming to talk with U.S. Government and private-industry representatives and at the same time to inspect domestic ATC systems.

Just whom the Soviet Union will buy from is highly uncertain, but its representatives, who have already been wined and dined by the French, British and Germans, have indicated that they could make their first purchases this fall. Consequently, U.S. Government and private interests are hurriedly working out plans to put American industry on equal competitive footing with the Europeans.

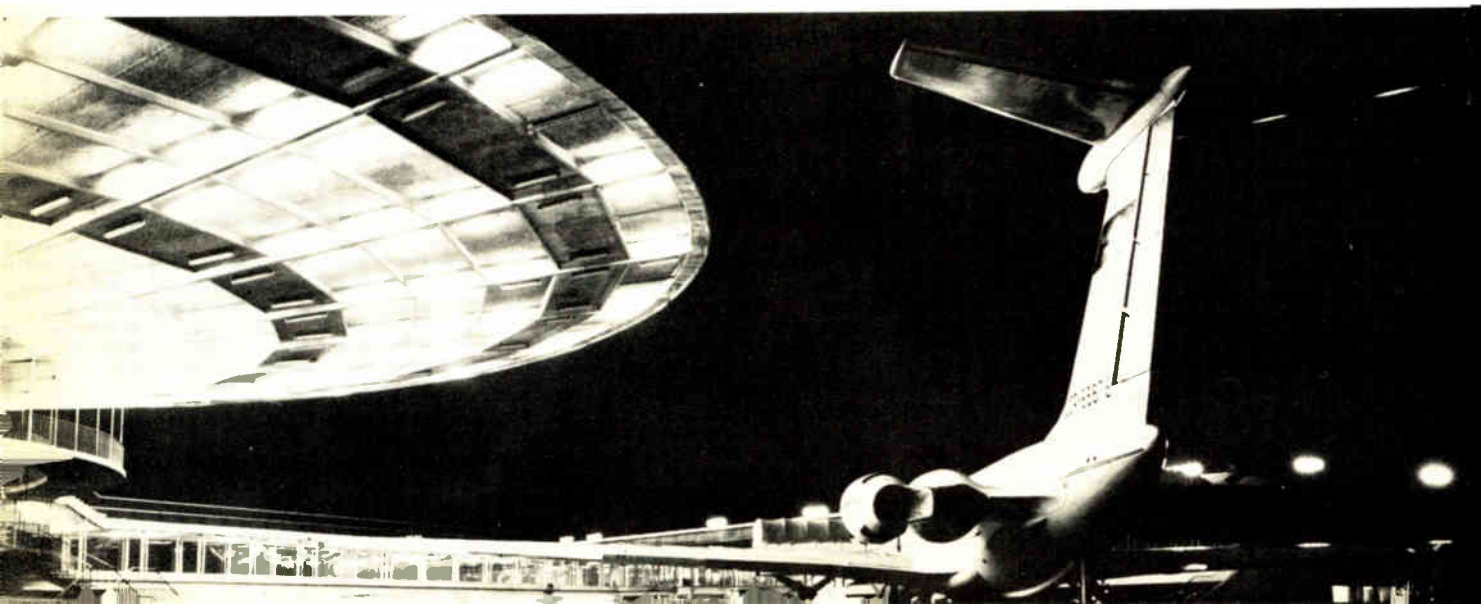
The American Institute of Aeronautics and Astronautics of New York City has invited the Soviet team of technicians and administrators to its annual meeting in Washington, D.C., on Jan. 8–10. The Federal Aviation Administration will show them domestic ATC facilities, and the team also will talk with some representatives of the more than 60 U.S. manufacturers of ATC and related equipment who are interested in selling to the USSR.

Terminal-area ATC systems seem to be the USSR's top priority, followed by ATC simulation, ATC training aids, and instrument landing systems, with vhf omnidirectional range/distance-measuring equipment and en-route systems at the bottom. The present Soviet system uses a mixture of their own, French, German, British and some U.S. equipment. These and other details were given to industry by AIAA and FAA officials at closed briefings last month.

Why will they buy? The AIAA and FAA drew their figures from talks with the Russians and published Soviet material, including long-range plans to upgrade their systems. This data shows the Soviets to have an air system that is becoming strained. Over-all traffic is rising about 8% a year, with the Moscow region jumping 12% annually. Some sources believe there is political pressure to avoid the kind of air accident like the crash of the Aeroflot jetliner on Oct. 13 near Moscow, which killed 150 people.

The big question on everyone's mind is: do the Russians really want to buy so much gear abroad? Apparently, the Soviets want to upgrade their systems with foreign equipment because they have not made the research and development effort necessary to do it themselves. Indicative of this, "they were most cordial and interested, almost enthusiastic," says Thomas J. Harford, AIAA's director for international affairs, who led an AIAA-industry mission over to talk with the Russians in December. "They gave every indication of serious interest," comments Sigbert B. Poritzky, an associ-

Future site for western ATC equipment? Air traffic at Moscow's Sheremetevo airport is increasing at the rate of 12% annually.



Them and U.S.

The USSR's single state-owned airline, Aeroflot, is quite unlike the U.S. airlines in that it doesn't need to worry about competitive pressures. And there are other differences, too.

With two-and-a-half times the land area of the U.S., the USSR operates about 15,000 nautical miles of transcontinental and about 22,000 nm of domestic trunkline service, compared with about 335,000 nm for the U.S., excluding Alaskan interior service. In 1971, Aeroflot carried some 77 million passengers and 1.6 billion tons of air freight, as against 152 million and 1.2 billion for the U.S. in scheduled domestic flights.

Russia has more than 3,200 airports, of which 500 are classified as permanent and 135 can accommodate civil air-carrier operations. The U.S. has more than 12,000 airfields, of which 531 have FAA facilities. Eight Russian airfields are more than 14,000 feet long, and 1,900 are less than 4,000 ft; the U.S. has 60 airports with landing strips over 10,000 ft long.

The size of the Soviets' civil plane fleet has been estimated at up to 5,000 planes. The U.S. air carriers have 2,679 planes, of which 2,136 are jets. Soviet air travel is increasing about 8% a year, compared with a U.S. estimate of 10.5% a year on average during this decade. Resembling the U.S. system, the Soviet air system is divided into 55 flight information regions, controlled by 40 area control centers.

ate director with the Air Transport Association, in Washington, D.C., adding that "they made it pretty clear that they want the best and plan to build up on a modular basis."

Bernie Bernstein, assistant director, traffic control sales, for Lockheed Electronics Co., Plainfield, N.J., who attended the industry briefings in December, says that while the U.S. has the technological lead, the French have been working closely with the Russians in other areas and may offer more favorable financing than U.S. firms. AIAA's Harford, however, believes that "we have a very good chance to sell to the Russians. It depends on: the political climate, which is very good now; the technological edge, which we have; and financing."

On dealing with the Russians. However, negotiating with the Russians may be tough. "They drive a hard bargain," observes Joel Feiner, special assistant to the executive vice-president for international business development, AIL division of Cutler-Hammer Inc., Deer Park, N.Y.

It is not known how the Soviets are going to handle their ATC buying—whether they will ask for an airport-by-airport system, whether they will specify an air sector, or whether they will want a plan for the entire country. "If they ask for any kind of a systems approach," says an industry expert who has traded with them, "a number of bidders could invest a lot of money in preparing studies. The Russians might evaluate these proposals, take the best and least expensive elements of each of them, and wind up doing their own systems integrations. Right now, the U.S. has the best ATC technology available. If the Russians want to buy it, they have to be prepared to deal on our terms."

In the past, according to this source, the USSR has asked for a system price and requested the names of the components manufacturers and subcontractors. Then, the Soviets would contact them and obtain their prices, and the systems contractor would be out on a limb. "This is how the Russians have compiled what's probably the best pricing index in the world," he says.

But, besides potential bargaining strategies that have to be worked out, U.S. industry faces several problems within its own Federal Government. It may take a White House directive to get cooperation within the Government among the FAA and the State, Commerce and Defense Departments, say Government and industry observers.

The removal of export controls on the computers necessary for ATC systems could raise DOD's hackles, for instance. "DOD may not be as enthusiastic as Commerce about this," observes an FAA official. But several sources indicate that export controls may be changed to improve the U.S. balance of trade. "If anybody can buy anything elsewhere in the world, we should be able to sell it," comments the official.

Team problems. Even harder may be getting individualistic U.S. companies to cooperate with each other. FAA officials fear that some companies may go charging off to hard-sell the Russians and queer any possible U.S. sale. This is important because the Soviets have indicated that they want to deal with one entity and not a number of companies. Thus, the FAA is stressing the systems approach.

But, if companies get together to agree on pricing structures, they could be violating anti-trust laws, and historically the Justice Department is loathe to rule on any such arrangements before they form. "The Russians went to the French government and were told that the French vendor was Thomson-CSF," says Robert J. Maroni, Radar products manager, Singer-Kearfott division, Little Falls, N.J. "Frankly, I don't see how we'll get that in the United States."

Some companies already are grumbling that if the Russians are interested in buying terminal ATC displays and equipment, that leaves the potential market to only a few U.S. companies, namely, the builder of Advanced Radar Terminal System 3, Univac division of Sperry Rand, and its subcontractors, Burroughs Corp. and Texas Instruments. Others, saying that ARTS-3 is more than the Soviets need, think the market is wider and will include navigation aids.

Some experts think that some way can be found around the problem of teaming. AIAA's Harford believes that "new industry and Government relationships have to be established." Devising such mechanisms should receive the highest Administration attention, following the successful trade agreement between the U.S. and the USSR last year. AIAA team members say that the Russians repeatedly mentioned the agreement as expressing desire for U.S. trade. Meanwhile, "we're trying to figure out how U.S. companies can trade collectively with a state-owned organization," sighs an FAA official. □

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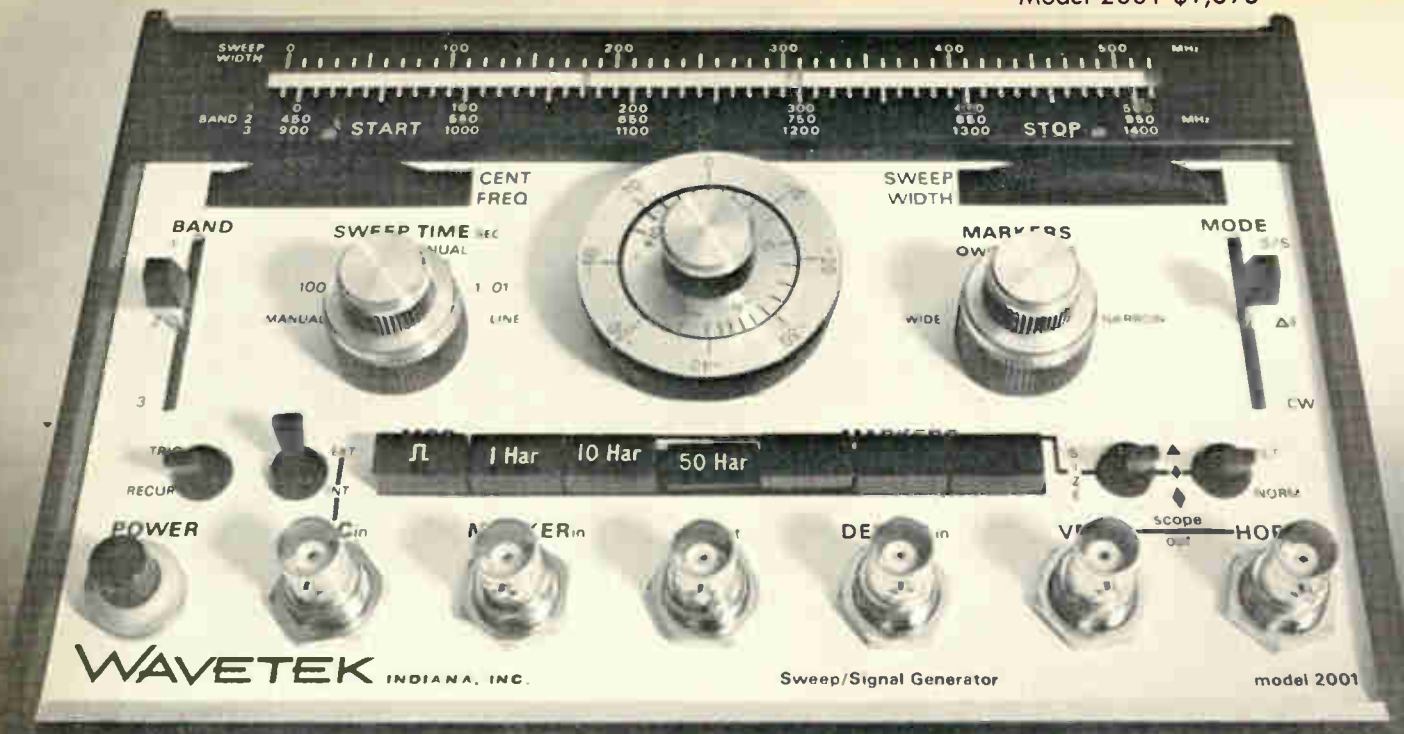

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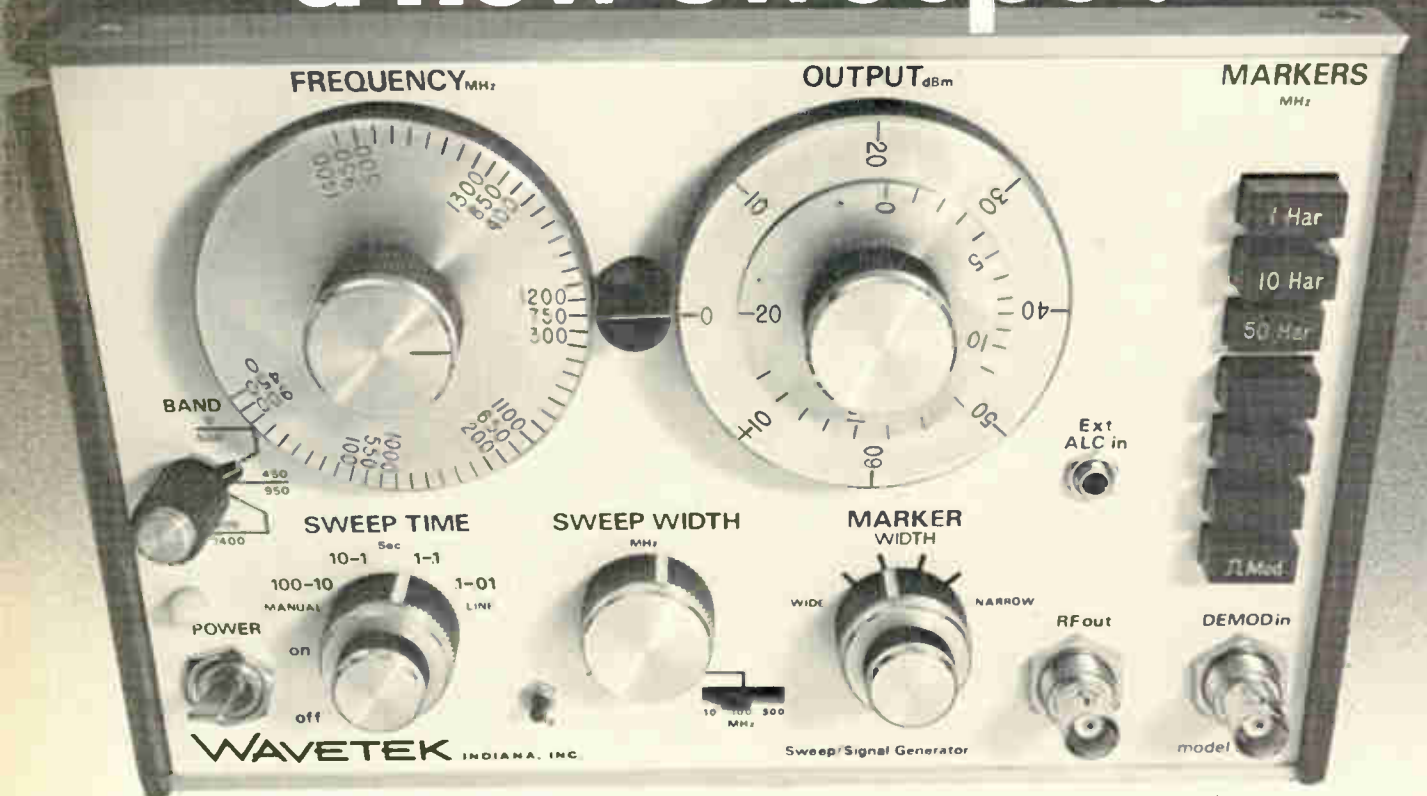

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Washington newsletter

Interim MLS choice seen as delayed

The Federal Aviation Administration—to which White House aide Alexander P. Butterfield has been named as the new administrator—plans to **decide on an interim standard microwave landing system for general aviation by summer,** sources say. But they doubt whether the FAA can meet that deadline, and charge that it will be a long time, if ever, before the agency selects one. One source speculates that, **having procrastinated thus far, the FAA could afford to delay further** until the "universal" MLS gets so near implementation that an interim standard seems unnecessary.

Originally, the FAA wanted to make the interim MLS eligible for matching Federal funds, but it walked into a storm of problems [*Electronics*, Aug. 28, 1972, p. 29]. For example, choosing one technological approach from among the competing systems would solve the problem of compatibility within a national airspace system, but the FAA would anger the losers among the competitors: Boeing Co., Cutler-Hammer's AIL Division, Singer's Kearfott division, Tull Aviation Corp., Britain's MEI Equipment Co., and France's Thomson-CSF.

Satellite space wanted by Maritime Administration. . .

The Maritime Administration and NASA are talking about dusting off Applications Technology Satellite C2, **the engineering prototype for ATS-3, for use as an experimental L-band communications link.** Marad has been shopping around for space on a satellite so that it can get operational experience for its projected ship-shore-satellite program to automate maritime communications and navigation [*Electronics*, March 27, 1972, p. 68]. Hughes, which built ATS-3, estimates **refurbishing costs at less than $12 million for launch and a year's operation.** It may be Marad's only hope, as ATS-F, besides having limited beam antennas, is nearly booked up for its launch next year, ATS-G won't go up until 1975, and NASA still is only mulling a possible family of Small Applications Technology Satellites, which Marad might use.

. . .but OMB cost-cutting clouds the whole deal

In one of many tough whacks it is dealing throughout Government these days, the White House **Office of Management and Budget is trying to prune the ATS-C2 project out of the Maritime Administration's fiscal 1974 budget**—which could throw the whole ship-shore-satellite program out of kilter. Maritime officials reportedly argue that since the ATS-C2 would serve other users by testing aeronautical equipment and carrying cloud-imaging cameras, it would **strengthen U.S. technology in competition later this decade** against improving European communications/navigation satellites. **The C2 proposal amounts to about half of the $25 million satellite program through fiscal 1977.**

Singer to unveil inertial navigator before FAA

The Kearfott division of Singer-General Precision Inc. is readying for FAA certification **a new third-generation inertial navigation system, Gamma 1, which will list at just under $100,000** for large executive aircraft, cheaper than competitive equipment, the company says. Key features of the 25-pound unit are an improved inertial platform and a computer with 7,168 words of LSI read-only memory on a single band.

Washington commentary

Perkins McGuire's mouse

Perkins McGuire is a name most persons in the capital don't even know, much less reckon with. Yet his name will surface shortly as the 12-member Commission on Government Procurement, which McGuire chairs, delivers itself of some 125 recommendations to improve the way Government makes contracts with industry. With roughly one-third of the Federal Government's annual procurement of nearly $60 billion spent by the Department of Defense and another 5% or so going for civilian data processing hardware and services, there will be much in the McGuire commission's report of interest to electronics.

In releasing its procurement reform recommendations this month to the Congress, by which it was created in November, 1969, the commission will have wrapped up two years of work into four prodigious tomes. The question now becomes: was it worthwhile?

White House favored

Certainly the CGP's vice-chairman and its congressional sponsor, Rep. Chet Holifield (D., Calif.), believes it was. And the White House, where Richard Nixon is busily consolidating the power of the Executive Branch, is reportedly delighted with the commission's central recommendation: creation of a strong Office of Federal Procurement Policy under the jurisdiction of the already powerful Office of Management and Budget. The new procurement-policy organization, designed to untangle the snarled Federal buying rules and regulations and coordinate spending with bankrolls, bears the mark of former OMB chief Caspar Weinberger, now designated by the President to head the Department of Health, Education, and Welfare. Weinberger, a Californian, is a staunch advocate of reforming the Federal appropriations process along California lines, where the budget is passed as a package—rather than on an agency-by-agency basis—along with legislation for revenues to match the spending proposals.

With such sweeping internal appropriations reforms unlikely to be adopted by the 93rd Congress, the White House hopes to effectively balance outlays and income with its new procurement-policy office in OMB. However logical and laudable the goals of such an economic policy may be, the McGuire commission's prime recommendation is headed for trouble in the Congress for several reasons. First, it bequeaths the spending controls to the Executive, rather than the Congress, which has always had the power of the purse. Second, those controls will be in the hands of OMB, whose increasing power in Government operations is becoming as controversial a subject as the man President Nixon has named to head it, Roy L. Ash, late of Litton Industries Inc.

Ash, not a cabinet member *per se*, is not subject to Senate confirmation. He headed the Nixon task force that four years ago recommended the restructuring of the old Bureau of the Budget into the more powerful OMB. And now Ash is coming under fire for alleged pressuring of the Navy last summer to settle Litton Industries' claims against the service on the shipbuilding contracts handled by its Pascagoula, Miss., shipyard. The Navy puts the combined figure for its Landing Helicopter Assault ships and destroyers at $659 million. Litton says the number is $547.7 million.

The claims of pressure by Ash have led one top Navy civilian procurement chief, Gordon Rule, to call the Nixon appointment of Ash "a mistake," one that would have former President Eisenhower, the creator of the military-industrial shibboleth, "twitching in his grave." (Since making that pronouncement, Rule says he has refused a request for his resignation and has been reassigned to less important duties.)

The issue submerged

The net effect of all of this is to make the names of Perkins McGuire and, for that matter, Gordon Rule, worth no more than two or three headlines. And the more crucial issue of whether the best way to reform Federal procurement policies is to create one more Government bureaucracy under White House control is likely to be submerged by congressional criticism of Ash.

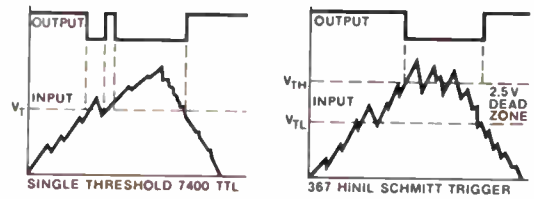
The knot of Federal procurement regulations existed long before Mr. Ash or Mr. McGuire came to Washington to try and cut it. And the efforts of the McGuire commission appear insufficiently innovative to resolve them. Creation of an Office of Federal Procurement Policy may give the White House greater direct control over what is bought, yet it says little about how and why things are bought in the first place. At best, the commission on government procurement offers the 93rd Congress a platform from which it can launch a program to simplify industry's passage through the procurement maze. Yet if that proves the best product of the McGuire commission's two years of labor, it must rank with the mountain that brought forth a mouse. **—Ray Connolly**

Schmitt, the name that made the trigger famous, now makes HiNIL universal.

Schmitt is Teledyne's new HiNIL 367, noise-proof line receiver. It's the new way to go for a universal input-port to logic blocks. In industrial applications, for example, most inputs are either a switch or a relay closure. They usually cause contact bounce. But the most amazing thing about the 367 is that it has a truth table that simply eliminates contact bounce by definition.

And by the way, the noise immunity of the 367 is more than enough to handle any long lines between the logic and input. It has a 5.0 volt worst-case noise immunity and an additional 2.5 volt dead-zone Schmitt Trigger margin.

Because the 367 is a Schmitt Trigger, it holds that 2.5 volt noise immunity *even* during logic transition. Slow-down capacitors, as you all know, do not provide true noise immunity during switching. But, with the 367 in there, you can use those slow-down capacitors at the rate of 4msec/uFd *and* achieve a high guaranteed noise immunity too.



For fussy people, we put an inhibit pin on the 367 that allows information to be accepted only at times of low noise.

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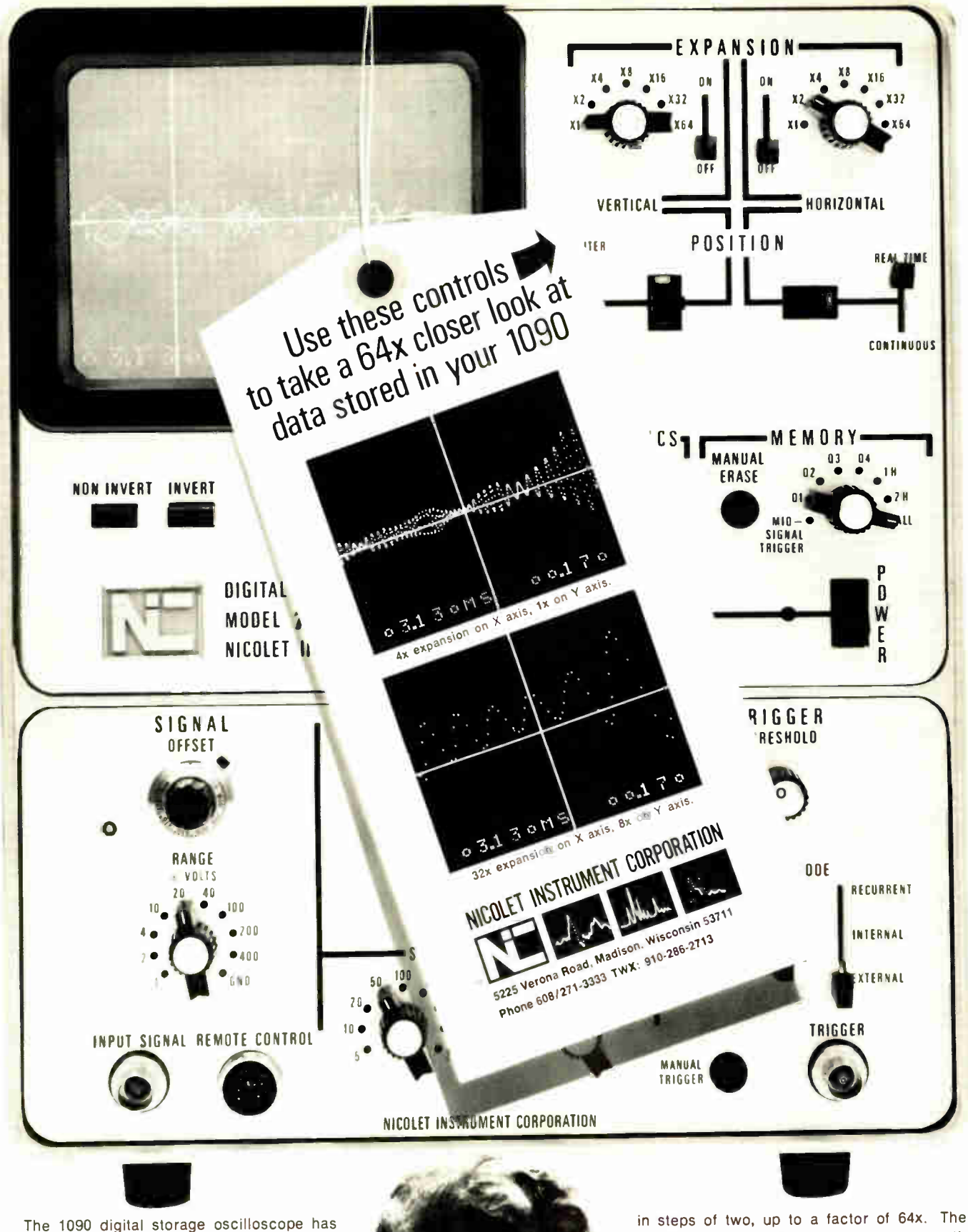

Use these controls to take a 64x closer look at data stored in your 1090

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The 1090 digital storage oscilloscope has non-volatile magnetic core memory with the capacity to store a waveform to a resolution of one part in 4096 on both voltage and time axes. Moveable crosshairs are used to select any region of the stored waveform for closer inspection. This selected area can then be expanded in voltage and/or time dimensions.

in steps of two, up to a factor of 64x. The selected region of the waveform is automatically centered on the expanded display. Time and voltage values at the intersection of the vertical crosshair are displayed numerically. For complete details on the 1090 display and its other unique features, please phone or write Nicolet.

Integrated circuit aimed at car speedometer market

Electronic speedometers have long been longed for in the automobile industry because they eliminate the need for the flexible shaft that runs from the car's transmission system to the dashboard. That shaft is notoriously susceptible to wear and tear, which limits speedometer accuracy and life.

Car accessory makers came out with electronic speedometers as early as the mid-1960s. But those instruments, which used discrete components, could hardly compete with the less expensive, mechanically driven ones. Now, with a new IC from West Germany's Intermetall GmbH, an electronic system, once it's mass produced, can match the price of conventional types, the company says.

Now standard. Designated the SAY 115, Intermetall's IC was designed in cooperation with several big automotive instrument firms in West Germany, France, and Italy. Originally a custom IC for these companies, it is now being marketed as a standard device.

The unit provides an output both for speed and mileage indication. It also incorporates the circuitry to produce a signal that can be used to trigger an external alarm if the car speed exceeds or falls below a preset limit. Foreseeing the day when governments make speed warning systems mandatory on cars, Intermetall has incorporated the required circuitry.

The SAY 115, a bipolar device, integrates onto a 4-millimeter-square chip six functional units: A Schmitt trigger, a monostable multivibrator, a current source, a distance-counting circuit, a power stage, and an analog signal generator. The IC can be controlled with input signals of arbitrary waveform. This allows the use of almost any type of transducer—such as reed contacts, an inductive sensor, or a proximity switch—as a pick-off device at the car's transmission. □

France

Pyrolytic graphite grids lead to new transmitting tubes

The technological history of transmitting tubes has been marked by stages as distinct as archeologists sometimes discover when they probe the site of an ancient Mediterrean city.

The first stage was characterized by tungsten cathodes, metallic grids, air-cooled anodes, and glass envelopes. Then ceramics took over from glass in the envelope, marking the second stage and a shift to much higher power. After that, cathodes were bettered by a change to thoriated tungsten, which operates at a relatively cool 1,600°C, instead of the older cathodes' 2,200°C. The third stage came with vapor-cooled anodes.

Pyrolytic. Thomson-CSF, the largest French producer of professional electronics equipment, quietly entered the fourth stage seven years ago but only now has started to talk about it. The chief characteristic of the stage is a different grid material—pyrolytic graphite. "We started development of pyrolytic graphite grids ten years ago and still are perfecting our techniques," says Pierre Guénard, scientific director for the tube division.

Thomson's new gridded transmitter tubes have all-graphite grids. The company, for example, has one order for a dozen 500-kilowatt transmitters. The output tubes have graphite grids roughly 140 millimeters in diameter. Thomson's most powerful tube using graphite grids has peak output of 1.6 megawatts at 108 megahertz. The pulse duration is 4 milliseconds and the duty cycle 25%. These tubes are about half as large as they would have to be if they had conventional tungsten mesh grids.

Thomson, of course, is not the only company that recognizes the inherent merit of pyrolytic graphite. However, Guénard maintains that his group is the first to get graphite's advantages into grids. Essentially, Thomson deposits pyrolytic graphite onto a cup-like form and then machines the monolithic graphite structure into a grid. Hence the trade name for the grid, Pryobloc.

Pyrolytic graphite has a crystalline structure that is eminently suitable for grids. The material deposits on the form in planes, parallel to the axis of the cup-shaped form. The graphite is also highly conductive, both electrically and thermally. This means, for example, that heat generated in the grid is transferred easily to the grid support.

Plus. Graphite is nearly a "black body" when it comes to thermal radiation. These two factors hold down the grid temperature and make for lower grid emission. Added to this, graphite has very low secondary emission compared to other grid materials, like tungsten or molybdenum.

Even more important for high-frequency operation is the mechanical stability of pyrolytic graphite at high temperatures. This stability, which makes possible closer electrode spacing in tubes, is the key to high frequencies. □

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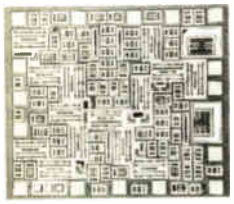

Monochip is a one chip custom bipolar IC. Nothing fancy or expensive. But it gives the superior performance you need without circuit tradeoffs or sacrificing reliability. Plus, you can forget about huge development costs and long waits for evaluation parts. $1,800 gets you 50 packaged units in 3 short weeks. That's a promise. And no matter how many production units you order, they'll cost less than hybrids or discretes of equal complexity. We can do it because we inventory diffused wafers with only the interconnect metalization left unfinished. Each Monochip die has hundreds of active and passive components that can interconnect into a fantastic variety of linear and digital circuits. Almost any circuit configuration is possible, even with the most complex performance requirements. Excellent component matching and tracking are present too. And Monochip is available in any IC package or in dice form. There is an Interdesign Design Kit that contains everything you need to breadboard and simulate exact performance, including stray effects. Easy-design rules. Large Monochip drawings to determine interconnect patterns. 16 DIP kit parts. All for $39. Or, we can do all the evaluation work for you for free. Just send in your circuit drawing and specs. Either way, Monochip makes a lot of sense.

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International newsletter

Europeans give up on Europa 3 launcher, form new command

Europe's Space Launch Development Organization (ELDO) is being politely phased out under terms of a agreement reached at year-end to create a single European Space Command. The European Space Council decided in Brussels to halt development of the costly heavy launcher, Europa 3, the main raison d'etre of ELDO. **Still in suspense is the fate of Europa 2, which is scheduled for its 13th test firing next summer.** Council working groups are to decide by the end of January whether to abandon Europa 2 as well.

The space command, purposely put on a vague timetable, is to be established by Jan. 1, 1974, if possible. The new organization will technically combine ELDO with ESRO, the satellite development organization, but in fact will deal exclusively with satellite projects once Europa 2 is complete or canceled. The Brussels meeting also made decisions in principle to finance about 40% of a French heavy booster program to replace Europa 3, and to back construction of a sortie module, an optional project in the U.S. post-Apollo program. **Details on the French rocket and post-Apollo financing also were left to be worked out by lower-echelon teams.**

Bonn getting tough on EDP buys

The Bonn government, West Germany's largest single computer user, is considering tougher contract policies for future EDP equipment acquisitions. According to these policies, computer suppliers will have to pay a penalty for any nonfulfillment of contract terms and any nonperformance of equipment installed. Specifically, suppliers will be required to compensate for the delay in equipment deliveries, to bear the cost of computer down-time caused by malfunctions, and to live up to more stringent maintenance and software contract terms. Furthermore, the government reserves the right to cancel rental contracts under certain conditions and on short notice.

The new policies, to be coordinated for the various government agencies by the Ministry of Interior, will become effective sometime in 1973. What's prompting the tougher conditions is the government's feeling that it has often settled for disadvantageous EDP contracts. In West German computer circles it is expected that **other users—private industry, for example—will establish similar contract conditions in the future.**

Barclay's switches computers for its 2,400-branch network

The British national banking chain Barclays Bank Ltd. has abandoned its attempt to build a computerized on-line accounting network, for its 2,400 accounting branches, around Burroughs computers and will standardize on IBM equipment. The bank planned its network around three Burroughs 6700 dual-processor machines, of which two are working and one is partly installed. It also has two IBM 370/155 machines. Now two IBM 370/165 machines will take over from the Burroughs units. However, **the 2,750 Burroughs terminals will be retained.**

Barclays says that the switch is based on comparative evaluation of the performance of the two systems, plus promised early delivery of the 370/165 computers and the convenience of standardizing on one make of processor. **Also, the Burroughs plan has been running very late:** originally it was hoped it would be working by February 1971, when Britain

switched to decimal currency. The IBM machines will be built in Britain and cost some $12 million.

Britain to foster IC development with $25 million

The British government will pump $25 million of public money into British integrated circuit manufacturing companies over the next six or seven years as direct support for development of complex custom ICs. **Thus, the government is acknowledging that British companies need to develop advanced LSI capabilities but cannot do so by straight commercial methods,** mainly because domestic markets are not big enough. Initial recipients will be British-owned companies, but eventually some foreign-owned companies with strong British orientation might also benefit. The government will probably recoup some of the investment by levies on sales.

Plastic antenna boasts accuracy of 0.1 mm

Designers at Rohde & Schwarz have come up with a **small-diameter parabolic television antenna made entirely of plastic material.** The 60-centimeter antenna, developed in cooperation with a couple of West German chemical firms, is designed for signal reception in the 12-gigahertz range, which communications authorities want to use for future TV broadcasts in large cities.

The antenna has several big advantages over conventional metallic versions: lighter weight, lower cost, and higher parabolic contour accuracy. Once it is mass produced, the antenna is expected to be from 30–40% less costly than metal systems. This reduction is acheived by fabrication techniques in which both the antenna dish and its equipment case are formed in a single compression molding step. The exciter, also of plastic, is made by injection molding. **The contour accuracy of the antenna dish is within ±0.1 millimeter.** This, Rohde & Schwarz men say, compares with ±1 mm for metallic dishes of the same diameter.

Facit's new director is electronics engineer

Sweden's office machine maker Facit AB will get an electronics engineer as managing director. He's Hans Werthen, managing director of household equipment manufacturer Electrolux, which has acquired Facit and which will run Facit as a wholly-owned subsidiary [*Electronics*, Nov. 20, p. 57] Werthen started his career as an electronics engineer with AGA and was an early specialist in television in Sweden. He moved to Svenska Philips, where he was in charge of television receiver production and later assistant managing director before getting the top job at Electrolux. Now he has announced that he will hold down managing director jobs at both Electrolux and Facit.

AMD takes over its West German distributor

Now it is Advanced Micro Devices Inc. that is mounting a push in European markets. The California Company **ushered in the new year by taking over the Munich distributor that had been handling its line in West Germany.** An AMD-owned sales subsidiary in the United Kingdom may follow. AMD's goal, says company president Jerry Sanders, is to boost its overseas sales from the current 4% of total sales to 15% within the next two years. To hit this target, **AMD will assemble at its new facility in Penang, Malaysia, but do the testing in Europe.**

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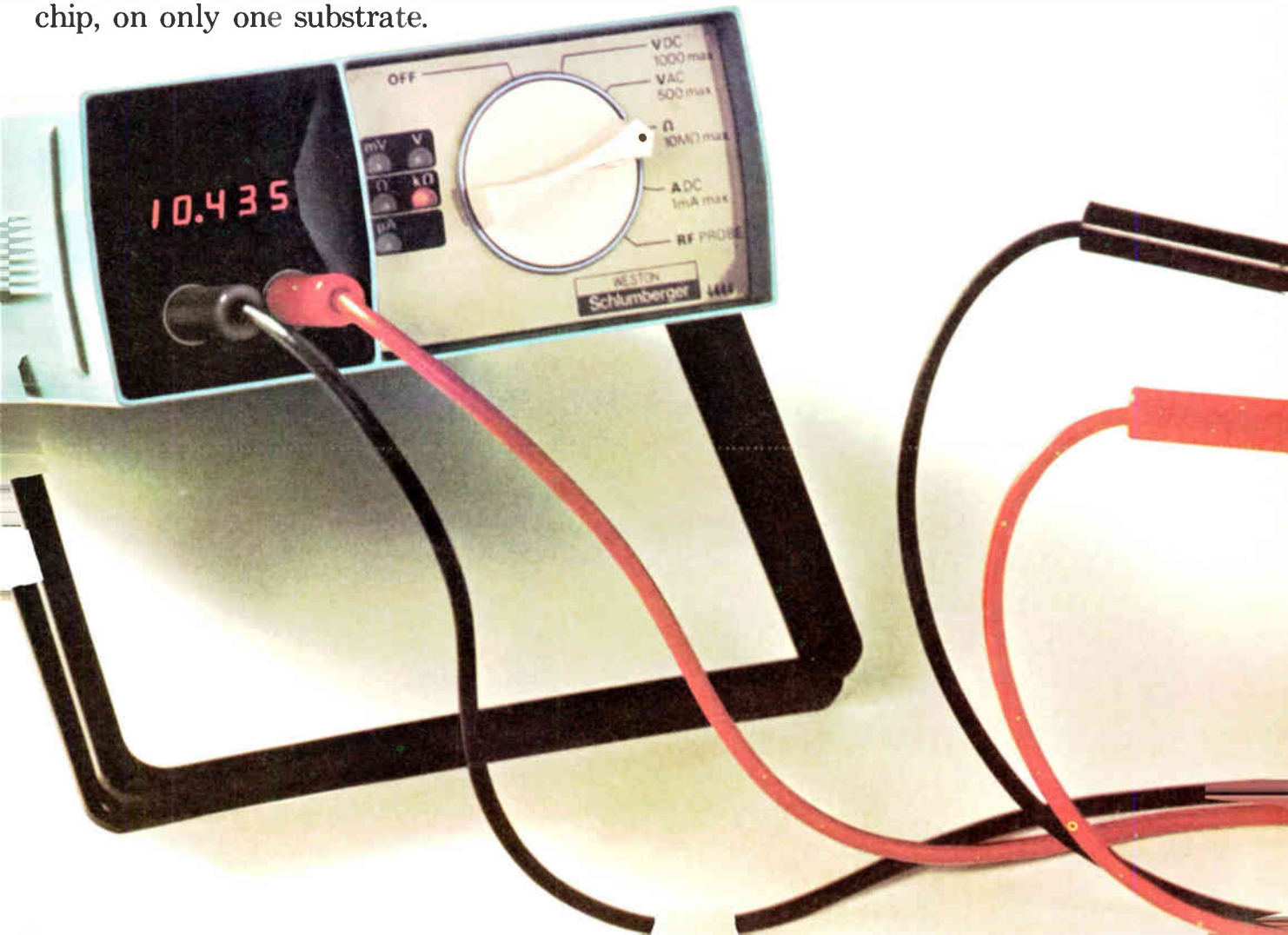

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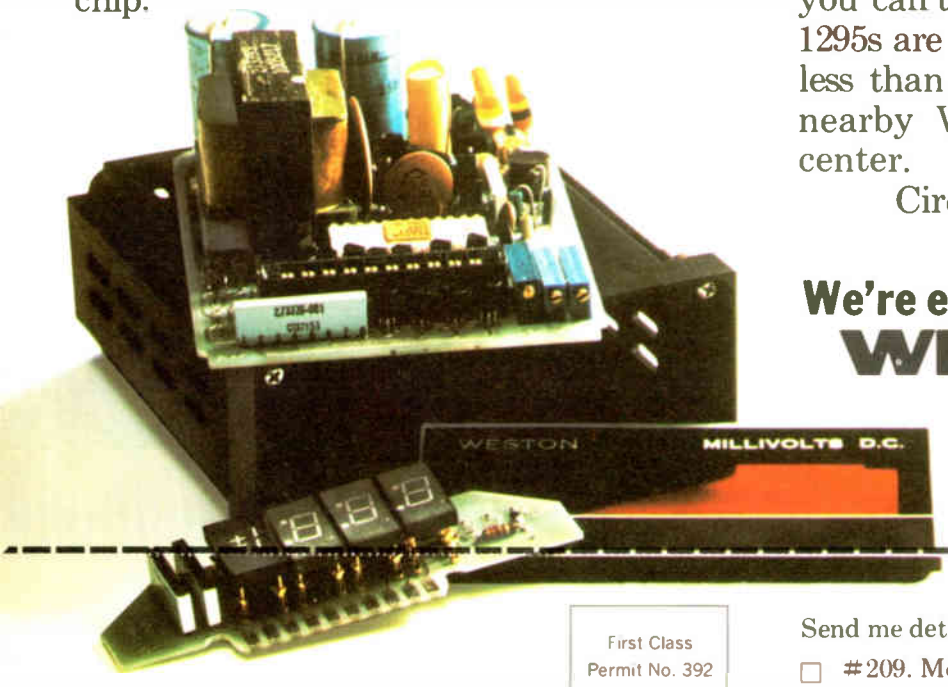

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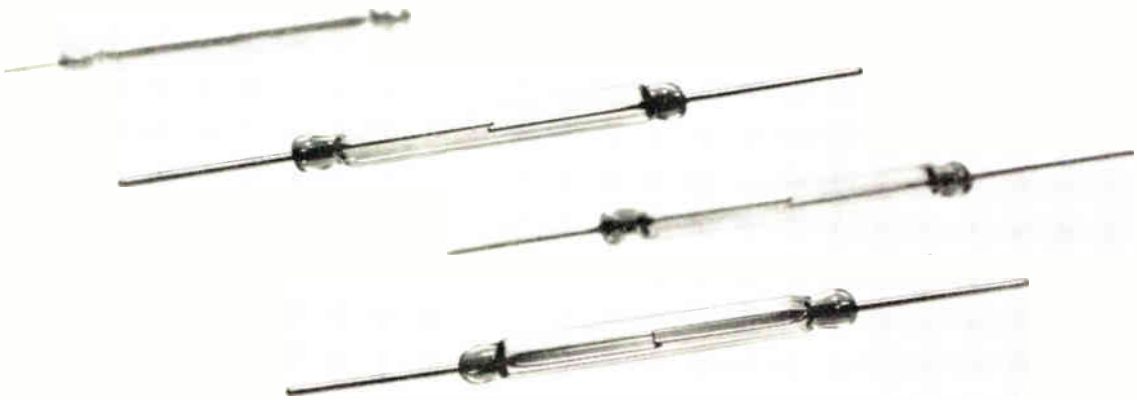
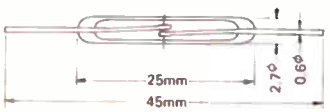
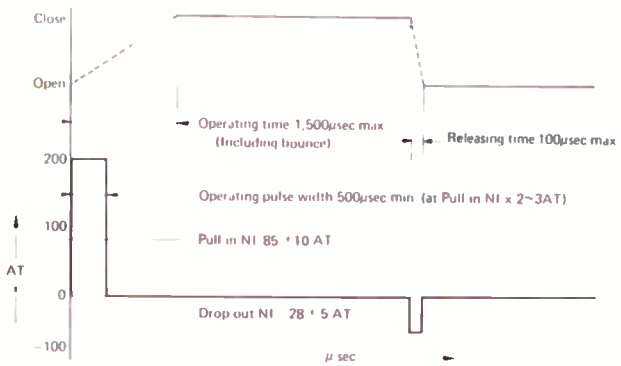
Contact Rating	5 VADC(0.5 A max)	Shock	50 G @ 11 mS
Dielectric Withstanding Voltage	600 VDC		



Dimension



MEMOREED - operation



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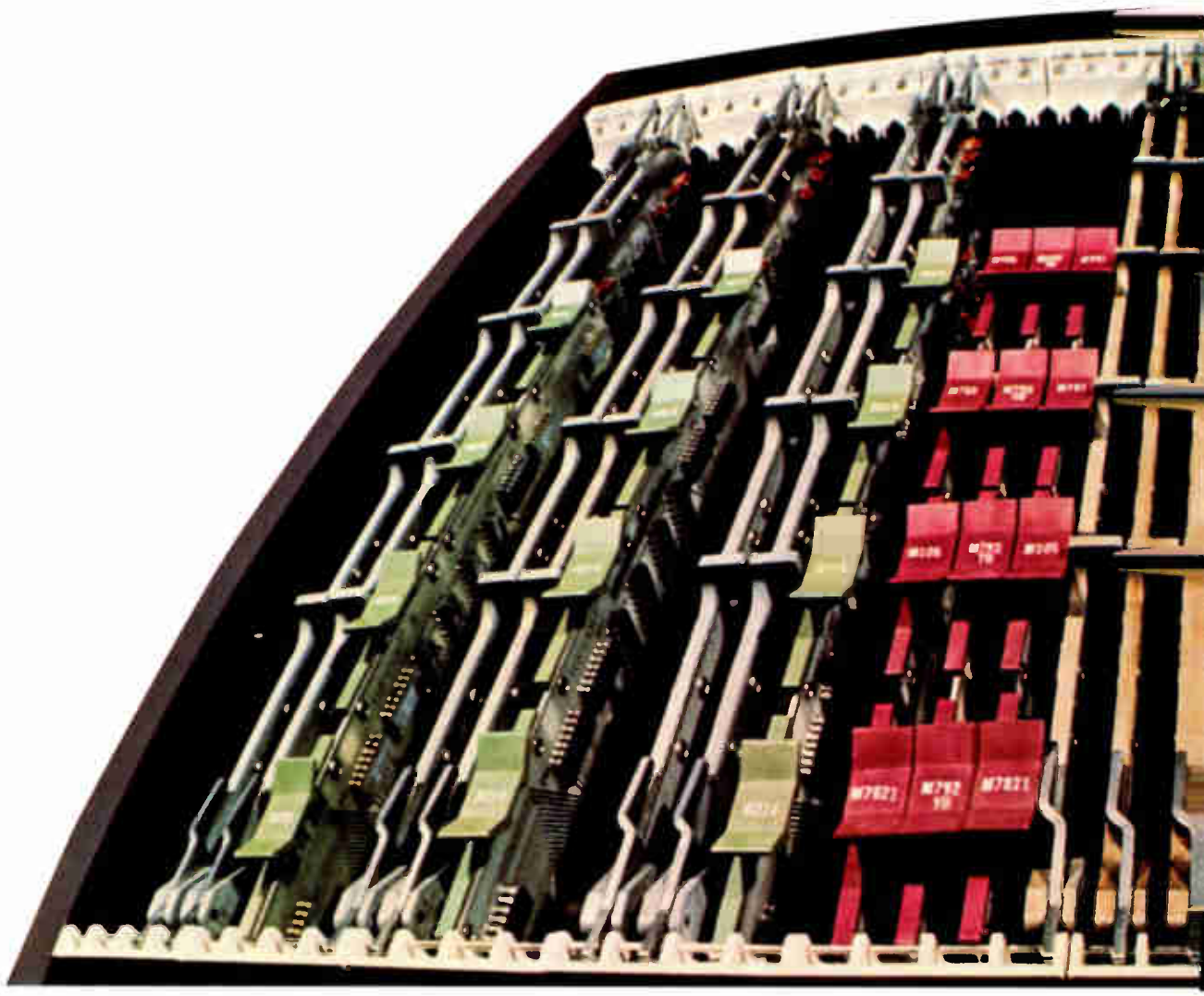
Circle 61 on readers service card



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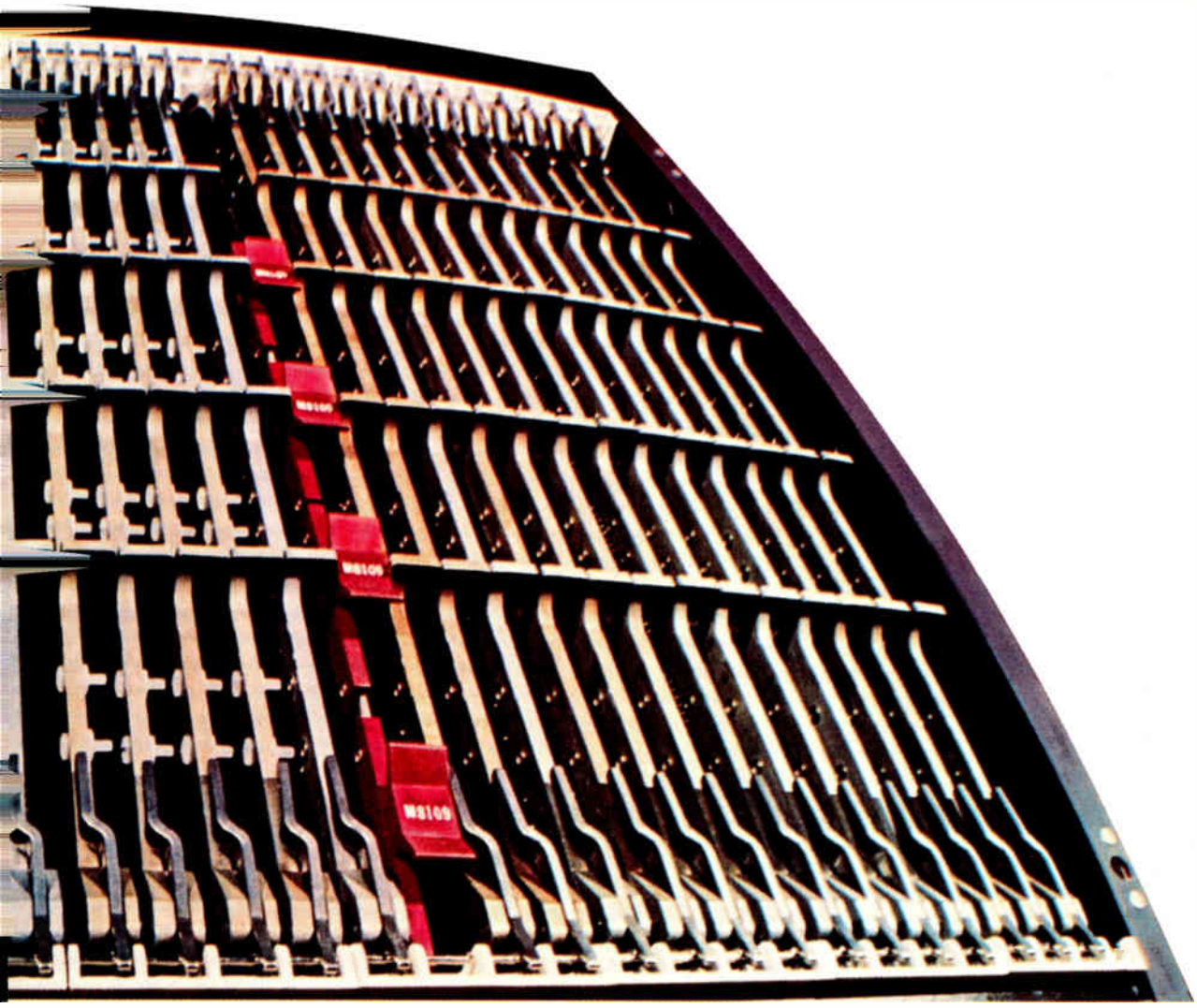

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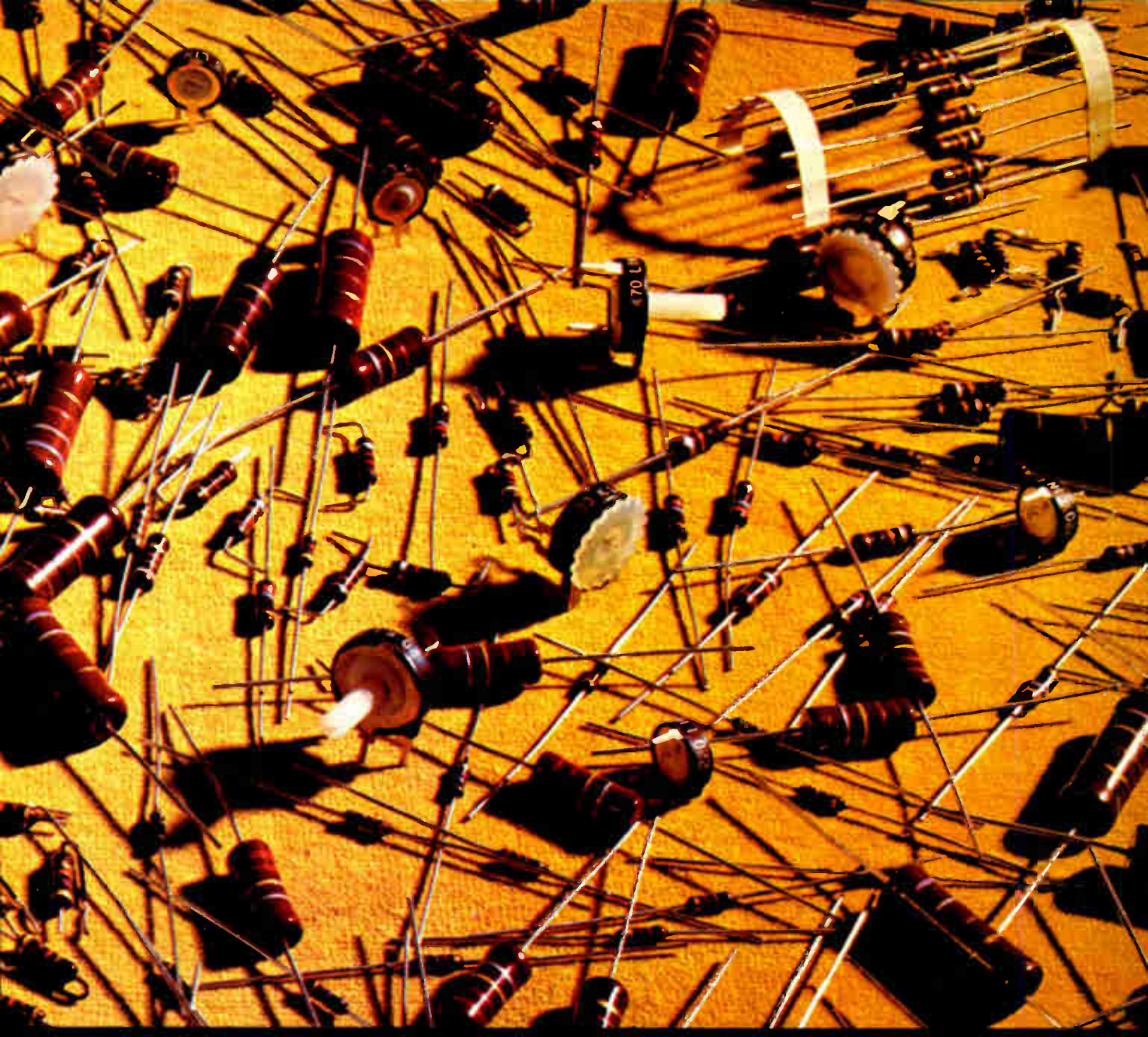

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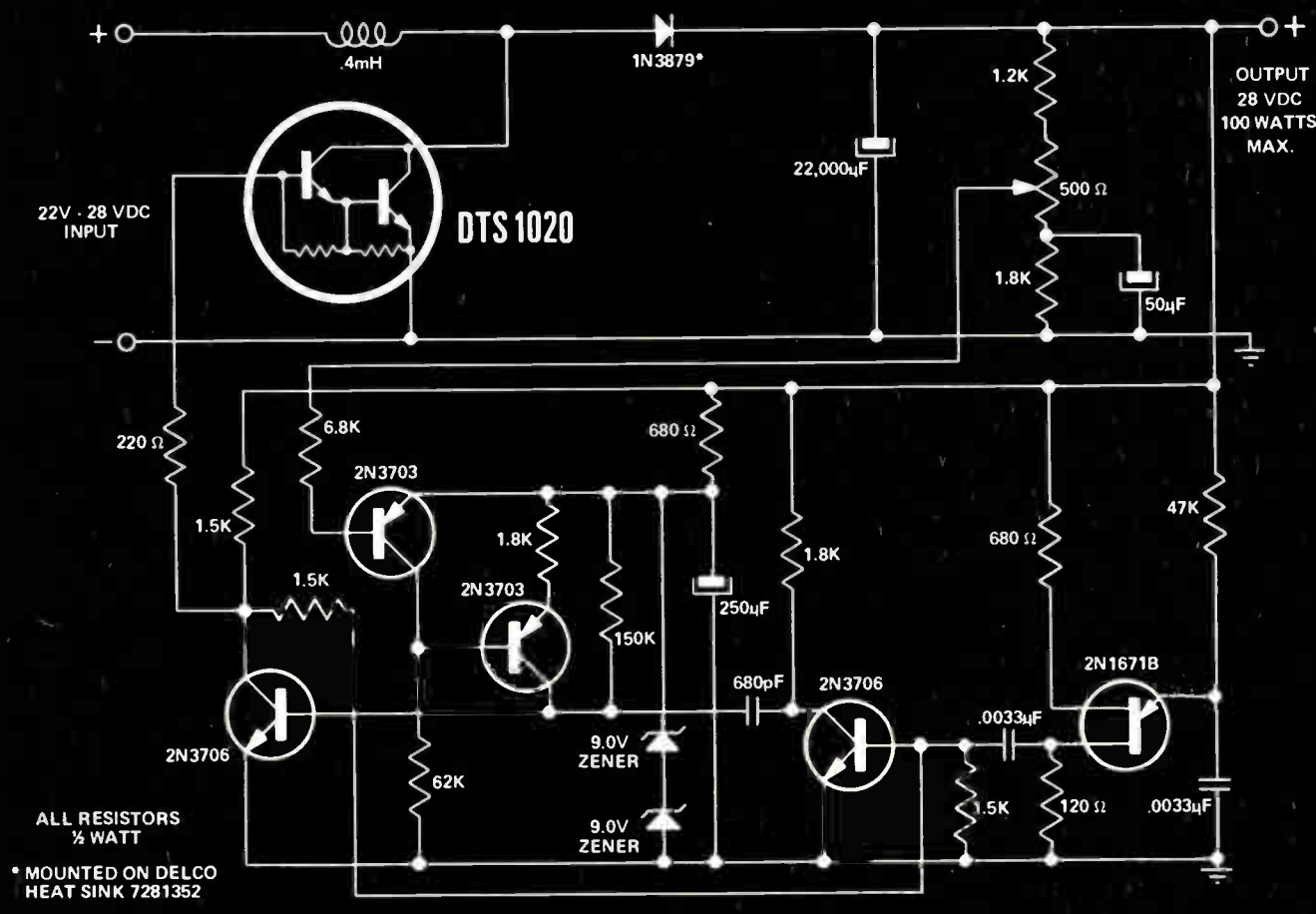

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DTS-1010	120V	7V	80V	12	200	1.8V	10A	100W*
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Circle 68 on reader service card

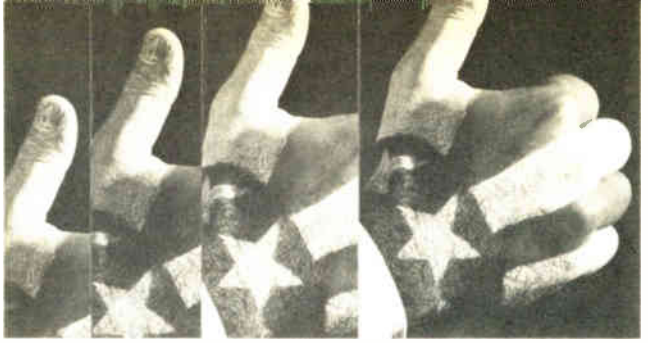
U.S. electronics markets to surge 10%, reaching $33 billion

The warm glow that electronics industries executives began to feel at midyear in 1972 has blazed up into exhilaration in the face of 1973. From every segment of electronics, the charts show solid, and in some cases, spectacular growth under an expanding economy.

By far the most significant gains will be achieved in the industrial and commercial sector. With industry putting up heavy capital for automation to gain precious productivity, with computers continuing the upsurge they began last year, and with what can only be described as an explosion in communications, the makers of industrial and commercial equipment will ring up factory sales this year of more than $16 billion, a gain of 16.3%. Restraint in Federal spending for space and defense hardware will hold growth of the Government market to a modest 3.7%, but even so, Uncle Sam is a customer who accounts for about a third of electronics sales. Consumer products will also register a gain of about 4%, over a year that itself exceeded expectations.

Major beneficiaries of the upsurge in communications and data processing gear will be the components makers, particularly the semiconductor industry. In 1973, semiconductor sales will top $1.64 billion, posting a 13% gain over a surprising 16% growth last year. Even the more conventional components makers will enjoy healthy growth of 8%.

All told, the electronics industries, after topping $30 billion in 1972, can be expected to garner more than $33 billion this year, a heady gain of close to 10%.



Federal

DOD austerity will at best maintain status quo

The Federal Establishment will continue as the electronics industries' number one customer in 1973, regardless of a number of imponderables in President Nixon's second four-year plan.

Outlays for Government electronics in the new calendar year are forecast to rise to nearly $11.93 billion, an increase of 3.1% over 1972 (see table). The Defense Department, of course, will retain its position as the top U.S. customer for industry, with (according to an *Electronics* survey) proposed outlays of $10.39 billion, up 3.2% from last year and accounting for about 87% of all direct Federal budgets for electronics. The DOD forecast increase represents a small gain over the 3% rise between its 1971 and 1972 spending levels—one that seems sure to be countered by inflation, however.

But Federal budgeteers indicate in background briefings that the imponderables could very well lower these figures as the year progresses. Among these considerations are:

- *A strong White House commitment to cut spending levels and prevent a tax increase if possible.* Reductions that can be made in Federal personnel levels are limited by Civil Service regulations and what one Office of Management and Budget man calls "the bureaucracy's clout with the Congress." In addition, "pay raises and increased benefits already built into the system— particularly in the military—will probably offset" savings achieved by agency reductions-in-force this year. Thus budget-cutters must turn from such uncontrollable costs and seek out the "controllables," which now account for only about one-third of the total Federal budget. A recent independent analysis by the Brookings Institution in Washington showed that most of these are in the Pentagon budget, but the President is reportedly reluctant to cut hardware spending there as the U.S. enters the second round of Strategic Arms Limitation Talks with the Soviet Union.
- *White House refusal to spend congressional appropriations by freezing funds.* This is a controversial tactic being employed increasingly by the Administration. The technique will affect military electronics outlays less than it will those of social programs, analysts believe. Federal money in Department of Health, Education, and Welfare for health care and education electronics programs—particularly the latter—is scattered throughout the agency in small chunks. Even though spending will increase slightly this year, "we've written off education as a market at the Federal level," says one company man in Washington, "but Federal revenue-sharing could generate more money at the state and local levels. We're looking there."
- *A hostile Congress with a number of new, younger and more liberal faces in the Democratic majorities in both the Senate and House.* The Senate losses of Republicans Margaret Chase Smith of Maine and Gordon Allott of Colorado, both proponents of a strong national defense, are generating uneasiness about defense hardware outlays among military and industry professionals. Those losses are compounded by a growing sense of independence from the White House on the Republican side of both the Senate and the House. "There is a helluva fight shaping up on this new budget" for fiscal 1974, says one Electronics Industries Association member, "and defense is going to be right in the thick of it."

New faces at the first and second tiers of a number of agencies are adding to uncertainty about Federal outlays. Elliot Richardson's switch from HEW to DOD, for example, has military leaders nervous. Though Richardson has the precise mind for detail of former Secretary Robert McNamara, he lacks McNamara's personal abrasiveness Of concern to industry is his demonstrated interest in systems analysis and its potential for slowing the decision-making process and the selection of contractors. □

Military

New buzzwords for 1973 in the Department of Defense and the three armed services are "hi-lo force mix" and "design-to-cost." Both terms are destined to have significant impact on military electronics spending. The concepts, first laid before industry late last summer, will be implemented this year to counter rising public and congressional pressures to slow military outlays.

Outgoing Defense Secretary Melvin Laird has already warned that spending in the fiscal 1974 budget, due for delivery to Congress later this month, contains a built-in $4 billion increase, mostly for personnel pay increases and benefits already voted. On the other hand, President Nixon has ordered DOD to freeze $3 billion in spending proposed for fiscal 1973, which ends June 30.

Though economies are forecast to come in the form of civilian and uniformed military staff reductions, as well as cuts in the number and size of U.S. bases, military electronics manufacturers believe they, too, will be affected, particularly by the move to the new force mix and cost emphasis. The Pentagon "will become more selective," concluded an Electronic Industries Association assessment of major weapon system acquisitions.

Defense Research and Engineering Director John S. Foster Jr. was blunt about the consequences of cost increases by contractors: "failures under the design-to-cost approach will result in early terminations," instead of "desperate efforts to patch up an initial mistake."

RDT&E rise is largest

Spending in 1973 for research, development, test and engineering and for operations and maintenance ac-

counts are forecast to get the largest percentage increase. RDT&E is to rise by 5.8% and O&M by 5.4%, while procurement will go up a bit more than 1%, its smallest increment in memory.

"We have turned away from Vietnam and must now get our inventories in order," says one senior DOD budgeteer by way of explaining the RDT&E rise. "As for O&M, we will be retrofitting more systems, including aircraft, with new weapons and countermeasures, and substantial electronics will be involved there." However, the RDT&E increase "is less than Foster wanted," he concedes, and is not all that it appears to be, since it covers outlays transferred by Congress back to development from procurement accounts. Typical of these are the $53.2 million for the Advanced Airborne National Command Post and $1.6 million for the new Defense Communications Satellite. "Congress felt they weren't ready yet," explains the budget analyst for the DOD comptroller, "even though it left $107.6 million in for AANCP procurement." For DCS' communications R&D, the Air Force got another $31.8 million.

Congress expresses itself

The Democratic leadership in Congress, antagonistic to the Nixon Administration, before the session adjourned also expressed a number of other feelings about military spending that will affect this year's outlays. Although it reduced the total RDT&E budget request to $7.95 billion, a cut of less than 10% that left most electronics intact, the final fiscal 1973 appropriation dropped procurement accounts to $17.79 billion, down $3.36 billion from the request and initial authorization.

Leonard Sullivan, Foster's DDR&E deputy, sees "little opportunity for growth in 'purchasing power' by 1980" on the basis of inflation and maintenance of static force levels. DOD therefore is opting for the so-called "hi-lo" force mix, based on high-technology in "a small élite force" for first line of defense, plus a less sophisticated "standard force with low total costs."

In RDT&E appropriations, the Air Force and Navy came out on top in that order, as they did in procurement, and the Army is still struggling with cutbacks mandated by the Vietnam withdrawal. An Air Force advanced short-takeoff-and-landing aircraft is proceeding with $29.2 million in its accounts, even though it is merely entering the study-contract stage. The plan will need new avionics, the Air Force says, but those contracts are still in the future. The Airborne Warning and Control System, on the other hand, got $233 million for fiscal 1973, most of it to be contracted to prime supplier Boeing Co. and radar builder Westinghouse Electric Corp. for tests.

Renewed Air Force interest in strategic systems was demonstrated by a Congress that left $112 million in R&D monies for the Advanced Ballistic Reentry System and $48.6 million for the Subsonic Cruise Armed Decoy, which has more than 20 electronics subcontractors.

The Air Force will more than double its purchase of McDonnell Douglas F-15 air-superiority fighters in the next fiscal year. It asked to buy 77 for $802 million, compared to the 30 approved for $422 million this year. Also this year, the service will take 12 General Dynamics F-111F models at $180 million, building toward a larger buy next year. The Air Force will buy another 24 A-7D tactical jets from LTV Aerospace this year, as will the Navy with its A-7E Corsair II models.

Navy takes cuts

Navy tactical missiles, as well as a couple of aircraft and ship programs, have taken some funding cuts, however. Raytheon's AIM-7F advanced Sparrow missile, for example, has only $25 million instead of the $77 million the service wanted. On the other hand, the existing AIM 7E/F model receives $83.1 million. Still to be bought, but in smaller quantities, by the Navy this year are Raytheon's AIM 9-L Sidewinder, the Hughes AIM-54A Phoenix for the controversial Grumman F-14 fighter, General Dynamics' AIM-28A Standard, and the Texas Instruments AIM-45A Shrike, for which Sperry Rand is a second source.

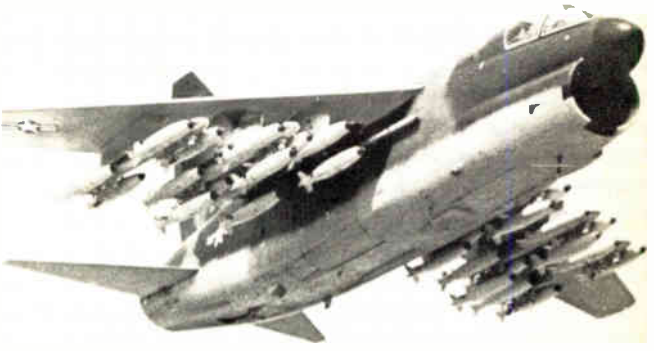
Increases in military spending for communications and intelligence systems will rise significantly for electronics, which typically happens when hot wars turn cold. Even though the Litton Industries Inc. DD-963 destroyer program is in trouble with Congress for cost overrruns and performance, as is Lockheed Aircraft's carrier-borne S-3A ASW aircraft, the Navy is pursuing a number of modular electronics programs for ships and planes that hold promise for industry. The service has budgeted, for example, nearly $57 million for this year's procurement of SSQ-53 sonobuoys, as well as a classified number of millions for a new ASW-center command-and-control system.

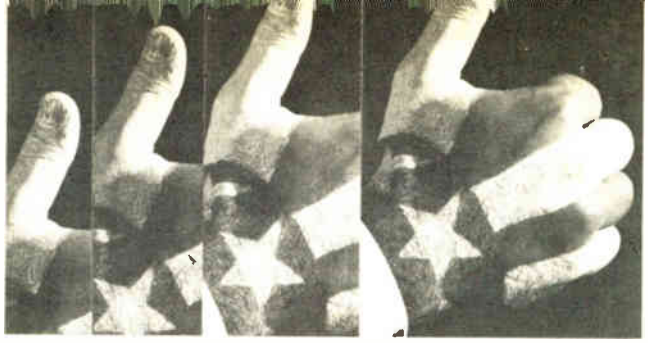
Its biggest new ship program, the Trident underseas launched missile and its new submarine replacement for the Poseidon boats, is proceeding with $311 million for the boat, plus $535.4 million for RDT&E and $505.4 million for missile engineering. And the Navy's Fleet Satellite Communications (FleetSatCom) system is going ahead with $27.5 million in procurement money, in addition to a nearly comparable amount for R&D. □

Aerospace

Barring drastic Administration-directed cutbacks, the Federal aerospace picture looks about the same this year as it did in 1972 for the two big civilian spenders,

More coming. The Air Force will buy 24 more A-7D tactical jets by June 30, giving LTV Aerospace and avionics suppliers a boost.





the National Aeronautics and Space Administration and the Federal Aviation Administration. But the skies aren't necessarily bright for electronics companies looking for new programs.

NASA isn't finding much room for new starts, and, in fact, is delaying some ongoing programs. The FAA, while spending at a higher rate, is continuing its mammoth upgrade of the air-traffic-control system and plans a small increase in research and development programs. As a result, companies will have to watch carefully to snare the good contracts.

For NASA, the $5 billion space shuttle will not only open a new era in space, but it also is designed to carry NASA's present budget level for the next several years. For electronics contractors, however, the space bus won't be carrying much electronics this year. The shuttle is under cost-reduction pressure so that hardware buys will be delayed. Avionics funds have been reduced for this year, and only an instrumentation and possibly a computer subcontract remain to be awarded for the $2.6 billion orbiter. Winner North American Rockwell has specified Honeywell for guidance and control and IBM for systems integration.

In space exploration, NASA hopes to begin two new starts toward the end of the year: a potentially $300 million-plus outer-planets program to Jupiter and Saturn, and a two-craft Pioneer/Venus program.

But, as a sign of the times, on-going programs are running into budget trouble. The $200 million-plus High-Energy Astronomical Observatory, being built by TRW Inc., has run into severe cuts so that the launch of HEAO-A is now set a year later for 1976.

Hughes Aircraft Co.'s first Orbiting Solar Observatory also will need crucial money this year to help it recover from funding setbacks. Even the proposed new start of Pioneer/Venus was cut from an estimated four-spacecraft program to only a probe and an orbiter.

Meanwhile, the $800 million Viking program of two automated probes to Mars for which Martin Marietta is the prime industrial contractor, is "on schedule and within costs," reports Vincent L. Johnson, deputy associate administrator in NASA's Office of Space Science. And Mariner Venus/Mercury, which Boeing is building for project manager Jet Propulsion Laboratory, is set for takeoff later this year.

NASA mulls Detroit approach

In applications satellites, NASA, taking a leaf from Detroit's book, would like to build three main families of satellites and buy them in lots of five or more. The first to surface as a possible new program is the heavyweight Earth Observation Satellite, essentially a huge box weighing up to 5,000 pounds at launch. A design contract could be let before the end of the year. NASA still is mulling the middleweight Interior Operational Satellite and the lightweight Small-Applications Satellite families.

The Applications Technology Satellite F, being built by Fairchild Industries, is back on a new course after encountering funding and design problems. NASA insists that the follow-on G will go up as scheduled a year later, in 1975. General Electric is building Earth-Resources Technology Satellite B for this year's launch, following the highly successful launch of the initial vehicle last year. GE's Nimbus E and Philco-Ford's Synchronous Meteorological-Satellite programs continue. But RCA's Tiros-N faces a potential delay.

In NASA's Aeronautics and Space Technology office, the promising digital fly-by-wire program [*Electronics*, Dec. 4, p. 76] faces a go-ahead decision for the next phase. The office will fund conceptual or small breadboard studies of such exotic approaches as automatic vertical-takeoff-and-landing flight systems, short-takeoff-and-landing avionics, pilot-warning indicators using open-access doppler technology, and low-cost flight directors for light planes, says Guidance, Control, and Information Systems division director Frank J. Sullivan. For space, the office will underwrite programs in such technologies as optical mass memories, optical parallel processors, magnetic-bubble memories and charge-coupled devices.

MLS phase award nears

Meanwhile, back at the FAA, the agency soon will award the second-phase contracts for development of the microwave landing system to no more than four of the six teams led by these companies: Airborne Instrument Laboratory, Bendix Corp., Texas Instruments, Raytheon Co., Hazletine Corp., and ITT Gilfillan Inc.

The agency is still agonizing over a national standard for a collision-avoidance system. Such a system could mean a huge market to electronics companies.

Two other Federal agencies are developing satellite programs. The Interior Department is so enamored with the ERTS-A that it wants to start building an ERTS-C this year. If approved, the $40 million program would probably go to ERTS-builder GE, which would most likely keep electronics subcontractors RCA and Hughes.

The Maritime Administration is trying several approaches on its way to getting an operational maritime satellite [*Electronics*, March 27, 1972, p. 68]. It is talking with NASA about dusting off an old engineering prototype of ATS-2, getting aboard ATS-G, or obtaining use of one of the proposed SATS satellites. □

Stretching the shuttle. NASA's space shuttle orbiter deposits a payload. Shuttle avionics hopefuls will have to wait for added funding.

Civil

Outside the blockbuster military and aerospace appropriations, Federal electronics programs tend to be small and scattered. The one exception this year is the quasi-Government U.S. Postal Service. It's about to embark on a multibillion dollar project to upgrade the nation's mail system [*Electronics*, Nov. 6, 1972, p. 67]. Otherwise, electronics spending in the civil category promises more in possible future markets than in current spending.

Big question marks this year are the Department of Health, Education, and Welfare and the Environmental Protection Agency. Officials in both agencies brace themselves for an unexpected Administration economy drive on their spending programs.

Thus, program managers at HEW, which has relatively small electronics programs, considering that it is the largest department, cloud their forecasts with extensive qualifications. Under a new Secretary, social programs using innovative and expensive electronics aren't expected to fare well. Another problem is that electronics education R&D now belongs to the newly formed National Institute for Education, which doesn't have a full head of steam yet.

The Postal Service hopes to let contracts within a year for the first equipment buys in what may turn out to be an electronics revolution in mail delivery. A host of companies are lining up to bid for electronics or electronics-related gear that the service estimates could cost some $2.4 billion over the next several years.

Automation planned on land and sea

Bolstered by a congressional mandate to upgrade the U.S. Merchant Marine, the Maritime Administration is embarking on a series of development contracts to automate cargo ships and tankers. It plans to spend about $6 million on R&D in two large advanced navigation and communications and shipboard automation programs to develop a range of equipment from collision-avoidance gear to automated ship-performance-monitoring and automated ship communications.

In the Department of Transportation, the Urban Mass Transit Administration and the Coast Guard plan electronics programs. UMTA spends about $30 million for technical studies and out of the research and development will come systems that can be certified. Automatic vehicle monitoring systems also will receive attention, says Carlos Villarreal, UMTA administrator. This year, the Coast Guard will enter the second phase of the river and harbor aid to navigation system (Rihans), for which Collins Radio Co., RCA Corp., and Tracor Inc. have been competing [*Electronics*, July 17, 1972, p. 28], and is planning to upgrade the domestic Loran A stations with Loran C equipment.

Companies looking for large projects from the Law Enforcement Assistance Administration face a continuing problem: the agency's research arm, the National Institute for Law Enforcement and Criminal Justice, hired two firms to perform its evaluation and development. And, although the agency does give grant money for computer information systems, the funds go to integrate existing local systems and hardly ever for mainframes, says George Hall, assistant administrator for the National Criminal Justice Information and Statistical Service. It plans to initiate some programs in electronic-hardware development, however [*Electronics*, Aug. 14, 1972, p. 42]. □

Computers

Economic recovery whips computer market along

For the computer industry, the recession seems over. Most companies did well in 1972, and the outlook for 1973 is rosy. Sales of computer systems, including peripherals shipped with the systems, amounted to $5.421 billion against $4.300 billion for 1971. In some areas, notably semiconductor memories, sales rose even more than that heartening 26%. As for 1973, the consensus is for another good year, totaling maybe $6.3 billion—up nearly 17% from 1972. That's not at all bad, especially since it starts from a higher base than did 1972's figure.

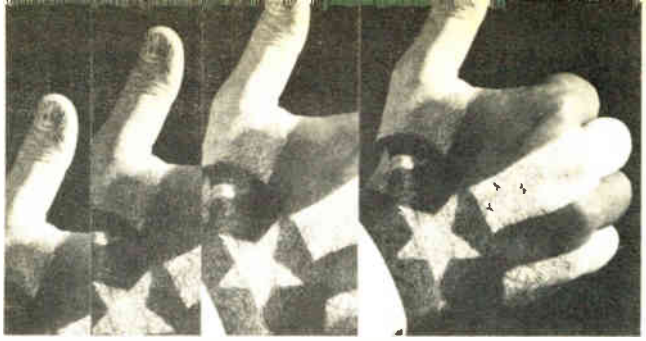
With the return of prosperity comes the prospect of a number of significant events in 1973:

- An increased growth rate for computer services, reaching perhaps 20% for the year.
- First installations of IBM's new virtual-storage computers.
- Further inroads by semiconductor memories into mainframes and sophisticated peripheral equipment.
- Accelerated use of distributed networks of computers, involving smart terminals, "democratic" computers (an array of equivalent members), and hierarchies of computers (transmitting successive levels of computation from small simple machines upward to larger, more sophisticated models).
- As part of the network concept, but going beyond it, increased use of data communications.

Recovery

Unquestionably the economic resurgence of 1972 will encourage the computer industry's growth in 1973. The downturn in 1970 and 1971 came late enough for many users to have already implemented their basic requirements; when the pinch came, they temporarily postponed their less important needs. "Now, as the economy improves, these backlogged applications will be developed and will provide an underlying strength to the market," says John J. Balco, a senior market analyst at Honeywell Information Systems Inc.

Already some companies are reporting a substantial improvement in incoming order rates, which will also be helped as the Vietnam war continues to wind down and research and development spending increases. "Our third quarterly report shows a 9% increase in order rate over the corresponding period of 1971," says a National Cash Register Co. spokesman. "Increased R&D spending means more computer procurements," says Donald E. McKee, vice-president, computer marketing, at Xerox Corp., "and that'll provide a real boost for



computer manufacturers in 1973 and 1974."

From 1973 onward, computer firms will be able to derive certain cost benefits from the increased use of semiconductors in consumer products and automobiles. While the computer industry may not utilize exactly the same components, it can take advantage of previously installed capital equipment, such as diffusion furnaces and wire bonders, which will have been at least partially charged off. Consequently, reduced prices will offset increasing shipments in terms of the number of units, and will tend to flatten out the dollar-shipment figures.

The predicted increase of 16% in computer markets actually will consist of only about 8% to 10% in the hardware market, according to one source, who calls attention to a sharply increased growth rate for computer services of perhaps 20%. These services include not only the usual service-bureau kind of operation, but also the programing skills represented in a system that is easy for an unskilled person to use. Such a system sometimes includes fancy hardware, but more likely fancy software, which can recognize the user's attempts to "talk computerese" and translate them properly.

New machines and new technology will figure strongly in 1973's computer-industry shipments. IBM's new models of the System 370—the 125, 158, and 168—will begin to appear in customer installations; all three feature virtual storage.

Trend setter

Because IBM clearly dominates the marketplace and enjoys unmatched economies of scale, it can set trends all by itself and bring about market acceptance of concepts like virtual storage almost without trying. Virtual storage is an old idea—Burroughs and RCA are among the companies that previously introduced it, and IBM also used the concept in its System 360 model 67. But its time seems finally to have come, for its use in the new 370s now makes it a significant trend of the future.

Virtual storage will also strongly influence the sales of high-performance bulk storage units, primarily magnetic-disk units and drums, because virtual storage relies on these external units to provide the capacity that appears to the user as one vast storage space. Independent makers of peripheral equipment compatible with IBM computers have already hastened to announce either new or added capability for use with the virtual-storage systems. "By the end of 1973, most manufacturers will have introduced or enhanced virtual-memory systems," says McKee of Xerox.

"But not everybody can use virtual storage," says Winston R. Hindle, vice-president and general manager of Digital Equipment Corp. for medium- and large-scale systems. "Our DECsystem 10 has the hardware capability, and we're studying how to incorporate the software required to utilize it; but at the same time we don't want to add overhead for those of our customers who don't need virtual storage—customers who run hundreds of small jobs all at the same time, or interactive time-sharing users."

Changing memory technology

Semiconductor memories came into their own in 1972. Although many observers had expected them to be widely accepted in 1971, they appeared in a significant number of new machines only the following year. In 1973, they are sure to continue to make new inroads into territory formerly occupied primarily by ferrite-core memories, although cores will still have by far the bigger market share. This progress is aided strongly by IBM's use of semiconductor memories. For the most part, they are showing up first in small systems and in peripheral equipment, and moving up gradually to the larger machines as they become cost-effective—although, paradoxically, IBM made its major move with semiconductors in two large computers.

But these trends, important though they are, don't mean that semiconductor technology will take over the entire memory market in 1973. "Computer equipment users relate technology to how it helps them solve a problem or how it reduces cost," says Honeywell's Balco. "They're not interested in technology *per se*."

"We expect also to see larger and lower-cost core memories," says Andrew Knowles, Digital Equipment Corp. vice-president and general manager in charge of small computers. "The core guys won't stand still; they maintain 90% of the market today, and they're not going to wait for the semiconductor guys encroaching on them. And we'll take advantage of better core memories in our small computers when they show up, as well as semiconductor memories."

As a result, the new trends in memories still have a way to go. "They'll be quite evident in 1973," says Curtis W. Fritze, vice-president and senior staff consultant at Control Data Corp., "but they'll reach maturity around 1975 or 1976."

The new high-density semiconductor chips with 2,048 and 4,096 bits will appear in systems during 1973—Microsystems International Ltd. already offers a system based on a 4,096-bit chip [*Electronics*, Dec. 18, 1972, p. 97]. But when compared with the total amount of memory capacity shipped, these will still be only "a drop in the bucket," according to Control Data's Fritze.

The year ahead should also see the computer marketplace altered by internal changes in IBM. Last year's report said the situation at IBM was unlike any it had experienced in recent years: the company's rate of growth slowed instead of continuing to increase. At that time, T. Vincent Learson was just beginning to make his presence felt as chairman of the board, having taken over from Thomas J. Watson Jr. the preceding summer.

His presence was undoubtedly felt during 1972—witness the sharp upsurge in earnings and the company's stiffer competitive stance. IBM's consolidated net income for the first nine months of 1972 was $938.8 million, up from $772.8 million for the same period in 1971 and $742.2 million for the first nine months of 1970. The differential from 1970 to 1971 was thus $30.6 million,

while that from 1971 to 1972—under Learson—was a whopping $166.0 million.

The company's posture will be affected in 1973 by two other factors. First, Learson is leaving the presidency, and his forceful, table-pounding presence won't be as strongly felt. Second, the anti-trust suit brought four years ago by the U.S. Department of Justice appears to be maturing rapidly.

Learson, having reached his 60th birthday, kept his promise made several years ago to retire at that age. He'll stay on the board of directors, however. His replacement in the top spot, effective Dec. 31, 1972, is Frank T. Cary. Although Cary is an able executive with several years of experience in the higher levels of the company, he is quietly persuasive—an entirely different kind of man from Learson. As such, he's almost certain to generate some differences in the company's operation and therefore in the computer industry.

In the antitrust case, it's an open question whether the Government's demand that IBM be divided into several smaller independent companies will be granted, and opinions differ on whether it should be granted.

But just what effect Cary's accession and the settlement of the antitrust case will have in 1973 is a matter of speculation.

Communication is hot

What isn't a matter of speculation is that communications-oriented systems are growing mightily in importance, pointing to a large market for switching equipment, which is usually minicomputer-controlled. Many of these systems are appearing as networks of computers of more or less equivalent capability. Others contain one or more large central processors with a multiplicity of terminals, which may themselves have more or less local computing capability. "I expect that many of today's terminal applications will become terminal processors," says Frank H. McPherson, vice-president, marketing, at Decision Data Corp., which manufactures a line of 96-column punched-card equipment. These processors will handle branch-office data processing routinely and communicate with the headquarters central processor when access to a central data file is required. "Communications terminals are a rapidly expanding product market opportunity," says McPherson, adding that he believes they will become more and more "intelligent" as time goes on.

"The acceleration of the movement toward distributed networks is the most significant trend we see in the 1973 market," says McKee of Xerox Corp. "Large centrally located computers will still be needed, but manufacturers will provide more and more equipment at remote sites."

McPherson's view is shared by Honeywell's Balco. "Current communications applications tend not to be complex, nor are they high-volume applications," he says. "But users who have gained experience in communications systems are preparing to expand applications to higher-volume, more complex systems." Meanwhile, Balco sees a payoff for present computer users who do not utilize communications capability to enter the new environment. These users see the demonstrated success of current systems, he says, and find a wide range of terminals and software available. Conversely, as the use of communications systems increases, the demand will increase for simple, easy-to-use software, terminals for specific applications, reliable, maintainable, fail-soft equipment, large, easily-accessible files, and flexible, powerful control equipment.

Winston R. Hindle of Digital Equipment Corp. agrees, with reservations. "There's a trend toward these small multiple systems," he says, "but there's still a lot of interest in batch work. I don't think batch computing is going to go away. At DEC we're trying to capitalize on time-sharing with simultaneous background batch capability."

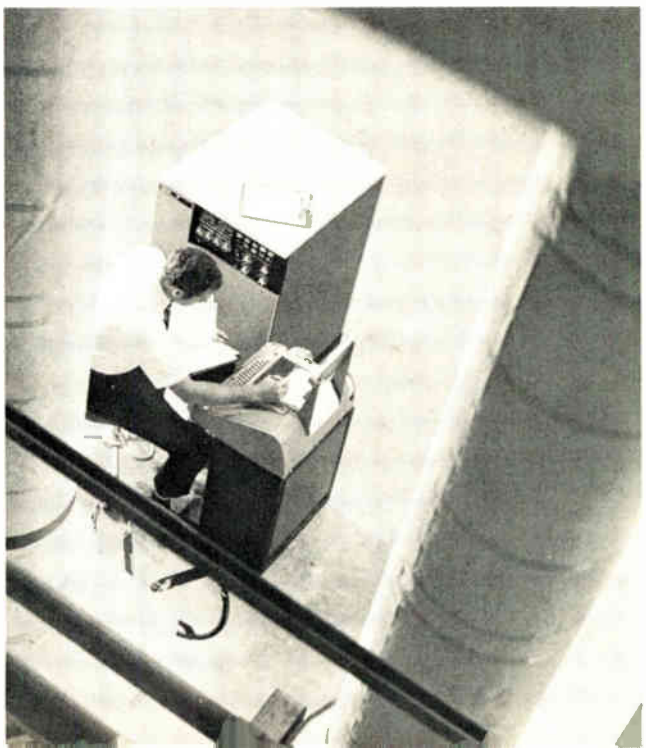
Expansion in minicomputers

For minicomputers, both OEM and end-user markets are broadening. To reach these markets, minicomputer makers will continue to expand their lines, both traditionally, by reducing price and increasing performance, and by breaking new ground—building peripherals "at home" rather than purchasing them and adding broader systems software, including high-level operating systems and programing languages. And the increased activity in services noted for the computer industry as a whole applies as well to minicomputers.

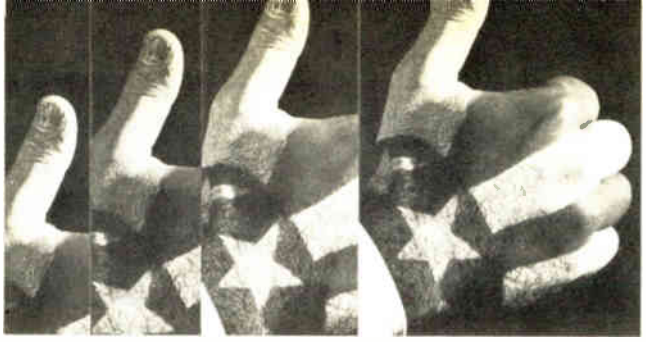
"Our problem at this point is not orders, it's producing enough to satisfy our customers," says DEC's Andrew Knowles. "Our sales forecast for this fiscal year—which ends next June—was optimistic, but we've already had to revise it upward once and probably will have to do so again."

"We see a strong demand from the OEMs," Knowles says. "And the end-user market looks good too—especially the industrial area. It's capital-intensive, for modernizing and improving productivity; and every new scheme for modernizing is minicomputer-based."

This growth in the minicomputer market applies not only to the classic scientific and process-control minis



Earning its keep. Computers are being used more in manufacturing, as typified by machines such as IBM's System 7.



but also to the small commercial systems, notably the IBM System 3. This is a particularly appealing prospect to Decision Data Corp.'s McPherson. "Computer users will continue to expand their existing facilities with increased emphasis on multiprograming and communications capability," says McPherson. "Meanwhile, larger computer users will continue the trend toward distributive data entry," as distinguished from pools of operators transcribing data onto cards or tape. "But at the same time," he continues, "the need for buffered card data recorders will expand for those applications where direct transcription is best and for the large base of new small-system users who require punched cards—80- or 96-column—as their main input medium."

Significantly, the rapid turnover in minicomputer firms seems to be tapering off. "The trend toward fewer, well-financed competitors—contrasted with the vast abundance of suppliers, many of them questionable, in recent years—should mature in 1973," says Edson D. de Castro, president of Data General Corp. "Eventually only five or six solid suppliers will remain to service practically the entire market—more effectively than the multitude of companies could before."

De Castro's firm, like all others, has been enjoying a strong trend toward new end-user applications. But he doesn't see the OEM market drying up. "If anything, it's stronger now than it ever was," he says. "Hundreds of new applications for minicomputers are popping up every day, and the minicomputer-maker's OEM customers will service most of them."

De Castro's remark about the consolidation of minicomputer manufacturers applies equally well to the makers of minicomputer peripherals—supplying those mainframe makers that don't build their own peripherals, as de Castro is doing. Eventually "there will be a half-dozen or so manufacturers offering complete peripheral product lines to the industry," says Frank Druding, chief executive officer of Iomec Inc. "This will spread the manufacturing and marketing overhead over a broad product base and is necessary for these firms to remain competitive. In addition, they will be able to offer the customer savings in selling and buying costs."

Meanwhile, these manufacturers will continue to penetrate markets that have been captives of the mainframe companies up to now. Also they'll be able to lower their prices even further. "We see average price decreases of 10% to 15% from 1972 levels, due more to competitive pricing among independent manufacturers than to conditions that mainframe manufacturers might impose," says Eugene E. Prince, vice-president and general manager of Ampex Corp.'s Computer Products division. He emphasizes that many independent manufacturers will have to improve their production techniques to withstand these reductions. □

Solid state

MOS, bipolar ICs whirl semi sales to new heights

Riding the upsurge in demand from computer, datacommunications, and industrial-equipment manufacturers, the semiconductor industry will reach an historic $1.65 billion, posting a 13% increase over an unexpectedly strong 1972 finish. Indeed, the advance expected this year is the more impressive when judged in terms of 1972, which itself scored a resounding 16% increase over a rather dismal 1971 market, reaching $1.45 billion in U. S. factory sales. That level of activity surprised even the most optimistic '72 forecaster.

Though all segments of the semiconductor industry will participate, MOS integrated circuits are still growing fastest, and digital bipolar ICs are prospering only slightly less. Linear ICs will also boost their 1972 total by more than 25%, and optoelectronic devices will end up with an increase of more than 40%. Even discrete components will be in strong demand.

While the industry is basking in the glow of new prosperity, however, some forecasters are warning that the second and third quarters of 1973 could be a real test of whether the current boom will continue. The most pessimistic of the seers look for an actual downturn in the fourth quarter, while others expect the market to continue expanding into mid-1974. Whether or not a slump actually occurs, the current business climate is certainly a challenge to the semiconductor industry to avoid building up the disastrous overcapacity that occurred two years ago and that culminated in vicious price-cutting and attrition among the semiconductor vendors.

MOS: still king of growth

From its modest beginnings ($2 million in 1970), MOS activity has grown so rapidly that it now rivals TTL circuitry for dominance among ICs. Once a minor custom market served by a handful of specialty manufacturers, the MOS business is fast becoming a highly competitive standard-product industry, in which many semiconductor makers, both large and small, are searching to find their place.

Significantly, the crossover from predominantly custom to predominantly standard products will occur this year. This shift some observers interpret as signaling a measure of maturity, and with it a degree of price erosion, in MOS products. Their argument is that, as the standard-product segment increases, so does the number of manufacturers making competing products. The result: drastically lower prices. These analysts point to the dismal price experience of TTL suppliers, and see the softening of the unit price of some MOS products, such as calculator chips and standard random-access memories, as early indicators of trouble ahead.

However, to judge by the dollar activity for both the custom and standard segments anticipated in Fig. 1, this theory does not presently apply to the MOS market. Clearly, standard products represent the bulk of MOS growth, and will indeed account for 75% of the total

market in 1975—$210 million in U.S. factory sales. Nor does the custom segment of the MOS market look like sagging, for, although its fraction of market share declines, its total dollar value is maintained at the $90 million level, which is nearly as high as the market value of the entire linear segment.

If standard products are spearheading MOS growth, then memory is the tip of the spear and random-access memory is the thrust behind it. RAMs will double in market value in 1973 and again by 1975, by which time they will have two-thirds of the MOS memory market. In contrast, read-only memories and shift registers, the other MOS memory segments, will exhibit at best a slight increase.

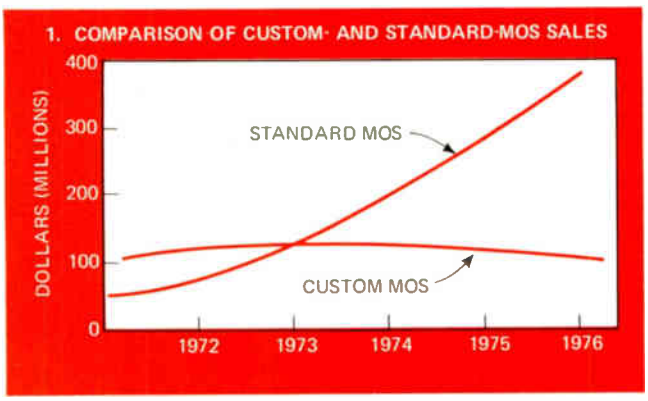
By far the best-selling RAM product in 1972 was the 1103-type memory pioneered by Intel and now second-sourced by a dozen manufacturers. Having been designed into many systems, it should continue to dominate MOS memory sales in 1973. Because it is so widely sourced, however, the 1103 is under strong pricing pressure, with some big buys in the $3 per unit range. By 1974, moreover, it will also come under growing technical pressure from other 1-kilobit p-channel RAMs—such products as Advanced Memory Systems' 6002, National's 5260, Fairchild's 3534, and Mostek's 4006.

N-channel comes on

Following a trend that started in 1972, 1973 will see n-channel MOS memories enter the marketplace in volume, a development that is likely to bite sharply into the existing 1-kilobit p-channel market. Already 1,024-bit n-channel RAMs with fast access times of less than 100 nanoseconds are causing computer memory designers to consider it as an alternative to the 1103 type. Another popular n-channel memory, the static RAM, needs only a single +5-volt supply, thus offering both speed and an ease of use not found in the dynamic memory, which requires multiple supplies.

To further complicate the MOS memory market picture, the 4,096-bit n-channel RAM will also make its debut in 1973, putting another nail in core's coffin. Another mainframe technology, the 4-kilobit RAM is attractive for its high speed and low price per bit. It will be available from several semiconductor suppliers, including Intel, Microsystems International, Signetics, National, Mostek, and Electronic Arrays.

As for the balance of the MOS memory market, read-only memories and shift registers will still be mainly confined to terminal and point-of-sale peripheral equipment. They are expected to stay at about 10% of the MOS market over the next few years.



On the MOS custom market front, calculators are still the big action area, accounting for 40% to 45% of the total 1973 MOS market. Charles Kovac, vice-president, marketing, of North American Rockwell Microelectronics Co. (NRMEC), puts the sales of calculator chips in 1972 at $1.5 million and looks for double that in 1973. Says Kovac, "The demand caused the severe calculator chip shortages last year and spilled over into calculator displays as well." He sees the shortages ending in 1973, when makers have added capacity.

The next custom market boom may well be for microprocessors. Bill O'Mera, manager of MOS marketing at Fairchild, says that the three- to five-chip set for microprocessor machines will "take over the spotlight after the calculator. In fact, by 1976 it could be larger than the calculator market itself." NRMEC is another supplier bullish about the microprocessor chip-set market and is planning a microcomputer set adaptable for use in cash registers, terminals, and other business machines. NRMEC sees a 30% MOS growth rate coming partly from some of the opportunities in new equipment.

Unlike other semiconductor manufacturers, National's custom MOS business is "going through the roof," according to Jerry Larkin, MOS marketing manager, who sees "the next big business-machine opportunity as the six-digit chip that will show up in consumer calculators selling for $39.95." Larkin puts the custom MOS business at about 50% of the total 1973 MOS market, dropping to 40% in 1974 and reflecting the industry trend toward standard circuits.

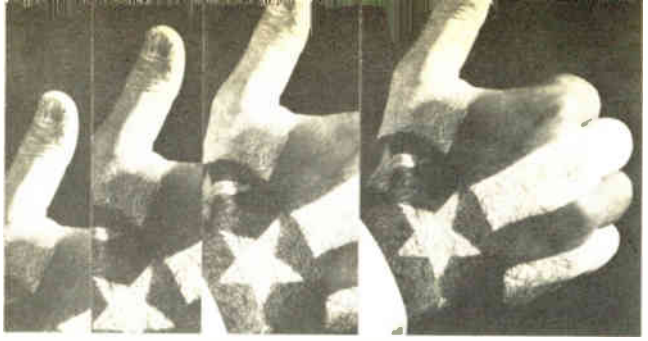
C-MOS: taking the great leap forward

One of the brightest spots in the semiconductor market is the sudden emergence of complementary-MOS as a standard logic technology, foreshadowing a great future for this family of the late 1970s. Originally used primarily for custom low-power applications, C-MOS is now showing itself to be extremely competitive with TTL, and in some cases emitter-coupled logic, for jobs requiring the lowest speed-power products. This means the high-volume, big-computer control logic boards. Traditional applications are watch circuits and battery-operated communications systems because of C-MOS low power requirements, and automobile control, because of its high-noise immunity.

There are now two kinds of C-MOS logic chips: the conventional 4000 type, pioneered by RCA and followed by Motorola, which also has its own proprietary C-MOS circuits, and the standard TTL type. Until recently the only C-MOS logic on the market was the 4000 type.

Then late in 1972 National announced its C-MOS 74 series, pin-for-pin replacements for the low-power TTL parts. According to Bob Bennett, C-MOS marketing manager at National, the acceptance of the C-MOS 74 series has been so gratifying that he expects to have about 35 C-MOS parts in the line by early 1974. "The move from the low-power TTL (the 74L) to C-MOS (74C) is now underway," he says.

With this in mind, Bennett puts the C-MOS market for TTL-type logic is expected to reach $15 million in 1973, and $65 million in 1976. When all other circuits are



counted, the C-MOS logic market should reach $100 million by 1975, up by an astonishing ten times from its $8–10 million 1972 figure.

Both RCA and Motorola are optimistic about the C-MOS logic market. RCA is planning to expand its 4000 series along these lines, adding more MSI circuits in 1973 and 1974. Motorola is planning to add a variety of proprietary C-MOS MSI and LSI circuits, including the first majority-logic C-MOS circuit.

The 4000-type C-MOS family is indeed still expected to dominate the market for several years. It has been, and continues to be, designed into almost all C-MOS systems. The design cycle for the TTL type of C-MOS is now just starting, and its market presence will begin to be felt this year. Major semiconductor manufacturers, such as TI, who have committed themselves to a C-MOS type, are apparently watching this trend closely before deciding which way to go.

In any case all C-MOS logic families have an advantage in all systems, not just those that are battery-operated or power-sensitive. Examples of these are military programs using airborne equipment and mobile communication. "In industrial and computer equipment," says Bennett, "power costs about $1 per watt, and typical TTL systems may consume about 100 watts. C-MOS logic equivalents could cut power costs in half."

As for new technology in C-MOS, Harris Semiconductor is leading the way with the dielectric-isolation C-MOS family it introduced in mid-1972. Following the RCA 4000 series, Harris plans to add to its DI family throughout 1973 and also plans to reproduce some of Motorola's C-MOS circuit types in DI versions. It expects to have a DI family of about 50 parts by the year end.

As for the watch and calculator C-MOS market, it is difficult to pinpoint the exact market totals because it is a custom business, but many put it in the tens of millions. C-MOS is fast becoming the standard electronic watch technology so that as the price of these watches drops below the $50 mark, this segment of the market could account for 50 million C-MOS circuits sold every year. However, there is competition in watch circuits: TI has developed a low-power bipolar watch circuit that has gained a strong market. And p-MOS approaches to low-power circuits are under development.

C-MOS circuits also are gaining in popularity in many battery-operated communication systems and in many military systems where high noise immunity is needed. Moreover, C-MOS lends itself to radiation-hardening, and is used increasingly in military weapon systems.

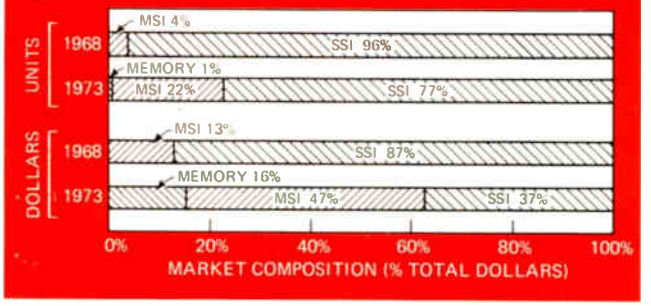
Bipolar memory: a new ball game

1973 will see bipolar memories come into their own. Most impressive will be the growth of the 1,024-bit RAMs that were only just being sampled last year. These are expected to come on stream from a host of semiconductor manufacturers. The bipolar memory market in 1973, when the ROMs and 256-bit RAMs are included, should reach $62 million, more than a 90% increase over 1972.

Most interested in the new bipolar RAMs are the big mainframe manufacturers who see them as the great white hope for the speed planned in the next generation of machines. But bipolar RAMs also will be a mainstay of the add-on manufacturers, who until now have been using the 256-bit RAM, with its 35-ns access time, but will switch to the 1-kilobit part when it is available—it provides them with the same speed and four times the bit density on a quarter of the board space. In 1972, 1 out of 11 bipolar RAM units shipped were 1-kilobit parts. But this year at least half the RAM market will be 1-kilobit, accelerating by 1974–75 to 75%.

Another trend in bipolar memory is the use of ROMs, instead of standard TTL, to perform logic functions in random logic designs. This technique began catching on in 1972, so that now about 30% of all ROMs sold are for random logic applications. ROMs have the advantage of sharply reducing the number of logic packages needed, saving both wire-up cost and board space. They also enable computer-hierarchy designers to combine logic and memory on the same LSI chip. The bipolar ROMs are ideal for this application because they can be programed to look like TTL and accept a +5-v supply. ECL ROMs for logic are also in the offing in 1973.

2. TTL MARKET FOR MEDIUM- AND SMALL-SCALE INTEGRATED CIRCUITS AND MEMORIES



One significant aspect of the memory market in 1972 was the strong acceptance of electrically programable ROMs for random logic and buffer memories—a trend that's expected to quicken as more manufacturers get into the business. Indeed, by 1975 the programable ROM may well become the dominant ROM technology, and account for 75% of a predicted $15 million ROM market. Harris Semiconductor's general manager, Donald Sorchyk, says that the acceptance of the PROM is due to its ability to do "everything mask-programable ROMs will, but the customer programs his own unit." Clearly, this flexibility allows designers to order the basic PROM, optimize the design, and then program in quantity.

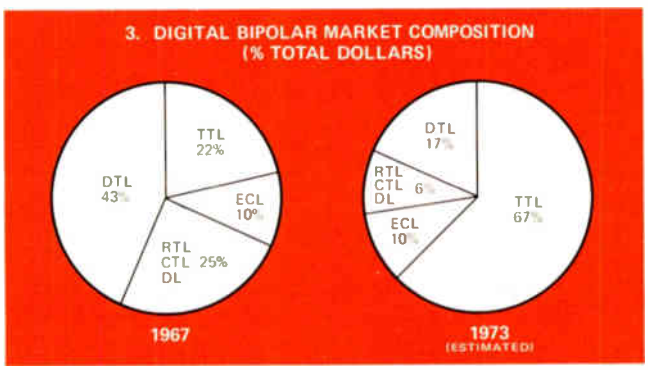
Activity in digital bipolar circuits, which this year will be the greatest ever, surprised even the most loyal TTL rooter. With some prices slipping to 10 cents per gate late in 1971, and supplier after supplier getting out of the business, many looked at the TTL market as a declining market, to be inherited by a few large manufacturers as a tag-on service for its more profitable memory

business. Indeed, start-up semiconductor companies entering the market place for the first time in 1971 chose not to supply TTL circuits, and established giants like Motorola seemed to be wishing they were out of the TTL business.

Then suddenly the turnaround came, early in 1972. TTL prices firmed, big computer contracts came rolling in, and all at once TTL was the golden boy again. And, since so many suppliers had already gone out of the business, the few big ones remaining were reaping the big profits. Estimates of TTL activity put the units shipped last year as 65% over 1971 shipments, with a 50% increase in dollar sales.

What makes the TTL business even more attractive in 1973 is the continuing trend to more complex circuits, with their higher dollar value per package. MSI TTL is a boon to the user since by offering him more functions per package, it lowers package count and assembly costs, reduces interconnect defects, increases reliability, and saves board space. The growth in complexity has indeed been dramatic (see Fig. 2), so that this year almost 25% of all TTL circuits will consist of more than 100 gates. In dollars the gain is still greater, so that MSI dollars account for almost 50% of all TTL sales.

Douglas Rankin, TI's marketing manager for TTL, predicts that the shift to MSI will accelerate in the next few years. He sees the market breaking down at about 50-50 in units and 80-20 in dollars, in favor of MSI, with



half the 80% in memory. Rankin points out that MSI is now well established in the data path of computers, and is even getting into the random logic area—a trend that should greatly accelerate its domination.

Also accelerating is the move away from DTL and other logic families (RTL, CTL, DL) to TTL (see Fig. 3). The shift is primarily due to the flexibility that TTL offers: MSI circuits, low power, Schottky clamp, high speed—all the new varieties of TTL that came on to the market in the last few years, speeding the doom of DTL as a competitive technology.

ECL: nice and flat

Emitter-coupled logic, the fastest logic family, has maintained a 10% share of logic market for the last six or seven years (see Fig. 3). This fact is surprising to many people who thought that, because of its speed, ECL would quickly become the dominant logic system for large mainframes. Even Doug Powell, manager of computer industry marketing for Motorola—the company that pioneered in ECL and supplies most of the industry's circuits—admits that the ECL market "is slower in developing than anyone expected." He feels the sluggish performance is due primarily to the success mainframe companies have had in upgrading their systems with the newer TTL families. Powell sees ECL "taking off in 1974–75, when the new generation of fast, large computers get into production."

Two factors are speeding the growth of the ECL market: introduction by Motorola in 1971 of its 10,000 MECL series, which consumes less power and is cheaper than earlier MECL lines; and the announcement last year by the four other major semiconductor manufacturers (Fairchild, National, Signetics and TI) that they will second-source the 10,000 family—a development that promises lively competition and lower pricing. Already there's a controversy over which 10,000 family type will predominate—some are voltage-compensated, some are not.

Linear ICs: betting on the consumer

Two industries will account for the lion's share of the linear market growth: automotive and entertainment. The auto industry alone could total 15% of the market in 1973, and as much as 25% in 1974. This is exclusive of automobile entertainment systems, which could add on another 10%.

Art Fury, market manager for linears at National, figures it this way: "There's about $3 per car in ICs excluding entertainment—that's $30 million—primarily in ignition control systems, and seat belt sensing and warning systems." For comparison, *Electronics*' survey shows a total automotive market for electronics of $118 million in 1972 and $163 million in 1973.

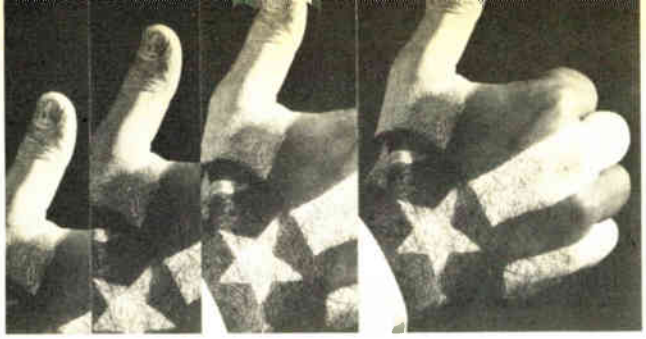
It should be pointed out that the automotive market for electronics is split about 50-50 between linears and discretes. This means a natural elasticity in IC involvement as ICs take on more of the discrete functions.

In the entertainment segment, the greatest activity is in home video systems, in audio amplifiers, where high-power ICs are taking over from discrete devices, and in TV, where single-chip sound channels are becoming available. Another linear trend is the availability of IC function blocks, such as the quad op amp and quad comparator, which lowers the cost per function of these devices.

Rounding out the market in integrated circuits are hybrids. Often overlooked as an IC activity, they nevertheless will reach the $112 million level by the end of the year. A large fraction of their activity is accounted for by military programs, many of which in 1973 will specify more hybrid circuits than ever. In many instances hybrids are being used to replace monolithic ICs because they offer a higher function density and lower weight.

Although most people do not think of the hybrids as a replacement market, Mike Scott, hybrid marketing manager at National, says much of the military activity in hybrids is just that. "In electronic countermeasures, for example," he says, "the equipment designs are continually being changed, and where the older equipment was from 10% to 20% hybrid, the newer systems are from 50% to 100% hybrid.

For discrete semiconductors there's both good news



and bad news. The good news is the unexpected strength of this market, which has been declining. The bad news is that it probably won't continue: the market as a whole is expected once again to give ground as more and more ICs become available that can handle discrete functions.

Discrete devices ride again

Meanwhile, though, discretes are pretty hot. According to Bob Silco, marketing manager of small-signal discrete components at TI, the turnaround came like a shot, early in 1972. "For discretes," says Silco, "the year started as a dog, but suddenly in February, the orders began pouring in. Across the board they came—transistors, diodes, zeners— the whole works. It was fantastic. And it's continued right through the year. It hasn't let up yet."

The boom in discretes can be attributed mostly to computers and to consumer products which are using more and more solid-state components—not only ICs but discrete devices as well. In computers, one of the biggest areas for discretes continues to be core memory drivers, which require high-current transistor outputs to drive the bit lines. "Supplying currents of 600 milliamps and more at high switching speeds is still a discrete function," explains Silco, who sees a fair amount of memory interface staying discrete for a few more years.

This statement underlines the dilemma of obsolescence facing the discrete market. Indeed, a growing number of IC core memory drivers can now handle the high-current outputs. Worse yet, the new semiconductor memories have drivers on the chip, and use IC sense amplifiers for logic detection, completely eliminating the need for discrete devices at either end.

Unlike the computer industry, consumer products account for a growing volume of discrete devices. Three product areas already are experiencing very strong acceptance: MOSFETs, tuning diodes, and multiple components.

FETs are becoming popular for the low-noise, high-gain input in audio receivers and amplifiers. At one time restricted to top-of-the-line products, the MOSFET is now being used in many less expensive units. The price of the device is falling rapidly as methods of building it become standard, so that the number of FET units sold in 1973 should be two to three times greater than the 1972 figure.

The market growth of tuning diodes has been spectacular—from a modest $3 million in 1970 to better than $20 million market today. Many see this market reaching $100 million by 1976.

The very strong showing of optoelectronic devices in 1973 will be tied closely to the calculator boom, which even now consumes a large fraction of the light-emitting-diode displays sold. This display market alone may reach $35 million by the end of the year—up from about $16 million in 1972. This of course presupposes that manufacturers will prove capable of meeting the demand. Some shortages of calculator LED displays have already shown up.

A new development is that many suppliers of calculator displays are selling the complete display module, including the display driving and decoding circuitry. This allows the supplier to assemble the display package and saves the manufacturer the assembly and testing costs. This procedure is being used by Fairchild, for example, with two major calculator makers. □

Commercial

Calculators, auto electronics, POS take off, but not CATV

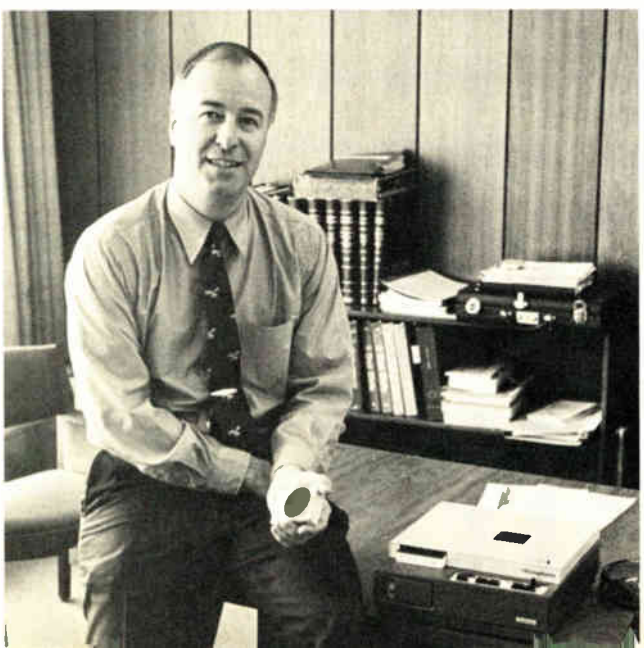
Though business calculators and point-of-sale systems slammed into high gear last year, automotive electronics eased away from the curb, and CATV hardly got out of the garage. Thus, these segments of the industry continued to be a mixed bag of success, potential success, and future potential success.

American business-calculator companies will continue the battle to recapture and hold the market from the Japanese, centering the competition on technical innovations rather than price cuts.

During 1973, North American Rockwell Microelectronics Co., Anaheim, Calif., foresees the high end of the market ($800 and above) shifting down to the middle—that is, around $400 to $800—and the middle-range machines dropping out of existence. The action will center around the low-priced, semi-personal models and the high-end, easy-to-use programable units.

The year of acceptance for point-of-sale terminals and systems was 1972, although retailers have yet to exploit this equipment to its full capacity. This year

Word processor. Hobart G. Kreitler, Dictaphone vp, expects a new burst of profits in office equipment used for word-processing chores.



The 1973 business outlook

For 1973 we forecast a 10% gain in the gross national product, a slightly bigger increase, in dollar terms, than 1972's expansion. Real GNP, after adjustment for inflated prices, will dip to 6.1% from the strong 6.4% gain in 1972. The pace of inflation, however, will be stepped up in 1973, rising to 3.7%, compared with only 3% in 1972.

Over the two years, 1972 and 1973, the economy is expected to expand by more than 20%, while real growth for the two years will approach 13%, a very rapid rate of expansion for any two-year period in our economic history. For comparison, real GNP rose only 5% over the three years of 1969 through 1971.

Business' expenditures for new plants and equipment, which provide a large part of the nation's economic lifeblood, will be up about 14.5% this year, after a 10% gain in 1972. Capital spending will probably rise more than the 11% increase in plans reported in our latest survey. The principal reason investment in new manufacturing facilities will be soaring in 1973 is that many industries will need more modern capacity than they now have. Increases in output have been outstripping gains in new capacity so that the operating rate at the end of the year was about 83%, compared with only 75% 16 months earlier. By spring, the utilization rate should top 85%, the trigger point when companies start stepping up their investment to take account of additional needs for capacity.

Business inventories are still relatively low, compared with current sales and incoming new orders. But a significant pickup in inventory buildup should occur in 1973 in order to keep pace with the rising level of business activity ahead.

Consumer spending for goods and services is forecast to rise strongly. The Index of Consumer Confidence is signaling a far more optimistic attitude on the part of the consumer toward his own and the business outlook than it has for some time. A surge in intentions to buy durable goods, such as consumer electronics and autos, is also in the cards.

Higher wages and salaries, along with rising employment, will provide the thrust to consumer spending in 1973. We now expect an average increase of 7.5% in hourly earnings of manufacturing workers, compared with 6.5% in 1972. It is certain that wage controls will affect considerably fewer workers this year than last.

The number of jobs is expected to rise by about 2 million, sopping up most of the new 1973 entrants into the labor force. Nevertheless, the unemployment rate is not expected to drop below 5% at any time this year.

Housing is the only sector of the economy that will not contribute to growth this year. New starts should average around 2 million units, but that is 20% under 1972's record of 2.4 million units.

The Nixon Administration plans to put the brakes on Federal spending in order to hold down Federal deficits for fiscal 1973 and fiscal 1974. Thus, we don't expect much of an upsurge in spending on defense products, although it is clear that some funds in 1973 will go for replenishment of depleted military stocks.

Finally, the net foreign trade will show a modest improvement over the very poor 1972 showing. U.S. exports should be stimulated by economic recovery throughout the industrialized world. But imports into the U.S. will also get a lift because of the expanding domestic economy.

Although unit labor costs in the U.S. are the highest in the world, the rise was just about halted in 1972 because of a significant productivity improvement. Meanwhile relative increases in labor costs around the world have far outstripped those at home since 1970. The shift from a big deficit to a small surplus in our net foreign trade will result in a positive swing of about $5 billion in the 1973 GNP.

In sum, GNP will top $1.266 trillion this year for a gain of $115 billion, compared to $101 billion in 1972.
—Douglas Greenwald, Chief Economist, McGraw-Hill

should make a sales plateau of around 20,000 terminals a year right through to 1980, leading to a cumulative total of 200,000 units in that period. There are some 35,000 to 40,000 terminals in use now. Dollar volume will lag, however, because the average selling price per terminal will drop from the current level of $3,500.

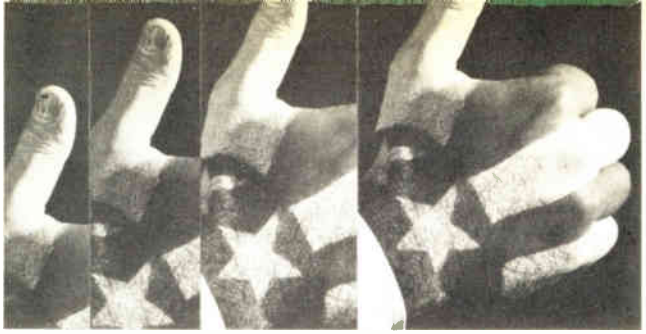
This estimate is only for terminals in general-merchandising applications, and it does not include the potentially lucrative supermarket business that will begin to open up later this year. Because of the difficult environment presented by food-store check-out counters and the need for complete industry-wide acceptance of merchandise coding, it will be 1976 before this end of the business can reach a peak.

A realistic estimate for 1975, including credit check units and electric registers is $253 million. On the retail level, the market will broaden to smaller stores using stand-alone terminals and may grow faster than the units installed in the big chains and discount houses.

This is going to create a broader line of products or systems, extending from the complex total control installations down to simple electronic cash registers. There are also good opportunities this year for credit-authorization systems for retailers not quite ready to use electronic cash registers fully.

It's finally happened in the auto industry—cars have begun using electronic devices for fuel injection, ignition, and, to a lesser extent, anti-skid control. A conservative estimate puts electronic fuel injection at $108 million and anti-skid control at $170 million in 1975. That's the key year, because it will be the beginning of Federal regulations for emission control and safety standards. Certain electronic products, which the auto makers have experience in building—such as ignition systems—will remain with the car manufacturers, while anti-skid devices will likely be made by outside OEM manufacturers. Emission-control systems will be produced mainly by the Big Three, but look for fuel injection to be an OEM unit. This year, according to the *Electronics* consensus, auto entertainment products will log $315 million, and non-entertainment, $163 million.

Robert R. Hoge, director of automotive electronics for Bendix Corp., Detroit, has estimated that the business, including both control electronics and entertainment systems, will be worth $1 billion a year by 1980. This year, automotive diagnostic systems will also take



hold, so electronics will park both inside the 11-plus million vehicles expected to be sold in 1975 and in the service stations repairing them.

CATV snarled in red tape

All bets are off on the glowing predictions held for cable-television installations this year. Once again the operators vying for municipal franchises across the country have been stymied. There are two bottlenecks, first, at the local level, where cities and states are bickering over regulatory jurisdiction and, second, at the FCC, where certificates of compliance for approving cable systems ready to be installed have piled up a backlog.

Meanwhile, equipment suppliers have had to wait for the bottleneck to be broken. It won't be this year in any significant way, but the new sense of realism that has come to the industry recognizes this stretch-out. Maybe by 1976, the optimistic figures published by market researchers will be more meaningful than today. Estimates for that year show head-end equipment around $20 million; origination equipment around $19 million, and subscriber terminals and converters at $17 to $18 million. In short, cable's expansion is still in the cards, but someone keeps shuffling the deck.

In the burgeoning field of word-processing, which includes dictation and automated typing systems, Dictaphone Corp., Rye N. Y., expects substantial growth for its endless-tape dictation systems. This is just one part of the two to three years of steady increase expected for word-processing equipment sales. Total value of the industry last year, reports Hobart G. Kreitler, group vice-president for Dictaphone, was $200–225 million. He predicts it should hit $600 million to $750 million in 1976 and move along at that level until 1980. □

Consumer

Color TV, calculators, hi-fi are winners

Consumer-electronics executives at the end of the year were still marveling about how good 1972 was, even though the booming record was clearly evident for most products by June. It was a year worth the marvel, and there is no reason to believe that the many products that make up this sector of the industry will not continue to enjoy healthy sales this year. (The *Electronics* markets chart shows consumer electronics will reach $4.9 billion this year—$3.1 billion for TV receivers, $1.3 billion for total audio equipment, and $90 million for consumer calculators.) Gains for color and black-and-white TV, audio components, and consumer calculators last year exceeded most expectations.

Home video players didn't do much in consumerland, but they weren't expected to make an impact in 1972, nor will they be in the big money this year. Electronic watches and microwave ovens flexed enough muscle to be considered strong members of the consumer electronics industry. The ovens market is predicted to be $79 million this year.

Except for a couple of developments in video players and unveiling of another "Land-mark" camera from Polaroid, technical innovations were on the mild side. In a sense, 1972 was cashing in on earlier developments, such as the all-solid-state color TV chassis with three to six integrated circuits, the single-chip calculator, and the MOS watch circuit, to name a few.

This year, consumers can expect announcements of not only lower-priced calculators, but models that perform more functions for the same price. The first substantial appearance of liquid-crystal displays will show up this year and be widespread by 1976 in watches, calculators, and maybe TV tuners and tape players. The tempo will also pick up for complex MOS LSI circuits in home organs. Linear ICs performing more functions on fewer chips will also be designed into color TV sets.

In the consumer market, everyone watches color TV, which accounts for over half the dollar value of that market. By the time all the numbers are added up for 1972, U.S. manufacturers will log 7.5–7.7 million units in factory sales, a record year that will mark a new plateau for color. Springing off a good 1971, last year's sales pace maintained steady increases into the fourth quarter and ended more than 20% ahead of that of the previous year.

The reasons for the expansion were the growth in second-set families, strong replacement demand, and increased hotel and institutional sales. With total market penetration at about 60%, color TV is in an ideal growth groove, for it has the exposure in people's homes to make non-owners see and buy, and it's been around long enough to reach the replacement stage.

Color TV a rerun of '72

Replacement sales, which are expected to continue growing, are based on sets purchased during the peak of the late 1960s. This means that users are replacing or doubling up on receivers that are only three to five years old. Richard Kraft, director of product development for the Consumer Products division of Motorola, Inc., Chicago, points out that this is quite a compliment to the technical innovations in solid-state chassis, picture tubes, automatic tuning, and screen sizes.

It's a tough act to follow, but industry officials are confident that the momentum will carry into the first half of this year at a rate equal to 8 million sets a year. Since there is some question about the second half, there's hedging on exactly how many units will be sold, but 7.7–7.9 million wouldn't be a surprise. There will be more solid-state chassis, remote tuning at lower prices, linear ICs of more complexity, and more receivers with in-line gun tubes, though these tubes will not really take off until 1974, says William Boss, marketing vice-president for the entertainment products group, Sylvania

Electric Products Inc., Batavia, N.Y.

Monochrome TV is still alive and well. Actually, the total market did not expand much last year, but because Japanese imports were stifled by a combination of surcharge and yen devaluation, American producers got a bigger share of the pie, boosting unit sales by at least 10%. This year, like last, should record another 5-million-plus monochrome units, which *Electronics* predicts will be worth $504 million.

With sales for audio products, the second largest money-maker, doing as well as they did last year, no one is worrying about the still unresolved controversy over competing and incompatible four-channel systems. The four-channel matrixes still don't speak to the four-channel discretes, but when the new lines were announced during the year, manufacturers made it clear that they were prepared to make units adaptable to any of the competing systems.

What delighted the industry was that hi-fi components were selling handsomely, thanks to a free-spending youth market and wide exposure to components provided by the mass producers who have turned department stores and TV dealers into audio buffs.

Herbert Horowitz, president of Empire Scientific, Garden City, N. Y., and president of the Institute of High Fidelity, predicts that components hardware business worldwide will amount to $500 million a year in 1973 and will double by 1976. The business has grown some 14% over the 1971 rate, in spite of the confusion over four-channel, which was supposed to have been a big sales help, rather than a muddle-maker, and despite rugged competition from the Japanese.

A factor will be the amount and popularity of recordings, and right now the matrix camp is ahead. Another factor will be the decision by the Federal Communications Commission on which system will be the accepted four-channel broadcast mode.

Calculators by the millions

After 1972, further price declines would be no surprise in the wild consumer calculator market, which is built on the four-function, calculator-on-an-LSI-chip machine. Price tags on four-function, six-digit calculators will drop below $40 this year, and the average price of the simple eight- to 12-digit types will sink to about $40. At the high end of the line, machines with memory will bottom out at about $99.

This means, says James Mills, marketing vice-president for Royal Typewriter division of Litton Industries, Hartford, Conn., that the market will be segmented. The consumer may buy a low-end model and later step up to the more advanced memory types, he contends. A 2.5 million unit market, estimated at $150 million, may be possible this year and 4 to 6 million units could be sold in 1976.

Breathing hard from last year's production pace, the calculator companies anticipate settling down this year, with few new competitors getting into the game. An industry spokesman adds, however, that by 1976, manufacturers of consumer equipment like TV and radios will come into this market to cash in on an established field.

The kit business for audio components, color TV, calculators, security alarms, and test equipment has been tracking right along with the success of consumer-product sales, and it appears to be in good shape for this year, as well. Sales will be about $72 million in 1973, and as much as $96 million by 1976. Today, kits have become the high-quality way to get reliable equipment that the consumer-builder can fix himself. These are good selling points in this day of consumerism and high-priced repairmen. The next big push for kits will be overseas, until now almost ignored.

Relatively new to consumer electronics are solid-state watches. Prices have plummeted in a short time from $2,000 to $150 each and may drop to $50 this year. Because watches are also essentially jewelry, these electronic timepieces will be available in all price ranges and eventually will be priced on a par with today's conventional watches. Swiss, American, and Japanese watch companies will be in the competition this year, and the temptation of this market may also lure non-watch consumer companies, as well as new firms operating as assemblers. The parallel with the calculator market is unmistakable.

Last year, according to Litton Industries, Santa Barbara, Calif., 250,000 microwave ovens, valued at a total of $100 million, were sold. By 1976 the U. S. market is estimated to reach 1.5 million units; however, the luxury-status price will cling for a long time.

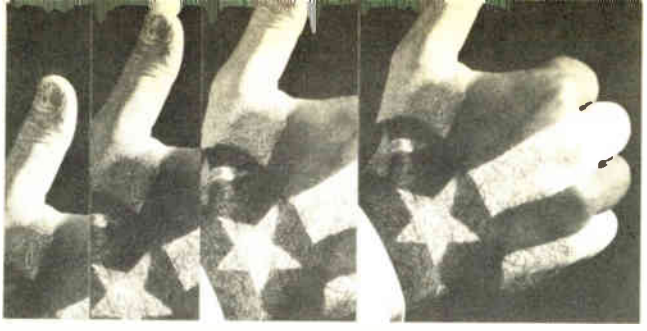
Home video players have had one of the longest infancies in consumer-product history. Late this year, however, the first kid on the block, Cartridge Television Inc., New York City, is expected to meet head-on with a new big kid from Indianapolis, RCA Consumer Product's Mag-Tape Selectavision system. No real battle will take place until 1974, but by 1976 the field should be alive with video-cassette/cartridge contenders from here and abroad. Also by 1976, the video disk systems, already developed in Europe and the U.S. and being researched in Japan, should be on the scene. *Electronics* estimates this market to be $45 million in 1976.

Once prices come down, consumer products have a way of growing up fast. For video players, a number of factors will be important—ample, low-cost programing to lure buyers, entry of more major manufacturers, such as Zenith Radio, Chicago, to either tape or disks or both, and availability of remote recording camera packs for the tops of the lines. □

Communications

Data communications surges ahead fast

Entering the new year, the communications industry has good reason for viewing its long- and short-term prospects with happy anticipation. Setting the pace is the tremendous growth in data communications—a market that is sure to surpass a half billion dollars in 1973. The interconnect market, too, growing out of the Federal Communications Commission's historic 1968 Carterfone decision, will soon pass the $100 million level in private automatic branch exchange (PABX) sales



alone. Longer range, there's no place to go but up. Other recent and anticipated FCC decisions will have a profound impact on major segments of the communications market. For one, the allocation of new frequency channels to services ranging from land-mobile radio to private microwave TV will produce new opportunities. For another, it looks as though the FCC may clear up procedural hurdles and begin okaying system starts on the domestic satellite (Domsat) [*Electronics*, July 3, 1972, p. 72]. And in more conventional terrestrial systems, the equipment sought by the specialized common carriers should pass $50 million this year, and account for about a quarter of the total microwave relay market.

Activity in the data modem market is centered around units that operate at speeds of 2,400 bits per second, including units that are compatible with existing Bell models 201 and 202. "The 1973 market for 201 class modems," predicts Steve Clark, director of marketing at Intertel Inc., Burlington, Mass., "should be 15–18 thousand units [at an average price of $1,000], while perhaps 10–15 thousand 202-compatible models will sell at an average of about $400 each."

As for higher-speed modems, Clark figures "the people who make 4,800-bit per second modems are running scared. Bell's introduction of its model 208 has forced some makers to cut prices by a factor of two." However, most people who are following this market closely see higher-speed modems playing an increased role in the future data-communications markets, since they hold the key to increased efficiency and savings in the use of wideband communications channels.

Paralleling efforts to meet users' needs for faster modems, designers are busily adding other features to modems at all speeds. "We are pushing ahead to supply 4,800-b/s units with turnaround times [time required to switch from a transmit mode to receive] of less than 50 milliseconds," says John Rilling, president of Rixon Inc. Other modem suppliers have built test functions into their modems. General Electric's Data Communications Product department, Waynesboro, Va., for example, recently incorporated test circuitry into its Diginet 2201 modem to speed the locating of faulty segments in data-communications links.

But the data-communications industry has spurred an even larger and more rapidly advancing market for a broad category of equipment collectively called communications processors. Segments of this market include: remote concentrators that process signals from low-speed terminals at one location for transmission to central processing points; front-end processors that sort communications data at the host computer; and message switchers to route messages from one node in a data-communications network to another.

Creative Strategies Inc., a consulting firm based in Palo Alto, Calif., foresees the market for communications processors in 1973 topping $500 million, an increase of 60% over 1972. At a projected growth rate of some 25% annually, Creative Strategies expects this market to exceed $1 billion within 3 years.

The motivating force behind the communications-processor market lies in the economy involved in high-capacity transmission lines. And with the advent of new data services supplied by AT&T, as well as new specialized common carriers, use of these high-speed services will grow still faster.

Toward faster fax machines

In business facsimile equipment, the drive is toward cutting phone-line transmission time for an 8½-by-11 inch document to 1 minute. Prototype units have been recently demonstrated, but production quantities of the 1-minute copiers are unlikely before 1974. At their currently projected production cost, potential costs of the faster machines to the user do not offset the higher transmission costs of the present 4- and 6-minute units.

Marine change-over. Marine radio sales reach new peaks as boat-owners switch to the vhf fm radios that must be installed by 1977.

In the highly competitive fax business, efficient company organization counts heavily. Industry insiders suggest that lack of an effective nationwide sales and service establishment was the main reason that Magnavox Systems Inc., Fort Wayne, Ind., a leading manufacturer of facsimile equipment, got out of the fax business.

The importance of an efficient marketing force may explain why Xerox Corp., with its extensive copier sales offices already in place, has successfully taken the lead in the business facsimile market. And it was the awareness of needs for worldwide sales and service organization that prompted the recent alliance of Plessey (England), Matsushita Graphic Communications (Japan), and the 3M Company and Visual Sciences (U.S.) to de-

velop, manufacture, market, and provide service for a family of office facsimile equipment on an international basis. This measure marked the entry of 3-M into the facsimile business and underscored the potential threat of Japanese manufacturers.

PABX nets profits and problems

Like the market for data-communications equipment, the private automatic branch exchange (PABX) market still continues to grow rapidly, especially for the so-called "interconnect" segment of this market. From a minuscule level less than five years ago, when the FCC ruled that equipment not owned by the telephone company could be interconnected with the nation's dial-up phone network, the PABX interconnect industry now boasts annual sales of just over $100 million.

Of particular importance in the last year is the entry of several conglomerates into the PABX interconnect business, including Litton Industries, General Electric, and Teledyne. These companies with their extensive resources should add to the stability of the PABX market in the U.S., which generally consists of regional service companies that import equipment manufactured in Europe and Japan. Of the three new entrants, only Litton is manufacturing its own equipment, while GE and Teledyne are currently marketing foreign equipment.

The PABX user in 1973 will remain very cost-conscious, regardless of all the options being offered. However, according to Charles Pedler, vice-president of Teleresources, a White Plains, N.Y., firm supplying the New York City area, "this doesn't mean that some extra features, such as automatic toll accounting, won't be strong sellers."

Although the interconnect portion of the total PABX market has received greatest recent attention, the largest segment of this market remains in that of sales to the common carriers—both to AT&T operating companies and to the multitude of independent telephone companies. This traditional market is now over $400 million. As one industry spokesman estimates, "the increase in the traditional PABX market in 1972 almost equals the total size of the entire interconnect business."

The market for microwave relay gear experienced a noticeable boost when the logjam on construction permits for specialized common carriers broke in mid-1972. But one thing that might slow down U.S. sales is that equipment suppliers are being pressured to finance the common-carrier companies. The new carriers have little in the way of collateral, and the U.S. banks require that equipment suppliers guarantee the notes. Such a situation, complains one supplier, "puts us into the venture capital business."

Overseas firms, however, can minimize the investment risks through insurance arrangements with their governments. Thus, MCI has contracted with LM Ericsson of Sweden and CIT of France, and Datran is negotiating with Nippon Electric for about $100 million in long-term commitments. Still, the largest portion of equipment orders by specialized common carriers so far has been to domestic suppliers, and the importance of supplier financing will lessen as the specialized carriers mature and develop internal financing.

The electronics portion of the market for long-haul specialized carrier business is expected to reach about $50–60 million in both 1973 and 1974, after which many of the long-haul needs will be fulfilled. At that time, local distribution equipment should get a market boost. Adding these figures to conventional markets for telephone common carriers and private microwave systems, the 1973 microwave relay market should level off at about $195 million.

The 1973 market total can be broken into five major segments: specialized carriers, 30%; non-Western Electric sales to AT&T operating companies, 10%; independent phone company sales, 16%; various government systems, 22%, and industrial microwave equipment, 22%.

Although the demand for private industrial microwave service is steadily increasing, new equipment orders did not keep pace in 1972. According to James T. Lenehan, vice-president of Collins Radio's Microwave division, Dallas, Texas, "one reason for this is that some industrial users are delaying to see what services the new specialized carriers will offer. Therefore, we plot four or five flat years in the industrial market."

A new market for microwave equipment suppliers emerged in 1972 in the form of multipoint distribution systems [*Electronics*, Dec. 4, p.44], which will transmit color-television programs in major metropolitan areas. A central transmitter with an omnidirectional antenna will serve multiple subscribers within a 25-mile radius.

The market for such gear will reach only $2 million or $3 million in 1973, but this is an almost infinite growth rate over 1972. The sales for 1974 should increase by a factor of five.

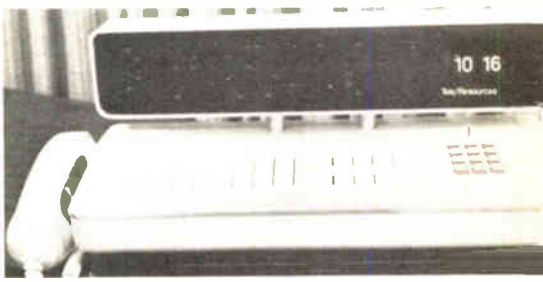
Stops and starts in mobile radio

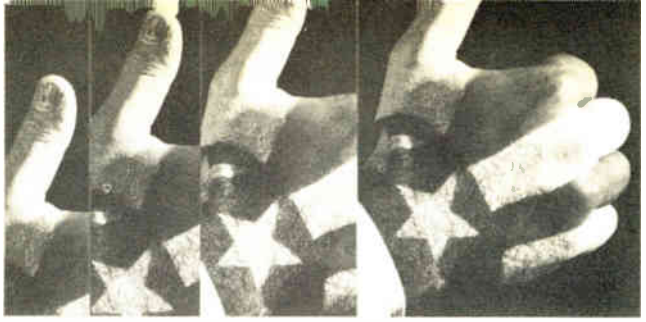
In land-mobile radio, interest focuses on the 900-megahertz region [*Electronics*, Sept. 25, p. 85]. But because of delays in resolving some of the regulatory issues, and then the delay in putting the regulatory go-ahead into effect by the introduction of 900-MHz equipment, sales in 1973 will be virtually nil.

However, clearing the roadblocks to 900-MHz development has been vital to the total growth of land-mobile radio. "The release of these new frequencies will insure that over-all activity in this business will continue to increase at a 9% to 10% annual rate," says Glenn Pe-

Satellite markets launched. Operation of the Canadian domestic satellite begins this week. Similar U.S. domsats will follow

Made in U.S.A. More and more domestically produced PABX systems such as this Tele-Resources unit are being sold in the U.S.





terson, general manager of General Electric's mobile radio department, Lynchburg, Va.

A second block of frequencies centered at 500 MHz has been assigned land-mobile services in the nation's top 10 urban areas, and it is this set of frequencies that is providing initial relief from overcrowding of conventional land-mobile channels. About 30 to 40 applications for systems operating at 500 MHz were received by the FCC in the last quarter of 1972, and licenses for about that many systems have already been granted, according to the Commission.

In citizens-band radio, the FCC is expected to move soon to establish an additional citizens-band service in the 220-MHz band. The new service would relieve present congestion at 27 MHz and, according to estimates of the Electronic Industries Association, could produce new markets for citizens-band gear of up to $400 million annually [*Electronics*, March 13, p. 31].

The major impetus in the marine radio business is an FCC mandate that frequency-modulated vhf transceivers be installed as primary communications equipment by Jan. 1, 1977. While the FCC conversion plan is now several years old, many industry observers did not expect any significant market movement until nearer the 1977 deadline. However, according to Robert McCue, market planning manager at Raytheon's Marine Products division, Manchester, N.H., "1972 amazed us—we saw a steep increase in sales about midyear, and I foresee an increase of about 25% in 1973."

Bill Jumper, marketing vice president at Intech Inc., Santa Clara, Calif., shares this euphoria. Further, where McCue sees the market leveling off as conversion to vhf is completed, Jumper identifies a continuing market potential. Only about 15% of those that could benefit by radios in their pleasure boats, but are not required to have them, have radios installed. "So we see about 85% of the pleasure-boat fleet as potential customers," he says. As for today's market size, the Intech executive places the vhf marine radio market for 1973 at 80,000 units and $28 million, up from 60,000 units and $24 million last year. The fact that these figures aren't proportionate reflects a drop in per-unit prices.

At least for the next several years, Loran C navigational equipment promises to outpace the growth of all other segments of the market in navigational aids. Both the military and the Department of Transportation are actively planning Loran transmitter procurements in 1973 (see p. 73). With this expanded coverage, Loran C will become a very attractive navigational aid for both commercial ships and aircraft. And two low-cost receivers aimed at the commercial market have already been developed under Coast Guard sponsorship by Teledyne Systems Co. and Litton Industries' Litcom division. Epsco Inc. and International Navigation Co. have developed $3,000 to $4,000 Loran C receivers on in-house funds.

Other types of navigational systems are also developing, but at a much slower pace. Inertial guidance systems predominate in the military and can be found in the newer commercial aircraft, but at $250,000 per installation these systems are not destined for widespread use in the civil aviation market. □

Components

Industrial sales will continue 1972's surprise upswing

Last year was a pleasant surprise to component manufacturers, most of whom had expected only borderline increases in sales. Even traditional components, like resistors and capacitors, enjoyed growth bursts of 10% to 20%. And both industrial and commercial market segments more than took up the slack created by cutbacks in military spending.

This year, sales for most components will still grow steadily, if not as fast, at a rate of around 8%. Display tubes and keyboard switches are two notable exceptions on the up side—they both have an unpredictably large sales potential because of the recent and continuing boom in calculators and data terminals.

In 1972, an upswing in consumer products was responsible for a good part of the brisk component sales, despite the constant stiff competition from overseas suppliers. But in 1973, industrial applications, particularly process control and machine tool equipment, are expected to offset the anticipated slowdown in the rate of consumer sales growth.

This year will also see traditionally electromechanical equipment—weighing systems, cash registers and, of course, calculators—going electronic. Medical electronics and the automobile industry are two other markets that will continue to grow during 1973.

Restocking the shelves

The resumption of inventory buying by original equipment manufacturers is keeping many a component company working overtime, in order to fill orders from a production capability that is beginning to expand again from the size it was reduced to in 1970. Computer houses are also stepping up their component purchases, and new markets, like point-of-sale equipment, are just beginning to mature.

Because of the anticipated slackening in the rate of sales growth, however, only conservative programs are presently scheduled for new products. Product announcements will primarily follow existing lines, with possibly fewer introductions than were made in 1972— a result of R&D economies during the lean years of 1970 and 1971. But though filling requisitions and meeting delivery dates may be the first order of business this year, several manufacturers are talking about introducing technologically significant products within the next three years—for example, industrial-type resistors with

dramatically improved wattage ratings, and capacitors with considerably higher volumetric efficiencies.

For perhaps the first time, the over-all growth rate of traditional components and of encapsulated-type hybrid modules will be about the same—approximately 8%. Several key module suppliers are now predicting sharp across-the-board sales drops in another year or so, due to market erosion by linear integrated circuits.

Modular op-amp sales have just about flattened out, while both analog-to-digital and digital-to-analog converters, as well as function modules, will show healthy gains of about 15%. However, even a marginal growth for op amps will bring in many more dollars than will even substantial leaps in the younger product lines, since the market for modular op amps is about $16 million.

The youngest product group, function modules, which includes multipliers, dividers, logarithmic units, and trigonometric operators, is only a few years old and has plenty of room for growth from its annual $2–3 million. In the coming year, manufacturers of these will be improving price-performance trade-offs.

Fred Jones, president of Zeltex Inc., Concord, Calif., a module producer, sums up the dilemma of all module houses: "To survive, you must look elsewhere—to other products and other markets for your products. You have to do something else one of these days if you're going to grow, or you're going to die." Analog Devices Inc. of Norwood, Mass., probably the biggest module supplier, has already diversified into two new market areas—integrated circuits and digital panel meters.

The picture for display tubes is considerably brighter. The Electronic Components division of Burroughs Corp. in Plainfield, N.J., is extremely optimistic about projected sales for its display devices. The company's Panaplex gas-discharge tubes are expected to quadruple in sales this year as well as next year. These single-envelope seven-segment displays containing from eight to 12 digits are being put in those fast-selling four-function (add, subtract, multiply, and divide) calculators that cost about $100. Moreover, sales for Burroughs' Self-Scan panels, which are dot-matrix displays, are expected to double in both 1973 and 1974.

Also riding the coattails of the calculator and data terminal activity are keyboard switches. Here, competition between vendors is keen, and proliferation is a problem, with a dozen different switching techniques from which to choose. Mike Hassett, vice-president of marketing at the Switch division of Oak Industries Inc. in Crystal Lake, Ill., blames companies that are "messing up the market by trying to make their alphanumeric keyboard switches, which are intended for data terminals, do for the calculator."

Some switches and relays will do well

Illuminated and nonilluminated, single-station and multiple-station pushbutton switches, making up a total market of approximately $46 million, are expected to do well, too, with conservative growth estimates of about 10%. Clyde J. Schultz, marketing vice-president at Switchcraft Inc., Chicago, attributes the growth in illuminated pushbuttons in part to "aerospace manufacturers getting into industrial processing machines and business equipment."

The $248 million relay market, on the whole, will be showing a real (after inflation) growth of approximately 5%. Some types of relays, however, will surpass this figure because of an expanded market base. For instance, the appliance business, microwave ovens in particular, will help to drive sales for some up 15% to 20%.

Reed relays, both the mercury-wetted and the dry types, will possibly enjoy a 10% to 15% sales rise. Jack Rowell, advertising and marketing manager at Guardian Electric Manufacturing Co. in Chicago, thinks that there will be significant moves over to reed relays this year and that, "by 1980, they will amount to about half the market." Currently, they make up less than 10% of the total relay market, and are being used in computers, business machines, and control circuits.

And, according to Phillip Gardanier, advertising manager at Magnecraft Electric Co. in Chicago, another relay manufacturer, there is a large growth potential for low-cost ($1 to $3) reed relays in consumer electronics.

A broader base for resistors

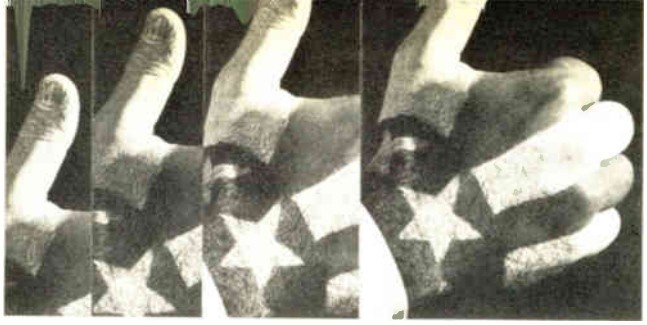
Carbon composition resistors will post their usual small but steady growth. This year, it is anticipated to be only 1% to 2% because home entertainment equipment sales are projected to be less than last year's. A specialist in carbon composition resistors, Stackpole Carbon Co. of St. Marys, Pa., is looking for more activity in automotive applications so that a "broader product base will offset technological obsolescence," according to Douglas Dobson, vice-president and general manager of its Electronic Components division.

Industrial-type resistors and resistor film networks should experience at least 5% growth in 1973, with the film networks likely to exceed this. A major supplier of these resistor lines, Allen-Bradley of Milwaukee, notes that the demand for existing products is quite high. "The expanding use of electronics in new and old markets, as well as restocking, is keeping us working six days a week, sometimes seven," says Clayton Ryder, the Electronics division's director of marketing.

Like resistor sales, the bulk of capacitor sales, including ceramic, tantalum, and film units, are expected to grow about 5% this year. As usual, the exception to this will be ceramic chip capacitors, which will probably gain around 10% because of the expanding market in standard and custom hybrid circuits.

"It still looks like the monolithic capacitor is the fast-

A warning. Japanese imports are a "ferocious factor" in all segments of the switch market, says Clyde J. Schultz of Switchcraft.



est growing capacitor product," observes Bert Wertchow, marketing manager of electric ceramic products for Centralab, Electronics division of Globe-Union, Milwaukee. The company, which is a large supplier of ceramic capacitors for use in television sets and automobiles, hopes to penetrate the computer and industrial markets.

Sprague Electric Co. in North Adams, Mass., a major capacitor house, anticipates strong growth in both solid tantalum and film capacitors. The company attributes some of this activity to communications equipment suppliers who will be buying capacitors, rather than making their own. For 1973, Sprague intends to introduce a number of new products, including aluminum electrolytic capacitors for computer power supplies, and multiple-section ceramic and solid tantalum capacitors in dual-in-line packages.

Connector makers are trying hard

Although the over-all connector business will be boosted by only about 8% in 1973, connector manufacturers are being particularly aggressive with new product programs. But while working hard to penetrate the industrial and commercial markets to pick up the slack in military business, they are also attempting to curb product proliferation. Many new connector lines are modular designs that can readily be customized by the user.

For example, the Willow Grove, Pa., division of Elco Corp. recently introduced a modular pressfit backplane wiring system [*Electronics*, Dec. 4, p. 139] that allows the user to get twice the work out of a single wire-wrapping. Since the pressfit contact posts need not be soldered for electrical connection or mechanical support, a double-layer printed-circuit board can be used instead of a single-layer one.

AMP Inc., Harrisburg, Pa., sees modular interconnection systems, flexible circuitry, and miniaturization continuing as strong growth trends for 1973. Ben Conner, vice-president of industrial sales, cautions that exceptional growth years do not usually run back to back. "We must first digest 1972, so to speak," he says. □

Packaging and production

Hybrids, pc boards do well; packaging adapts to LSI

A return to the good old days of 1969 doesn't sound like progress, but it is for the electronics packaging and production industry. The all-time high in dollar sales of printed-circuit boards was reached that year, for example. And today it's a measure of the prevailing optimism that the P&P business in 1973 is expected to ascend to 1969 levels—and then some.

In the individual market segments, trends worth noting are:

- In semiconductor production equipment overall, the combined 1972–73 improvement will add up to dollar sales two or three times better than in a depressed 1971.
- Hybrid circuits look specially strong for 1973.
- Semiautomated, rather than fully mechanized, production lines will be emphasized.
- There will be modest technological advances in P&P, but mostly proven methods will be used.
- The IC package business will record an increase of 10% to 13% in dollar volume in 1973, even though ICs themselves will climb more than 20%.

Upswing will engulf everything

The recovery in semiconductor production equipment will be across the board—as in the semiconductor industry itself. It will affect "everything from light-emitting diodes to DIP-housed ICs," says Martin Weiss, vice-president for U.S. operations at Kulicke and Soffa Industries, Fort Washington, Pa. In practice, he's skeptical about long-term forecasts, however—K&S plans six months ahead, and "beyond that, we call it 'dream dust,'" he notes, underscoring the cyclical character of the semiconductor business.

There seems to be little "dream dust" in predictions about hybrid circuits this year, though. They'll be particularly strong in consumer applications—automobiles, watches, toys—says Pete Bullock, sales manager at the Equipment division of Unitek Corp., Monrovia, Calif. "But new technologies are not what we see," Bullock adds. "It's thick film, and old chip-and-wire." However, he sees epoxy die-attach coming on strong in hybrids.

So does A. H. Moore, president of Radiant Energy Systems, Newbury Park, Calif., which makes bonders. The company also makes fully automated hybrid assembly lines but, Moore notes, "people are more interested now in semiautomated lines." They'll accept the need for having a few operators rather than the cost and lack of versatility of full automation. Much of the growth in semiconductors, Moore adds, seems to be overseas and in smaller companies that are not good candidates for complex capital equipment.

"Someone's selling a hell of a lot of tweezers," is the way another company official expresses the slow pace of automation.

Relying on offshore plants

The reluctance to embrace automation is more pronounced among makers of monolithic integrated circuits than among producers of hybrids. The IC makers are depending on offshore plants and, says Unitek's Bullock, "until they run out of countries or legislation interferes, I'm not sure that new technologies can compete with low-cost labor."

Volume of the semiconductor bonding market for 1973 is projected at $20 million, perhaps $5 million up from 1972. But pulsed die-bonding is expected to expand its share of the total to 50%, compared to 25% in

1972, at the expense of the hot-plate method, according to C. A. Rollins, manager of metal bonding products at Hughes Aircraft Co.'s Industrial Products division.

Dollar volume of the IC packaging market hovered around $200 million in 1972, including IBM and all of the packages and lead frames produced in-house by IC makers. While the IC sales are expected to grow more than 20%, the increase in sales of packages is forecast at between 10% and 13%. Major reasons are the shift to less expensive plastic housings, 30% higher yields in the manufacture of packages, and more package-sharing, says Bernie Fisher, vice-president of Darling and Alsobrook, Los Angeles.

Big volume in ceramics

It looks like 35 million ceramic packages will be sold in 1973, and about 9 million premolded plastic packages (this excludes the much larger volume of in-house encapsulated packages). Dollar volume of ceramic packages in the noncaptive market is forecast at $25 million; and of plastics, $3 million. In addition, glazed ceramic packages—alumina-ceramic with a printed solder-glass sealant—are expected to increase 10%, with worldwide volume projected at 350 million units.

The big comer in 1973 will be the side-brazed package, predicts Frank Rydwansky, manager of applications at Metallized Cermics, Providence, R. I. This type of package is designed to house the larger LSI chips [*Electronics*, March 27, 1972, p. 119]. Although there is interest in leadless and edge-mount packages for ICs, these are not expected to go into volume production in 1973—perhaps not for about three years.

Sales of printed-circuit boards reached a record high of $455 million in 1969, and Ray Pritchard, executive director of the Institute of Printed Circuits, predicts that 1973 sales will come close to that. He estimates that 1972 sales totaled $425 million, with independents accounting for more than $150 million.

Some industry suppliers are even more optimistic. W. J. McGinley, president of Methode Electronics, Chicago, expects a record year, with a 20% increase in business over the 1969 level. "Circuits are finding their way into products that were largely electromechanical," he points out, citing cameras, calculators, retail data terminals, and emission control devices for cars.

Competing vigorously with multilayer circuit boards is the wire-wrapping technique. Gardner-Denver Co., Quincy, Ill., originator of Wire-Wrap, anticipates a 15% to 20% increase in dollar sales of Wire-Wrap equipment, chiefly attributable to the computer mainframe business and to renewed strength in peripherals. □

Upswing. Martin Weiss of Kulicke and Soffa Industries sees across-the-board recovery in semiconductor production equipment in 1973.

Digital ICs boost business for scopes, DPMs, testers

Good, but not great, is the reading that cautious watchers of the instrument market are getting for 1973. Even that prediction is somewhat fogged, coming off a year in which sales figures were boosted by the after-effects of 1970–71's virtual moratorium on capital equipment purchases. And to add to the mix, European sales often increased, instead of tailing off as expected.

Nevertheless, several 1972 patterns can be discerned clearly enough to allow meaningful 1973 forecasts to be made. Perhaps the most important is the widening acceptance of digital LSI, which helped increase the demand for high-capability instruments by making them cheaper and easier to build. What's more, the trend toward greater use of digital circuitry, particularly in such growing areas as data communications, itself generates a need for more sophisticated test equipment.

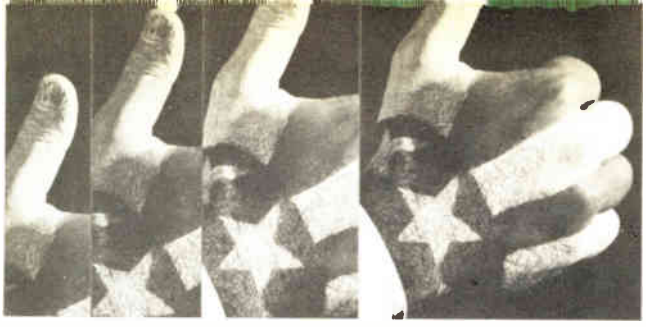
Other factors affecting the instrument business are the decline in the quality of delivered ICs—though the complaint isn't universal—and the opening of the microwave communications field. The IC problem cuts two ways: bad ICs are a problem for the instrument makers who use them, but they are also a boon to those who make automatic test equipment. Increased competition in microwave communications has improved the balance between Government and private spending for microwave test gear such as counters, signal generators, sweepers, and spectrum analyzers.

Digital consequences

Designing and servicing a digital circuit or system typically involves looking at low-repetition-rate signals, often with fast rise times. To save time, eliminate annoying flicker, and save the expense of camera equipment, more users are turning to the storage oscilloscope. Variable-persistence scopes are particularly valuable for displaying slow signals, since their persistence can be adjusted to exactly match their scan rate.

Hewlett-Packard's Colorado Springs division has been making variable-persistence scopes for several years, but last year, Tektronix Inc. of Beaverton, Ore., made its debut in this field. The competition between the giants is rapidly extending scope capability. As one example, the maximum available writing rate for a storage scope just last March was 5 centimeters per microsecond; by December it was 400 cm/μs. This should open up new markets for storage scopes; some observers predict a 30% increase in sales by 1973.

Digital panel meters and multimeters became popular toward the end of 1972. That popularity should grow this year. A major reason for their growth, however, has been the dramatic pricing decrease, so the increase in dollar volume will be significantly below the expected



increase in unit sales. Estimates of the expected increase in dollar volume for DPMs vary from 10% to 45%, while unit-sales estimates range up to 50% higher. Jack Lieberman, a product manager at H-P's Loveland, Colo., division, expects no great change in 1973 because "price erosion has been so severe."

Major users of DPMs are computerized industries such as petrochemicals, where an analog-to-digital converter is needed to feed information into a computer and a display device is needed to present the same data to a human operator. Here, a DPM with a digital output provides both functions in one package. An important growth area for DPMs is the medical-instrument market, where new low-power designs make battery operation possible, which gets around the ever-present shock-hazard problem of line-operated equipment.

Most manufacturers report that a significant, and growing, fraction of their DPM sales is to the European market which, being new, can expect rapid growth. Of the approximately $9 million 1972 DPM market, something less than $1.5 million is estimated to be European. That number could jump to some $2.3 million in 1973, and perhaps $4–4.5 million in 1976.

Like digital panel meters, digital multimeters were hit hard by price erosion toward the end of 1972—especially at the low-performance end of the spectrum. Thus, Bob Scheinfein, vice-president for sales at Data Precision Corp., Wakefield, Mass.—which introduced a $295 4½-digit DMM—predicts dollar volume will stay flat while unit sales go up and prices come down.

On the other hand, James F. Helfrich, director of marketing at Dana Laboratories Inc., Irvine, Calif., feels that dollar volume will climb because "a substantial part of the market is in the premium units, and we believe it will stay that way." And Helfrich is in a position to know, since his company "makes the broadest line of DMMs in the industry, but we find that we get the highest income from the higher-priced units—the premium 4-, 5-, and 6-digit automatic systems models."

Jim Key, new-products manager at the John Fluke Manufacturing Co., Seattle, Wash., however, feels that both low- and high-cost instruments will prove to be of significant economic importance in the future. He sees the high-performance digital multimeter as a proven instrument whose place in the market has been established—either by itself or by analog instruments that perform similar functions. Thus, he expects this traditional segment of the DMM market to grow as new instruments replace analog and older digital units, and as the electronics industry grows in general.

By contrast, Key feels, the low-cost digital multimeter will open nontraditional markets, by making DMMs available to users who previously couldn't afford them. Therefore, Key regards this area as important.

Unlike the low and high ends of the price spectrum, the medium-priced laboratory-instrument segment of the market showed little growth in 1972—except in communications-test equipment market. Here, the movement is toward: the highly stable signal generators, like those Singer, Logimetrics, and Hewlett-Packard recently introduced, which are needed to test land-mobile equipment; synthesizers used both for test purposes (especially in automatic test systems) and as satellite communications local oscillators; and such swept-frequency instruments as network analyzers, sweep generators, and spectrum analyzers. According to David P. Friedley, product manager for high-frequency equipment, General Radio Corp., Concord, Mass., his company "is doing extremely well" with its new, more expensive lines of frequency synthesizers and network analyzers. "We have found markets not necessarily with the traditional large companies," he notes, "but with a lot of small companies we didn't think would have the money—the CATV industry, for example. In the past, these people used to run R&D and manufacturing with unsophisticated equipment."

The question of IC quality

The same ICs that have made possible the great strides in digital instrumentation are also giving the industry one of its biggest headaches. Some observers, such as Bernard M. Gordon, chairman, Analogic Corp., Wakefield, Mass., feel that the quality of delivered ICs has actually taken a definite recent downturn; a second group feels that the downturn, if it exists, is too small to be significant; and a third group doesn't think anything has really changed. No one, however, thinks that IC quality is better.

The important facts about ICs are that they are being used in enormous quantities and that they are becoming ever more complex and difficult to test. Thus, their quality—whether declining or not— is becoming of increasing concern to the user. When they were simple devices, used in small quantities, 100% testing was no great problem. If they were very reliable, sample testing would be adequate. But when something like 0.5% of ICs purchased are defective, according to a major maker of semiconductor testers, you've got a problem.

Considerations like this boosted 1972 sales of automatic semiconductor test equipment about 50% ahead of 1971 sales. And while 1971 was a bad year to use as a basis for comparison, nevertheless, Frederick Van Veen, director of corporate relations at Teradyne Inc. in Boston, Mass., feels that 1972 has been a record year. He also thinks that the first quarter of 1973 looks good. "But," he points out, "it's awfully hard to do more than generalize. If ICs stay strong, so will we. Changes in units ordered show up here six months later."

Meanwhile, back in Oakland, Calif., Robert C. Allan, product manager for general-purpose instruments at E-H Research Laboratories, predicts that the IC tester market will increase from its 1972 level of $15–20 million to $25 million in 1973, and $50 million by 1976. "Manufacturers of ICs can't get away with the simple-minded test systems of the past," Allan says; they must do 100% testing now. And users too, he says, have realized they must do more testing now than previously be-

cause of the complexity of new devices.

As for the over-all instrument marketplace, two growing trends through 1973 and well into the future are portability and modularity. The success of portable instruments is already well established, but modular instruments are a much newer concept.

Bill Walker, engineering group vice-president at Tektronix Inc., has given this subject a great deal of thought since his company started making counter and digital-voltmeter plug-ins available for its 7000 series scopes. Tektronix has taken the modular design concept one step further now with its TM-500 line of instruments, which consists of a mainframe that can accept three plug-in instruments. The instruments can all talk to each other, and they share a common power supply. The main benefit of this concept, Walker says, is cost reduction. But he also feels that compactness and the elimination of inter-instrument ground loops will make the instrument system a pacesetter. □

Medical

Like the rest of the instrumentation business, medical instrument makers had a good year in 1972 and expect further growth in 1973 of between 8% and 9%. Advances should come across the board, but some areas may be singled out for special attention as the policies of newly appointed Health, Education, and Welfare Secretary Caspar W. Weinberger make themselves felt through the year.

Implantable electronic devices are likely to show better-than-average growth, if physicians' increasing acceptance of them is any indication. Cardiac pacemakers, for example, have traditionally been used only to treat heart blocks, but the recent trend is to use them also in the treatment of atrial disorders, tachycardia, and other heart ailments.

Further, since the Atomic Energy Commission approved the limited use of nuclear-powered pacemakers last June 30, it may be expected that sales of standard units—which are priced between $500 and $1,000—will drop and be replaced by sales of the atomic units, which sell for about $5,000.

Electroanalgesia—the control of pain by electrical stimulation of nerves—is another growing area, although its total dollar volume is rather small so far, compared to other areas.

Of more immediate economic significance is the growth in patient-monitoring systems, and in the use of computers in hospitals. Both are benefiting from increased acceptance by the medical community and the improved over-all economic climate, rather than from any spectacular technological advances, says John Post, manager of marketing support at Hewlett-Packard's Medical Electronics division in Waltham, Mass.

Although medical-device regulation has been imminent for four years now, this time the Administration really seems serious, and a bill can be expected to be passed by Congress in either 1973 or 1974. The impact of the bill will depend, of course, on how it is enforced. But it's safe to say that it will hurt those companies most whose business depends upon constant innovation and development of new products. Small companies, too, which have little experience in dealing with governmental paperwork, may be especially hard hit, as will those whose operating budgets are not large enough to permit them to comply with all of the provisions of the act. These firms may provide bargain-priced acquisitions for some of the larger corporations that are already in the field. □

Industrial

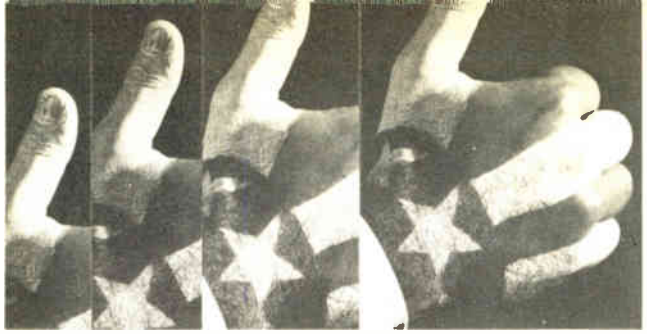
Drive to semiautomate sells computerized systems

The industrial segment of the electronics industries looks exceptionally healthy. Expenditures for new plant and equipment this year are expected to increase by 14.5% over 1972's $90 billion level, according to McGraw-Hill's economics department. That number could go higher, if traditional recovery trends prevail. History shows that business firms in an expanding economy wind up making higher outlays than their estimates early in the year.

And as manufacturing facilities expand, electronic equipment producers will benefit greatly from the increasing desire of management to automate and improve both productivity and control over production while lowering costs. The big, relatively new, market here is for automation in the factories of parts manufacturers, as opposed to the long-standing market for automation in the process industries. Electronics firms may already be supplying more than a quarter billion dollars worth of equipment to manufacturers of products running the gamut from packaged cereals to automobiles, *Electronics* estimates. The equipment here includes such items as numerical controllers for machine tools and production machines, automated test equipment, electronics for materials handling and storage, factory data collection systems, and industrial robots.

The growth in all of these areas is ballooning, according to a survey of factory automation made by market analysts Quantum Science Corp., New York. For example, sales of automated test systems for parts manufacturers are climbing at a 12% rate, building on a 1972 base of $94.8 million, points out John Rock, a senior staff man at the company. And factory data collection schemes will grow at a 24% rate on a base last year of $60.5 million, he estimates. But the fastest growth rate will belong to industrial robots—at 32% from a 1972 sales level of $6.8 million.

Minicomputer manufacturers will be principal beneficiaries of this growth. Some $100 million worth of the small, relatively inexpensive machines will be sold for manufacturing applications this year, a 40% jump over 1972, predicts Allan T. Devault, manager of Digital Equipment Corp.'s recently formed Industrial Products Group in Maynard, Mass. And Raymond J. Noorda, executive vice-president and general manager of another maker of minicomputers and minicomputer-based-systems, General Automation Inc., Anaheim, Calif., looks for a phenomenal two million computers to



be introduced to the manufacturing world over the next 10 years. By the early 1980s, roughly three-quarters of all new plants, according to another estimate, will be fully automatic. Presently, only a few percent are designed this way.

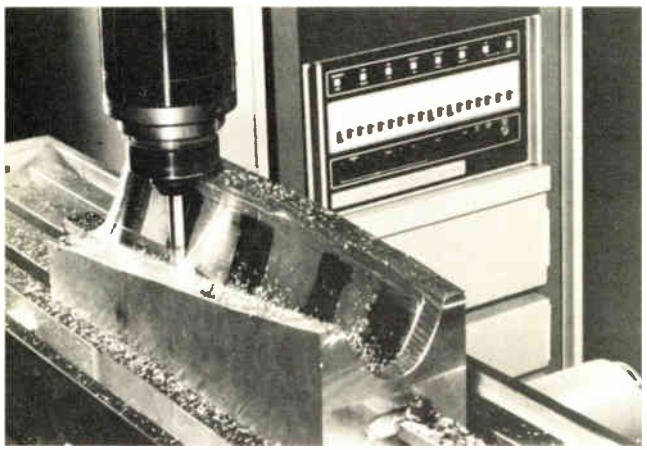
However, while full automation is a distant goal, a near-term strong demand is expected for "islands of automation"—including such things as parts test and calibration stands, data-collection systems, machine-tool controls, and materials-handling and -warehousing installations that could eventually be tied into a hierarchical computer-control scheme. Real-time operating systems for distributive processors with background/foreground processing capabilities will be increasingly evident, adds Jim Foults, product line manager for general-purpose products at Interdata Inc., the Oceanport, N.J., minicomputer manufacturer.

Numerical control to count for more

Also evident during 1973 will be an upsurge in sales of numerical-control equipment, which remained flat at best in 1972. Orders for machine tools taken during the first nine months of 1972 were up more than 50% to $947.6 million, according to figures from the National Machine Tool Builders Association, Washington. With shipments lagging as much as three to six months behind orders, these sales will go into the 1973 record books.

But suppliers of NC equipment, whose sales were in more than $40 million last year, tend to be conservative. For example, Don Law, general manager of General Electric's Numerical Control Operation, Waynesboro, Va., sets the 1973 increase at 10%—"a continually improving year on the basis of machine-tool orders already in hand."

Computerized NC. Trend is typified by General Automation's Adapt-A-Path control system, which incorporates SPC-16 minicomputer.



For the time being, however, large-scale direct numerical-control systems, which were touted two and a half years ago as the cure-all for an ailing NC industry, lie dormant if not dead. DNC, which employs a fairly large computer to control a band of perhaps 15 machine tools, proved too expensive—upwards of $200,000 for a typical system. Instead, the NC upswing will come in computerized NC machines, with one minicomputer controlling one or two tools, and in the low-cost end of the NC line for tools such as simple lathes that didn't have NC before, says GE's Law. The general manager of another supplier of numerical-control equipment points out: "CNC, not DNC, is about all the industry can afford right now."

But once users are trained on computerized NC, with its programing and data-monitoring advantages, the transition to DNC will be much easier. That transition is expected to begin by 1976, according to Chase Econometric Associates Inc., a New York-based subsidiary of the Chase Manhattan Bank. Predicts another man at a machine-tool house, "In three years, practically every numerical controller offered will have a computer in it." However, Econometric's director of industrial research, Dinah Nemeroff, points out that only 16.5% of all machine tools sold in 1973 will be automated—still below the 1968 high of 20%.

Progress in process control

Controls in processing industries—estimated in 1972 in the over $300 million range—are expected to do well this year, keeping pace with the general capital-equipment expansion. "We're looking for pretty good increases," says E.V. Dougherty, market planning and new development manager for Honeywell's Industrial Products division, Fort Washington, Pa., speaking of the chemical, petroleum and metals processing industries. Another growing area for controls that he cites is municipal and industrial water and sewage treatment.

Petroleum plants will be particularly hard-pressed during 1973 to meet consumer demands, points out Archie Harris, a market planner at Leeds & Northrup, North Wales, Pa. This is also true of the chemical industry, which is estimated to be operating at 80% of capacity and must expand, requiring new control instrumentation. However, petroleum refiners may hold back expansion plans, says a control-system supplier, because of uncertainties in the exact types of lead-free and low-octane gasolines required in the future. "They want the ground rules spelled out better," he says. After holding relatively flat during 1972, instrumentation will increase by as much as 10% for digital and 11% for analog controls during 1973, predicts Nick Scallon of Fisher Controls Inc., Marshalltown, Iowa.

Energy shortages are also cited as responsible for the boom in the power utilities field, which continued throughout the recent recession. Here, as in the factories, utility managers no longer doubt the ability of minicomputers to handle a control job, in the opinion of Melvin L. Couchman, manager of simulation training at NUS Corp., Rockville, Md., a systems consultant to the electric-power industry. □

U.S. Markets 1973 Forecast

Federal Electronics

(millions of dollars)	1971	1972	1973	1976
FEDERAL ELECTRONICS, TOTAL	11,174	11,503	11,929	14,213
Defense Department, total	**9,752**	**10,058**	**10,390**	**11,988**
Procurement, total	5,007	5,126	5,181	6,423
Communications and intelligence	887	962	997	1,460
Aircraft and related ground equipment	1,303	1,091	1,200	1,602
Missiles and space systems	2,027	2,205	2,101	2,352
Mobile and ordnance	297	265	238	289
Ships and conversions	493	603	645	720
Research and development, test and engineering	2,592	2,692	2,848	3,060
Operations and maintenance	2,153	2,240	2,361	2,505
NASA, total	**985**	**948**	**825**	**1,301**
Transportation Department, total	**148**	**188**	**399**	**550**
FAA procurement	–	–	159	177
FAA research and development	–	–	92	129
Highway and transit systems	23	41	80	164
Health, Education,and Welfare Department, total	**289**	**309**	**315**	**375**
Education systems	129	135	133	150
Health care electronics	160	174	182	225

Consumer Electronics

(millions of dollars)	1971	1972	1973	1976
CONSUMER ELECTRONICS, TOTAL*	4,257.7	4,742.0	4,936.3	5,243
Television receivers, total	**2,710.0**	**3,070.0**	**3,125.0**	**3,145**
Monochrome	500.0	515.0	504.0	400
Color	2,210.0	2,555.0	2,621.0	2,745
Audio equipment, total	**1,207.4**	**1,259.7**	**1,316.7**	**1,382**
Radios, total	439.7	447.2	451.7	460
Table, clock & portable AM / FM	129.7	134.6	136.7	140
Automobile AM and FM	310.0	312.6	315.0	320
Phonographs and radio-phonos	341.0	345.0	346.0	343
Tape recorders and players, total	282.7	307.5	329.0	349
Auto cassette and cartridge	135.0	145.0	151.0	160
Cassette and cartridge player recorders	86.4	112.5	131.0	151
Reel-to-reel	61.3	50.0	47.0	38
Hi-fi audio components (amplifiers, receivers, speakers, tuners, etc.)	144.0	160.0	190.0	230
Other consumer products, total	**340.3**	**412.3**	**494.6**	**716**
Antennas, TV & radio	48.0	50.0	58.0	69
Home video players/recorders	–	2.0	3.0	45
Musical instruments	50.0	51.8	52.6	56
Intrusion and burglar alarms	125.0	132.0	140.0	195
Kits	60.2	65.3	72.0	96
Microwave ovens	47.0	61.0	79.0	123
Calculators (personal, four-function)	10.1	50.2	90.0	132

*Includes domestic manufactured and domestic-label imports, but does not include foreign-label imports

COMPONENTS

(millions of dollars)	1971	1972	1973	1976
COMPONENTS, TOTAL	4,767.7	5,265.2	5,671.0	6,804
Capacitors, total	**421.8**	**453.8**	**475.6**	**752**
Paper	53.0	55.0	58.0	61
Film	81.3	87.5	92.0	108
Electrolytic, total	159.6	174.5	187.1	221
Aluminum	77.4	85.5	91.6	96
Tantalum	82.2	89.0	95.5	125
Mica	21.8	21.7	21.0	17
Glass & vitreous enamel	7.6	7.0	6.9	6
Ceramic	77.5	84.5	85.5	88
Ceramic chip	9.6	11.8	12.9	17
Variable	11.4	11.8	12.2	13
Connectors, total	**288.7**	**314.8**	**340.7**	**418**
Coaxial, standard	28.3	30.3	33.2	41
Coaxial, miniature	11.3	13.0	13.8	15
Cylindrical	91.6	94.7	100.8	123
Rack and panel	76.6	85.0	92.0	110
Fused	9.0	9.5	10.0	11
Printed circuit, total	68.9	78.2	85.9	111
Card insertion	44.5	49.2	53.0	66
Two-piece (metal to metal)	14.0	15.8	17.3	23
Plate module	10.4	13.2	15.6	22
Dual in-line package sockets	3.0	4.1	5.0	7
Electron tubes, total	**1,008.4**	**1,077.0**	**1,086.5**	**1,111**
Receiving	210.6	213.1	196.8	159
Power and special-purpose tubes, total	277.2	289.4	300.7	320
High-vacuum	54.0	52.7	50.4	44
Gas and vapor	16.7	16.5	15.3	12
Klystrons	31.8	31.1	30.0	29
Magnetrons	34.5	34.3	34.2	31
TWTs, including backward wave	60.3	59.7	58.1	56
Light-sensing	8.5	9.5	10.0	11
Image-sensing and storage	36.9	38.6	40.7	46
Display, except CRT (alphanumeric)	18.3	27.0	40.0	68
Cathode ray, except TV	16.2	20.0	22.0	23
TV picture, monochrome	56.3	47.0	39.0	22
TV picture, color	464.3	527.5	550.0	610
Filters, networks, and delay lines, total	**116.3**	**119.7**	**126.2**	**137**
Delay lines	16.5	14.9	15.0	14
Passive electric-wave filters (LC)	30.0	32.5	36.0	37
Crystal filters	25.0	26.0	27.0	30
RFI and EMI filters	36.9	36.8	38.0	41
Active filters	7.9	9.5	10.2	15
Magnetic components, total	**240.8**	**269.5**	**289.6**	**321**
Computer memory cores	20.0	32.0	30.0	26
Transformers and chokes, except TV	157.4	170.3	191.0	223
Laminated	100.0	110.0	120.0	140
Toroidal	36.2	37.0	42.0	50
Pulse transformers	21.2	23.3	29.0	33
TV magnetic, including yokes and flybacks	48.3	52.0	53.0	56
RF coils	15.1	15.2	15.6	16
Microwave components and hardware, total	**71.7**	**77.4**	**82.9**	**93**
Mixers	10.1	10.5	11.0	12
Detectors	3.5	3.8	3.9	4
Passive components (filters, couplers, terminations, attenuators, etc.)	26.8	29.8	33.3	38
Waveguide type	7.3	8.0	8.1	9
Coaxial and stripline	19.5	21.8	25.2	29
Switches	8.0	8.8	8.9	12
Waveguide type	2.4	2.7	2.7	4
Coaxial and stripline	5.6	6.1	6.2	8
Ferrite devices, total	19.3	20.3	21.4	22
Isolators	4.4	4.8	4.9	5
Circulators	10.8	11.1	11.5	12
YIG devices	4.1	4.4	5.0	5
Power limiters	4.0	4.2	4.4	5

(millions of dollars)	1971	1972	1973	1976
Printed-circuit boards, total	123.2	147.1	171.5	195
Single-layer	20.0	15.0	12.0	8
Two-layer	73.3	95.0	119.0	133
Multilayer	24.6	30.8	32.0	42
Flexible	5.3	6.3	8.5	12
Quartz crystals (including mounts and ovens), total	**46.0**	**49.3**	**52.0**	**54**
Relays, total	**236.8**	**248.3**	**263.2**	**304**
Solid-state	7.0	9.7	10.5	20
Electromagnetic, total	229.8	238.6	252.7	284
Contact meter	5.1	5.4	5.6	6
Crystal can	27.0	24.5	26.0	30
Dry reed	22.6	25.5	28.1	36
Mercury wetted	15.5	16.7	17.5	21
Resonant reed	1.9	2.3	2.8	4
Telephone type	28.3	29.2	30.0	33
Thermal	4.2	4.5	4.7	5
Other	125.2	130.5	138.0	149
Resistors, total	**354.4**	**382.9**	**400.4**	**423**
Fixed, total	183.1	195.1	199.1	196
Composition	67.6	74.0	74.7	65
Deposited carbon	13.0	13.8	14.5	16
Metal film	52.0	54.8	55.9	59
Wirewound	50.5	52.5	54.0	56
Variable resistors, total	128.9	141.3	150.5	165
Wirewound, precision	19.7	18.6	18.1	16
Wirewound, non-precision	9.7	10.0	10.5	13
Wirewound, trimmers	20.6	21.6	22.3	24
Non-wirewound, precision	9.7	9.9	10.5	11
Non-wirewound, non-precision	45.0	52.3	56.5	64
Non-wirewound, trimmers	24.2	28.9	32.6	37
Other, including varistors and thermistors	18.7	18.9	19.2	21
Resistive networks, incl. film	23.7	27.6	31.6	41
Switches, mechanical, total	**183.3**	**202.8**	**214.6**	**247**
Coaxial	9.0	10.0	10.2	12
Lighted pushbutton	32.5	35.0	38.0	42
Pushbutton	10.0	11.0	13.0	17
Rotary	30.5	33.7	33.8	35
Snap-action	70.1	73.5	76.5	82
Thumbwheel	9.4	13.2	13.8	16
Stepping	13.8	13.9	13.8	13
Keyboard	8.0	12.5	15.5	30
Transducers, total	**63.1**	**70.2**	**77.2**	**93**
Pressure	20.0	23.0	26.5	33
Position	8.3	9.5	10.7	13
Strain	17.4	17.9	18.3	20
Acceleration	7.3	8.5	8.9	12
Other	10.1	11.3	12.8	15
Wire and cable, total	**361.5**	**401.4**	**445.6**	**513**
Coaxial	89.0	99.5	113.0	120
Flat and flexible	10.5	14.9	20.1	36
Hook-up wire	95.0	99.0	103.5	114
Magnet wire	75.0	85.0	90.0	97
Multiconductor, shielded	45.0	49.0	59.0	68
Multiconductor, unshielded	47.0	54.0	60.0	78

(millions of dollars)	1971	1972	1973	1976
Semiconductors, total	**1,251.7**	**1,451.0**	**1,645.0**	**2,143**
Discrete, conventional devices, total	**493.3**	**494.6**	**492.9**	**443**
Transistors, total	301.5	302.4	300.0	262
Silicon bipolar, total	242.5	248.0	249.0	222
Small signal (<1 W dissipation)	146.0	138.0	134.0	90
Power (>1 W dissipation)	96.5	110.0	115.0	132
Germanium bipolar, total	39.8	33.3	28.0	14
Small signal (<1 W dissipation)	16.7	12.5	10.0	3
Power (>1 W dissipation)	23.1	20.8	18.0	11
Field effect	19.2	21.1	23.0	26
Diodes and rectifiers, total	191.8	192.2	192.9	181
Signal, total	51.5	46.1	43.3	32
Germanium	7.0	5.1	4.3	2
Silicon	44.5	41.0	39.0	30
Zener, total	42.0	44.5	47.6	50
Voltage regulator	33.5	36.0	36.5	39
Reference	8.5	8.5	9.0	11
Rectifiers, total	98.3	101.6	102.0	99
Silicon	75.0	79.6	82.0	86
Selenium, copper oxide	9.0	9.0	8.0	4
Assemblies	14.3	13.0	12.0	9
Discrete, special devices, total	**115.0**	**124.7**	**131.4**	**157**
Thyristors (SCRs, 4-layer diodes, etc.)	54.0	58.6	63.5	80
Tunnel diodes	1.8	1.8	1.5	1
Microwave diodes, total	19.5	22.2	22.4	22
Avalanche	0.5	0.9	1.2	3
PIN	5.0	5.5	6.0	8
Gunn	0.5	0.8	0.9	2
Varactor	6.7	6.9	6.2	4
Mixer & detector	6.8	8.1	8.1	5
Microwave transistors, total	8.0	9.5	11.0	21
Tuner varactors (less than 1 GHz)	7.5	8.0	8.0	8
Multiple devices (duals, diode arrays, Darlingtons, etc.)	20.2	19.6	20.0	20
Other (temp., strain sensors,etc.)	4.0	5.0	5.0	5
Integrated circuits, total	**508.9**	**669.7**	**815.0**	**1,182**
Digital logic, total	356.5	461.5	535.5	703
Bipolar, total	252.3	310.7	331.5	349
RTL	7.5	5.0	4.5	3
DTL	67.0	60.6	53.0	27
TTL	125.8	193.0	215.0	230
ECL	52.0	52.1	59.0	89
MOS, including CMOS, total	104.2	150.8	204.0	354
Digital memory, total	60.9	96.0	142.0	308
Read-only, incl. programmable, total	17.1	29.6	46.0	86
Bipolar	7.3	16.6	32.0	68
MOS	9.8	13.0	14.0	18
Random access, total	15.8	34.4	61.0	178
Bipolar	5.8	15.7	30.0	90
MOS	10.0	18.7	31.0	88
Shift registers	28.0	32.0	35.0	44
Other digital functions, total	18.2	19.6	20.0	17
Analog ICs, total	73.3	92.6	117.5	154
Op amps	33.8	39.6	48.5	58
All other, total	39.5	53.0	69.0	96
Industrial	10.0	15.0	18.0	26
Consumer & communications	12.5	18.0	22.0	25
Interface	17.0	20.0	29.0	45
Multicomponent or hybrid circuits, total	**92.5**	**105.8**	**125.0**	**216**
Optoelectronic devices, total	**42.0**	**56.2**	**80.7**	**145**
Photovoltaic (solar) cells	7.0	7.0	7.2	8
Photoconductive cells	6.5	5.0	4.5	4
Light-emitting diodes	4.0	7.0	9.5	17
Photodiodes, including arrays	2.5	3.5	4.5	7
Phototransistors, including arrays	9.0	9.9	10.9	13
Couplers and isolators	1.6	4.3	5.1	9
Silicon targets	3.0	3.5	4.0	12
Light-emitting diode displays	8.4	16.0	35.0	75

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Market estimates represent total value (at the factory level) of goods shipped by U.S.-based manufacturers. Some product categories have been added, deleted or redefined; therefore, these totals are not directly comparable to those of previous years.

Electronics
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Industrial and Commercial Markets

(millions of dollars)	1971	1972	1973	1976
INDUSTRIAL AND COMMERCIAL, TOTAL	11,470.8	14,000.2	16,277.0	22,014
Test and measuring instruments, total	**669.7**	**738.5**	**812.3**	**1,009**
Non-microwave instruments, total	**575.2**	**635.0**	**701.4**	**874**
Spectrum analyzers	16.1	18.3	20.0	27
Frequency synthesizers	16.2	19.2	22.4	29
Function generators	7.3	8.2	9.2	12
Signal generators	24.3	26.5	28.1	29
Sweep generators	7.6	8.8	9.9	13
Pulse generators	9.4	10.6	12.4	15
Waveform analyzers & distortion meters	13.0	15.0	17.0	20
Counters, time and frequency	30.5	32.6	34.5	40
Panel meters, total	29.7	28.7	31.5	35
Analog	22.0	20.0	19.0	18
Digital	7.7	8.7	12.5	17
Noise measuring equipment	2.3	2.7	3.0	4
Analog voltmeters, ammeters & multimeters	13.6	18.6	18.8	21
Digital multimeters, total	33.3	37.3	42.6	49
3½ digit and below	10.3	12.3	15.8	20
4½ digit and above	23.0	25.0	26.8	29
Calibrators and standards, active & passive	8.6	10.0	10.7	14
Oscilloscopes, total	147.5	158.0	174.7	222
Oscilloscopes, non-plug-in	74.8	80.3	92.5	114
Oscilloscopes, plug-in, main frame only	56.8	59.5	62.3	81
Oscilloscope accessories and plug-ins	15.9	18.2	19.9	27
Recording instruments, total	102.8	110.0	118.1	132
Magnetic tape	50.1	51.8	55.3	59
Strip chart	43.7	47.2	49.8	54
X–Y	9.0	11.0	13.0	19
Semiconductor testers	25.0	35.0	45.0	75
Power supplies, lab and industrial	75.0	80.5	85.5	115
Amplifiers, lab type	6.0	7.0	9.0	11
Phase-measuring equipment	7.0	8.0	9.0	11
Microwave instruments, total	**94.5**	**103.5**	**110.9**	**135**
Phase measuring	8.0	9.0	9.5	13
Impedance measuring	14.3	15.7	16.2	19
Power measuring	4.2	4.4	4.6	5
Spectrum analyzers	15.6	17.5	20.0	27
Frequency measuring and analysis	6.2	6.9	7.1	8
Frequency counters	5.5	6.0	6.5	9
Noise measuring	1.9	1.9	1.9	2
Signal generators	12.0	12.6	13.2	14
Sweep generators	15.0	17.0	19.0	23
Field intensity meters and test receivers	6.8	7.0	7.2	9
Antenna pattern measuring	5.0	5.5	5.7	6

Medical equipment, total	**545.0**	**606.1**	**675.8**	**878**
Diagnostic equipment, total	270.4	303.5	340.4	449
X-ray fluoroscopic equipment	217.0	245.0	277.0	371
Electroencephalographs	6.4	6.8	7.5	10
Electrocardiographs	14.9	16.3	17.6	22
Ultrasonic scanners	3.1	3.4	3.8	6
Scintillation cameras & counters	29.0	32.0	34.5	40
Laboratory equipment, total	115.8	117.9	122.6	130
Patient monitoring systems, total	41.8	48.6	59.3	86
Cardiac	36.8	42.3	50.0	71
Respiratory	5.0	6.3	9.3	15
Prosthetic equipment, total	75.5	86.9	95.8	138
Hearing aids	46.5	50.8	52.0	63
Pacemakers	28.5	35.2	42.0	70
Motorized limbs	0.5	0.9	1.8	5
Therapeutic equipment, total	31.1	35.3	42.4	55
X-ray equipment	15.2	17.0	22.0	27
Ultrasonic generators	5.9	7.0	7.7	10
Diathermy, shortwave and microwave	5.1	5.4	5.9	8
Defibrillators	4.9	5.9	6.8	10
Surgical support equipment, total	10.4	13.9	15.3	20

(millions of dollars)

	1971	1972	1973	1976
Computers and related equipment, total	**7,842.0**	**9,851.0**	**11,481.0**	**15,328**
Data processing systems, total	4,300.0	5,421.0	6,318.0	7,702
Mini (<$50K), OEM and end user	280.0	333.0	418.0	802
Small ($50K – $420K)	850.0	588.0	299.0	725
Medium ($420K – $840K)	1,150.0	675.0	1,600.0	1,190
Medium/communication ($840K – $1,680K)	900.0	1,980.0	1,356.0	1,390
Large ($1,680K – $4,000K)	800.0	900.0	1,702.0	2,070
Giant (>$4,000K)	320.0	945.0	943.0	1,525
Add-on memory, total	178.0	210.0	245.0	237
Core systems	170.0	190.0	190.0	129
Semiconductor systems	8.0	20.0	55.0	108
Data storage devices, total	1,298.0	1,724.0	2,056.0	3,302
Disk storage devices	620.0	875.0	932.0	1,300
Drum storage devices	30.0	35.0	42.0	60
Magnetic tape devices	620.0	762.0	1,021.0	1,862
Digital cassettes	28.0	52.0	61.0	80
Input/output peripherals, total (Shipped independently of systems)	794.0	943.0	1,126.0	1,732
Card read/punch	160.0	165.0	230.0	300
Line printers (impact)	350.0	409.0	460.0	690
Non-impact printers	10.0	11.0	16.0	38
Computer output microfilm	26.0	28.0	35.0	46
Optical character readers	170.0	238.0	285.0	517
Magnetic ink character readers	33.0	38.0	40.0	50
Electromechanical plotters	33.0	37.0	38.0	51
Paper tape devices	12.0	17.0	22.0	40
Key entry, total	414.0	496.0	461.0	420
Key punch/verify	260.0	300.0	248.0	110
Key to tape	108.0	110.0	108.0	75
Key to disk	36.0	66.0	76.0	155
Keyboard to cassette/cartridge	10.0	20.0	29.0	80
Terminals, total	462.0	598.0	723.0	1,243
Keyboard printers	186.0	198.0	190.0	192
Videos (CRT<$75/mo.)	100.0	110.0	120.0	128
Remote batch/intelligent	132.0	199.0	255.0	596
Graphic	30.0	35.0	40.0	50
Audio response	4.0	6.0	8.0	12
Point of sale	10.0	50.0	110.0	265
Office equipment, total	396.0	459.0	552.0	692
Calculators, total	322.0	380.0	463.0	585
Desk top	212.0	260.0	303.0	390
Programmable	110.0	120.0	160.0	195
Dictating devices, total	69.0	71.0	78.0	92
Other office equipment, total	5.0	8.0	11.0	15

Industrial operations equipment, total	**660.5**	**774.6**	**903.1**	**1,176**
Motor controls (speed, torque)	83.5	90.3	100.5	112
Numerical controls, total	38.7	43.4	47.3	76
Point to point control systems	14.5	14.9	15.2	18
Contouring control systems	24.2	28.5	32.1	58
Inspection systems, total	44.9	54.1	58.6	88
Ultrasonic test equipment	15.1	19.1	21.2	28
X-ray test equipment	27.8	32.6	34.8	56
Infrared test equipment	2.0	2.4	2.6	4
Thickness gages and controls, total	35.7	45.4	57.8	99
Photoelectric gages and controls	25.4	33.0	43.0	73
Radiation-based	10.3	12.4	14.8	26
Factory data acquisition systems	30.0	56.0	100.0	138
Electronic process controllers (temperature, pressure, flow, etc.)	38.3	42.2	45.2	52
Electronic process recorders and indicators (temperature, pressure, flow, etc.)	53.1	58.2	62.0	68
Program sequence controllers	8.8	12.2	15.1	27
Pollution monitoring systems	12.0	14.0	17.0	26
Industrial and process control computer systems, total	245.0	276.3	312.0	397
Digital	202.0	230.0	263.0	349
Analog	43.0	46.3	49.0	48
Power supplies – OEM type	70.5	82.5	87.6	93

(millions of dollars)

	1971	1972	1973	1976
Communications equipment, total	**1,598.3**	**1,834.9**	**2,154.5**	**2,963**
Radio, complete systems, total	555.9	619.4	681.3	786
Aviation mobile (includes ground support)	111.1	113.0	115.0	130
Marine mobile (ship and shore)	18.6	20.1	25.2	31
Land mobile (mobile and base)	283.0	300.2	324.3	386
Microwave relay (includes specialized & common carriers)	122.3	165.0	194.8	210
Amateur	11.0	11.2	11.5	13
Citizens band	9.9	9.9	10.5	16
Navigation systems	128.0	131.0	135.0	155
A-M and F-M station equipment	18.0	19.2	19.6	22
TV station equipment (excluding CATV)	142.1	150.3	156.6	165
Telemetry (industrial only)	35.8	47.1	50.6	59
PABX	155.8	161.2	172.6	215
Paging systems	18.8	20.4	21.8	24
Intercoms	195.7	214.5	235.7	273
Non-broadcast TV equipment, total	99.7	109.8	121.0	179
CATV equipment, total	80.2	88.3	97.4	147
Studio and head-end equipment	16.0	17.6	19.4	32
Distribution equipment (amplifiers, power supplies, couplers, transformers)	36.5	40.1	44.1	58
Transmission lines & fittings	26.0	28.6	31.5	42
Converters	1.7	2.0	2.4	15
CCTV equipment, total	19.5	21.5	23.6	32
Video recorders & playback units (non-consumer)	10.1	15.2	16.3	19
Data-communications equipment, total	238.4	346.8	544.0	1,066
Facsimile	42.3	53.7	64.0	105
Multiplexers	26.2	33.8	41.0	78
Modems	36.8	40.0	45.0	75
Remote programmable concentrators	35.1	45.3	60.0	175
Message switching systems	48.0	60.0	82.0	153
Front-end communications processors	50.0	114.0	252.0	480

Nuclear instruments and equipment, total	**39.2**	**42.9**	**47.2**	**63**
Reactor controls	7.9	9.3	11.1	19
Pulse analysis instrumentation	8.9	9.7	10.7	14
Radiation detection & monitoring equipment, total	6.9	8.3	10.0	15
Detectors, including ion chambers	3.8	4.6	5.5	7
Monitors (portable & fixed)	1.1	1.3	1.6	4
Personal dosimeters	2.0	2.4	2.9	4
Other instruments and controls	15.5	15.6	15.4	15

Lasers and equipment, total	**28.5**	**34.0**	**40.1**	**55**
Gas lasers	10.2	12.2	14.6	18
Semiconductor lasers	1.5	1.7	2.1	5
Other (including ruby, YAG, etc.)	10.5	12.5	15.0	19
Laser power supplies	4.8	5.8	6.4	9
Modulators	1.5	1.8	2.0	4

Automotive electronics, total	**87.6**	**118.2**	**163.0**	**542**
IC voltage regulators	37.5	41.9	43.0	46
Anti-pollution systems	–	10.0	20.0	95
Electronic ignition systems	5.8	12.2	28.0	81
Fuel-injection	–	0.1	3.0	110
Anti-skid control	6.3	8.0	11.0	112
Other	38.0	46.0	58.0	98

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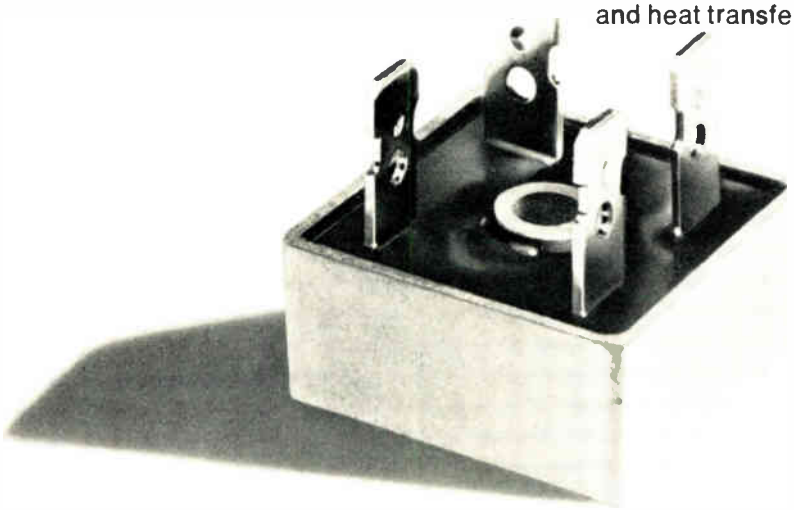

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V_f	1.2V @ 12.5A DC
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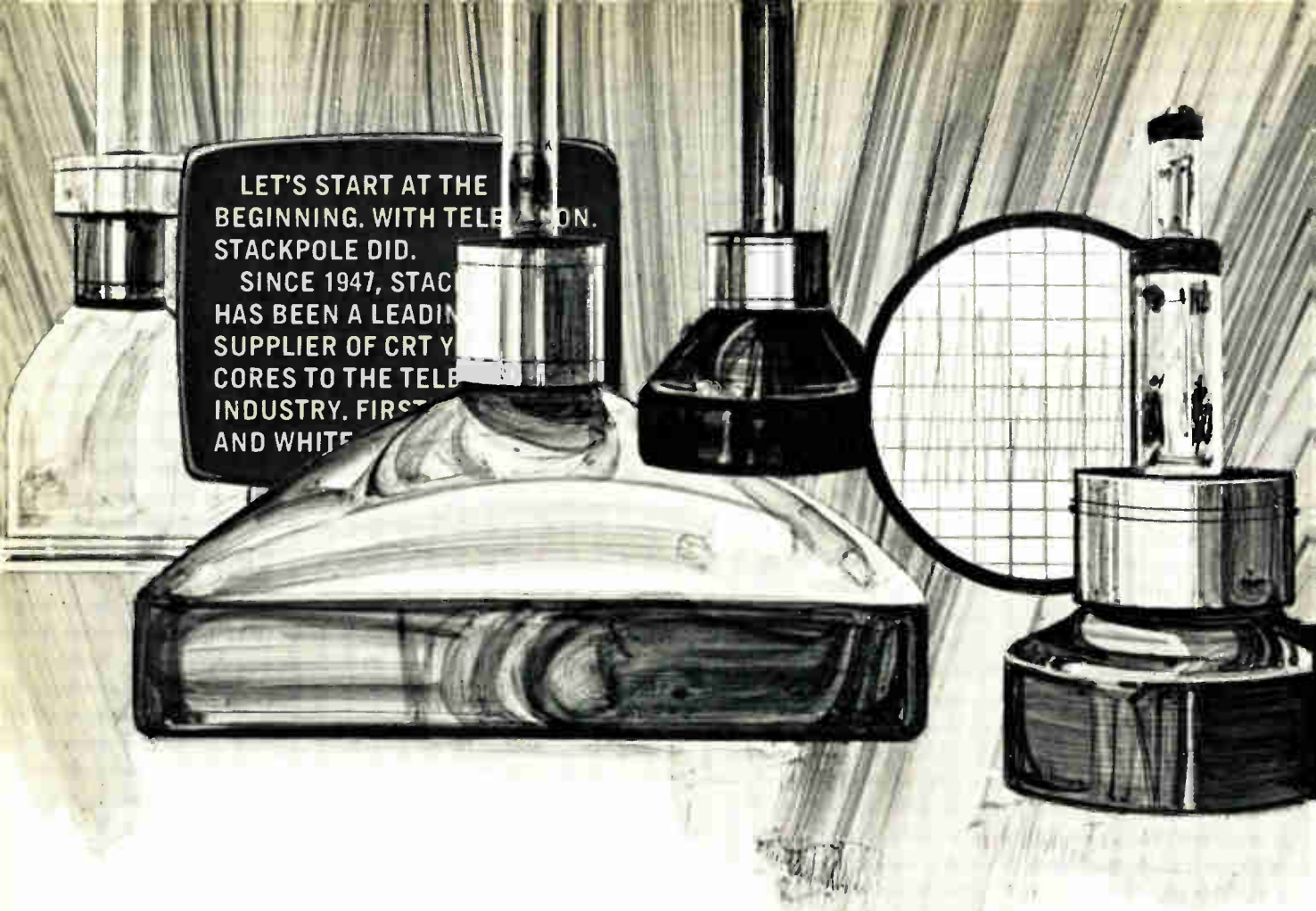

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Circle 98 on reader service card

How to protect data with ciphers that are really hard to break

The ciphers in use today to provide data security are based on a technique that is vulnerable to solution by linear equations; a nonlinear modification of the approach is much more powerful

by Philip R. Geffe, *Westinghouse Electric Corp., Baltimore, Md.*

☐ Sending valuable data over a nonsecure data path like a telephone line invites theft. A geophysical analysis, for example, may be worth millions of dollars. For safety's sake, therefore, systems engineers, who have for some years employed coding to minimize word length and combat transmission error, are enlarging their encoding library to include cryptography, the process of encoding information to conceal its meaning.

To deter data thieves, the cipher used must be hard to break. ("Breaking" a cipher means reading a message without knowledge of the key.) Unfortunately, much of the data-enciphering and -deciphering equipment employed today uses a cipher that is all too easy to break. The equipment makes use of a version of the key-stream encipherment technique, in which the key to the cipher is a number sequence generated by a linear feedback sequence generator. That sequence, however long and random it may seem, can be reconstructed by a cryptanalyst merely by solving linear equations.

But this defect vanishes at once if nonlinear generators produce the key stream—and nonlinear generators are easy to contrive. To understand why this should be so it is necessary to begin at the beginning, with the notion of the key-stream cipher.

Key stream explained

The key-stream method is normally applied to a series of binary digits. But its basic principles can be readily grasped in a message in written English.

First, the message is written out—in clear text, to use the cryptographer's jargon. Then beneath it is written a sequence of letters—the key—with one letter under each letter of the message. This is continued until the key stream thus formed matches the length of the message. Next, each pair of clear-text and key letters is combined to yield a third letter, the cryptogram letter. This combination is achieved by allotting each letter of the alphabet a number, allowing pairs of numbers to be transformed into a third number that represents a third letter, the cipher.

For example, suppose the clear text is SEND MONEY TOMORROW, and the key is CIPHER. The alphabet is numbered A = 0, B = 1, C = 2, . . . Z = 25, and every pair of numbers is to be handled by modulo-26 arithmetic.

In modulo-26 arithmetic, 26 is the zero of the number system, and any number is unchanged by the addition or subtraction of 26. Moreover, any number outside the required range of 0 to 25 may be brought back within range by adding or subtracting 26. For instance:

$(H + E) = (7 + 4) = 11 = L$
$(H - L) = (7 - 11) = -4 = -4 + 26 = 22 = W$
$(N + T) = (13 + 19) = 32 = 32 - 26 = 6 = G$
$(G - T) = (6 - 19) = -13 = -13 + 26 = 13 = N$

The clear-text message can now be enciphered, in this case by "adding" it to the key:

Clear text: S E N D M O N E Y T O M O R R O W
Key: C I P H E R C I P H E R C I P H E
Cryptogram: U M C K A F P M N A S D Q Z G V A

In more detail:

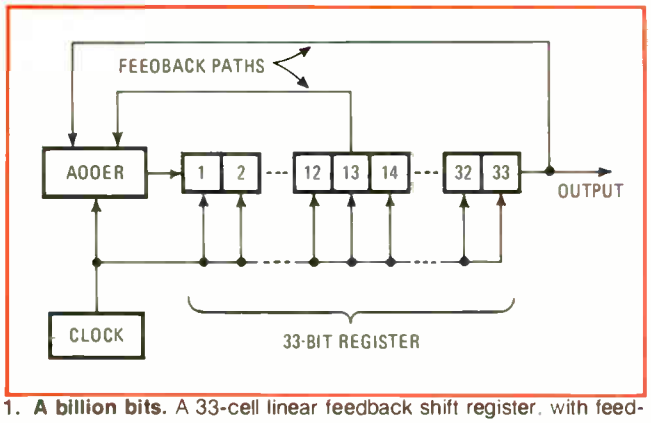
$(S + C) = (18 + 2) = 20 = U$
$(E + I) = (4 + 8) = 12 = M$
$(N + P) = (13 + 15) = 28 = 28 - 26 = 2 = C$ and so forth. To decipher the cryptogram, the process is reversed.

Breaking such a cipher is not difficult since the cryptanalyst can be assumed to have some *a priori* knowledge of the contents of the message. This is implied by the adversary relationship that exists between

GLOSSARY OF CRYPTOLOGY

An excellent general reference in cryptology is David Kahn's "The Codebreakers" (Macmillan, 1969). Basic terminology used in cryptology is as follows:

Cipher: a method of transforming clear text into a cryptogram by regular rules (dependence on a table as with code is minimal).
Clear text: the text of message to be put in secret form.
Code: a method of transforming clear text into a cryptogram by extensive use of large tables.
Cryptanalysis: the technique of breaking a code or cipher.
Cryptanalyst: one who employs cryptanalysis.
Cryptography: secret communication with codes and/or ciphers.
Cryptogram: the coded or enciphered text.
Cryptology: the combined disciplines of cryptography and cryptanalysis.
Decipher: employ a key so as to transform a cryptogram into clear text.
Encipher: transform clear text into a cryptogram.
Key: data that is needed for encipherment and decipherment but is specific for a particular message (cryptographic systems usually have a different key for each cryptogram).



1. A billion bits. A 33-cell linear feedback shift register, with feedback taps from cells 13 and 33, develops a sequence of more than 1 billion bits in length and with good randomness properties. The LFSR is a common source of key streams for digital enciphering.

himself and the cryptographer. Thus, a computer program thief must know how to use it, or where to sell it, else he would have no interest in stealing it. Accordingly, he can be expected to guess many of the words, or sequences, that may occur in the program. Then, by subtracting each probable word or phrase from the cryptogram in turn, he is likely to uncover the key.

As an example of this probable-word method, suppose the FBI has intercepted a cryptogram which it suspects is related to a plot to place nuclear bombs in American cities. The message begins:

UAROY FMIDS FRNFV . . .

The cryptanalyst knows that the cryptographer uses key-stream ciphers, and that the phrase "nuclear bombs" probably appears somewhere in the message. Accordingly, the first thing he will do is to subtract the letters of this phrase from the cryptogram as follows:

```
CRYPT:  U A R O Y F M I D S F R N F V
CLEAR:    N U C L E A R B O M B S
KEY ?:    N X M N B M R C E T Q V

CRYPT:  U A R O Y F M I D S F R N F V
CLEAR:      N U C L E A R B O M B S
KEY ?:      E U W U I I M R R F M N

CRYPT:  U A R O Y F M I D S F R N F V
CLEAR:        N U C L E A R B O M B S
KEY ?:        B E D B E D B E D B E D
```

Obviously, he has struck it rich on the third try, and within a few minutes will have obtained the entire clear text. The conclusion is obvious. A cryptanalyst can break a key-stream cipher with the probable-word method as soon as he recognizes a fragment of the key stream. This condition is both necessary and sufficient. When it applies, the cryptogram can be broken. When it does not, the system is secure.

LFSRs are little better

The aim of the cryptographer is to devise a key stream that the cryptanalyst cannot easily recognize. And hardware which generates such a key stream is the linear feedback shift register (LFSR).

The LFSR is a shift register with outputs from selected flip-flops returned to an adder at the input. Each flip-flop is termed a cell. Operation is linear since no multiplication occurs either by outputs or by constants.

In the initial state there is an arbitrary distribution of 0s and 1s in the register. (There is a degenerate case in which flip-flops contain all 0s, in which case the output is all zeros—an unusable key sequence.) By proper selection of taps for feedback to the adder there will appear at the LFSR output a repeating sequence of binary digits that has maximal length and also has good randomness properties (see Fig. 1).[1,2]

The LFSR is then called a maximal-length generator, and the period or the length of the sequence is $L = 2^N - 1$, where L is the sequence length and N is the number of cells. Obviously, therefore, a small number of cells will produce an extremely long sequence—if N = 20, then L = 1,048,575. The randomness and the length ensure that if such a sequence is used to form a key stream, it will not be recognizable to the cryptanalyst, even when he happens to see it at some stage of a probable-word analysis.

But this difficulty is not insuperable. It can be shown that all the details of the maximal-length generator can be reconstructed by solving linear equations, if 2N successive bits of the LFSR sequence are given. (This is to correct the theorem quoted in the first reference, the proof of which mistakenly concludes that 2N - 1 bits are enough.) In the above case, even though L = 1,048,575, the cryptanalyst needs only 2N or 40 bits to succeed—and 40 bits is only about eight alphanumeric characters.

Moreover, once the solution has been automated, a listing machine will spew forth trial decipherments, and the cryptanalyst need do no more than select the one that is obviously the clear text. Even the decision pro-

A POTENT MIXING TRANSFORMATION

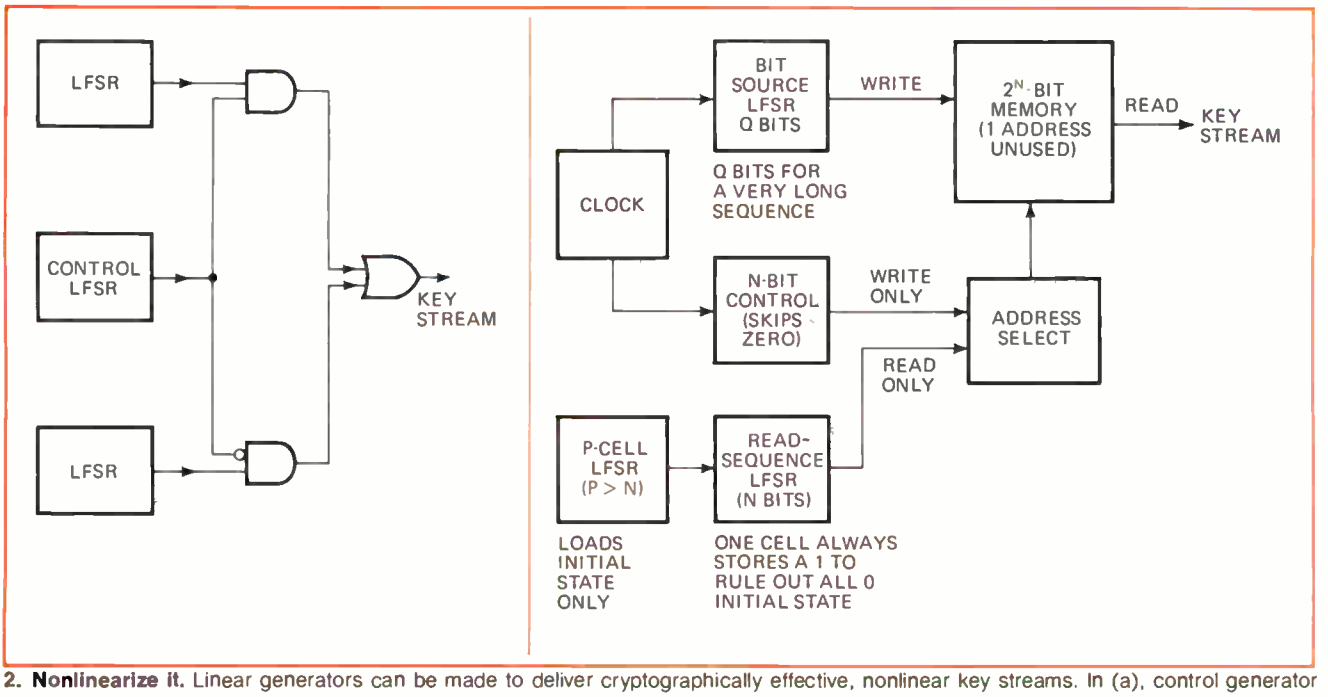
While a sophisticated cipher would use both a mixing transformation and a nonlinear key-stream generator, the type of mixing transformation recommended can be used as a fairly high quality cipher in its own right. A little experimentation on the part of the reader with the deVries cipher should clarify this point. The deVries cipher uses two substitutions successively. The first is:

E 000				
T 001	I 1000	F 11000	Y 111000	K 1111001
A 0100	S 1001	C 11001	P 111001	X 1111010
O 0101	H 1010	M 11010	W 111010	J 1111011
N 0110	D 10110	U 110110	B 111011	Q 1111100
R 0111	L 10111	G 110111	V 1111000	Z 1111101

This substitution replaces letters and numbers in a message with binary numbers. The resulting string of 1s and 0s is then parenthesized into five-bit groups. The second cipher is:

A 00000	I 01000	Q 10000	Y 11000
B 00001	J 01001	R 10001	Z 11001
C 00010	K 01010	S 10010	2 11010
D 00011	L 01011	T 10011	3 11011
E 00100	M 01100	U 10100	4 11100
F 00101	N 01101	V 10101	5 11101
G 00110	O 01110	W 10110	6 11110
H 00111	P 01111	X 10111	7 11111

It replaces each five-bit group with a letter or number. In actual practice, of course, both ciphers would use thoroughly mixed alphabets.



2. Nonlinearize it. Linear generators can be made to deliver cryptographically effective, nonlinear key streams. In (a), control generator chooses next bit from top or bottom LFSR. In (b), clock strobes bit stream from bit-source LFSR into memory addresses in sequence determined by n-bit control. Then n-bit read-sequence LFSR selects address sequence for key-stream output pseudo-randomly. (P-cell generator merely sets initial state of n-bit LFSR.)Read outs from memory differ seemingly randomly.

cess can be automated, since the computer can be programed to test the trial decipherments according to the statistical properties of the English language—or of Fortran IV, as the case may be.

Two steps to more safety

The LFSR cipher is unsafe because a relatively small fragment of the LFSR sequence becomes the means to obtain the entire sequence. One merely solves a set of linear equations.

However, two simple steps will create a key stream that is better by several orders of magnitude: a mixing transformation can be applied to the clear text[3]; and the key stream can be taken from a nonlinear generator.

One of the best mixing transformations is effected by first parenthesizing the clear text into five-bit groups. Binary numbers with varying group lengths are then substituted for each five-bit group. The groups that are substituted must have the comma-free property.[5]. This means that if the numbers of the sequence are run together without commas, spaces, or parentheses, the cryptographer can restore the commas (spaces, parentheses) by inspection of the sequence.

An example of this is the deVries cipher (see "A potent mixing transformation," p. 100), which performs two successive substitutions on the clear text. The second substitution erases the group-length indicators of the first—a situation that is very confusing to the cryptanalyst because he cannot parenthesize the groups of the first substitution until he has solved the second. Thus he is reduced to solving both simultaneously, and this is why the deVries cipher is considered the best of the elementary ciphers.

The general theory of nonlinear generators is still in its infancy.[6] Nonetheless, it takes only a little ingenuity to construct a wide variety of such generators. All that's necessary is to apply singular transformations (many-one transformations) to linear sequences, and this can be done by manipulating the outputs of two or more maximal-length linear generators (see Fig. 2). For instance, three LFSRs, with different values of N and called Left, Right and Control, can be connected so that whenever Control puts out a 1, the bit from Left goes into tm key stream and the bit from Right is deleted. Conversely, when Control puts out a 0, the bit from Left is deleted and the bit from Right becomes part of the key stream. Alternatively, the output of one generator could be used to load a memory from which a stream of bits can be read out in accordance with addresses taken from the output of another generator. A cryptographer would describe this as "dynamic pseudo-random transposition."

The fact remains that any finite cipher based on a closed algorithm can be broken in time if the cryptanalyst has enough material to work on. While this dictum appears to defy common sense, it has certainly been established by experience. For the last five hundred years, at least, the most complicated ciphers have been broken by cryptanalysts as a matter of routine. The only realistic goal for the cryptographer is simply to make the work as long and hard as possible within the practical limitations. The principles described in this article, if applied with care, should help him to do this. □

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Doubling breakdown voltage with cascoded transistors

by Peter T. Uhler
Tinker Air Force Base, Midwest City, Okla.

When bipolar transistors are connected in series to increase their over-all breakdown voltage for power-circuit applications, high-voltage zener diodes are usually needed to protect the transistors. And generally, besides being expensive, these high-voltage zeners have rather modest power ratings.

An alternate approach, a saturating cascode switch, effectively doubles transistor breakdown voltage without requiring costly zeners. The cascode switch generates 600-volt rectangular positive-going pulses with 350-v transistors. It employs a shunt, rather than series, approach for additional load protection.

In the region of operation where output voltage (V_o) is greater than half the supply voltage ($V_{CC}/2$), the switch works as a conventional cascode amplifier, and the collector currents of transistors Q_1 and Q_2 are equal. The base voltage of Q_2 never exceeds $V_{CC}/2$ (unless Q_2's reverse collector saturation current, I_{CBO}, becomes significant), because of the voltage divider formed by the two same-value biasing resistors, labeled R. Therefore, the maximum voltage drop across each transistor is effectively limited, and the need for zener diode clamps is eliminated.

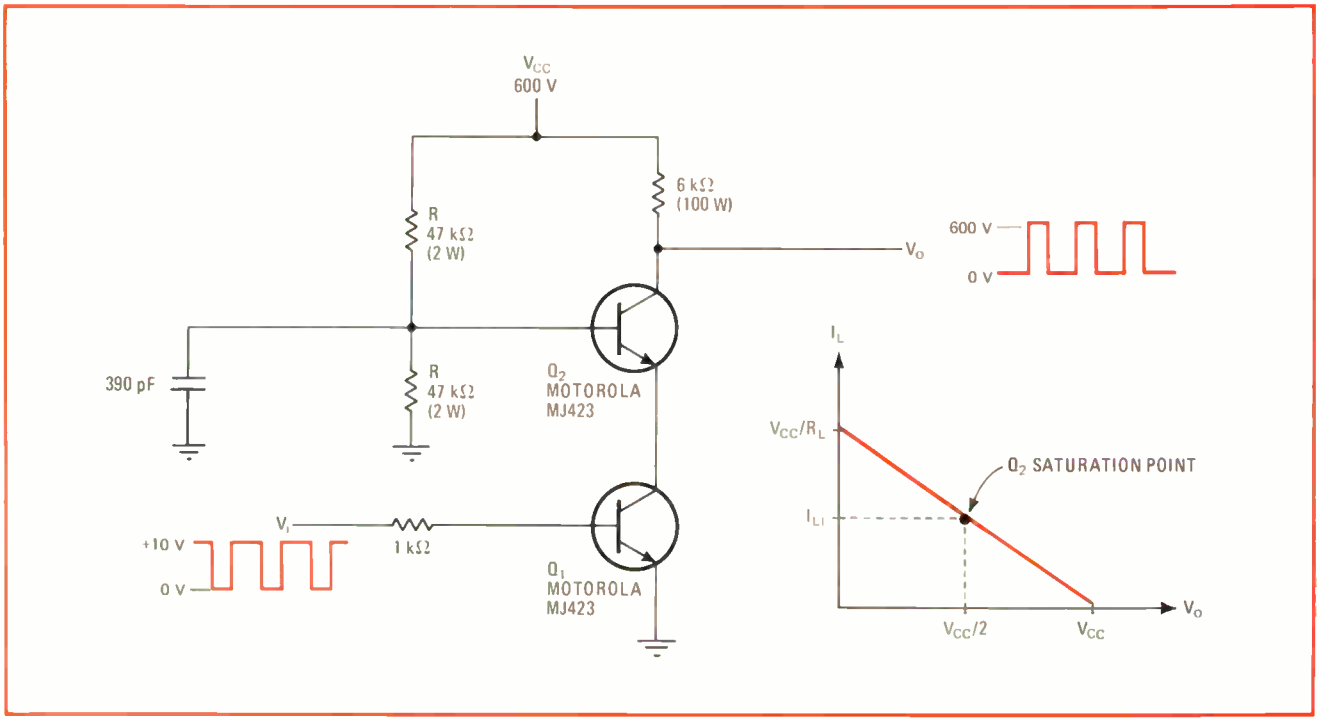
As load current I_L exceeds the midpoint current value (I_{L1}) shown on the static load line, transistor Q_2 saturates and transistor Q_1 becomes the sole controlling element. The load resistance for the switch is now the parallel combination of the load resistance itself and half the biasing resistance ($R_L \| R/2$), which is essentially equal to R_L, since $R/2$ is much greater than R_L.

Only a slight discontinuity occurs in the load line when transistor Q_2 saturates, so that the circuit's output voltage is practically a continuous function of its input voltage throughout the entire output voltage range of 0 to 600 v. The capacitor at the base of Q_2 eliminates the positive-going charge-storage transient that is generated if this transistor is forced out of saturation rapidly.

The biasing resistance value of $R/2$ must be small enough to prevent Q_2's reverse saturation current (I_{CBO}) from causing a significant rise in the potential at Q_2's base. Also, the $R/2$ resistance value must be less than the factor, $h_{FE}R_L$, to assure that Q_2's collector-emitter voltage is a decreasing function of collector current.

The saturating cascode switch can be modified to handle even higher voltages by using three transistors and two separate biasing resistor pairs to bias the transistors at supply voltages of $2V_{CC}/3$ and $V_{CC}/3$. □

Eliminating high-voltage zeners. Cascoded transistors generate 600-volt pulses without using high-priced high-voltage zener diodes for protection. Biasing resistors limit voltage across transistors to $V_{CC}/2$. When V_o is greater than $V_{CC}/2$, transistors Q_1 and Q_2 behave like conventional cascode amplifier. When V_o is less than $V_{CC}/2$, Q_2 saturates, and only Q_1 determines load current.



Variable-gain amplifier yields linear rf modulator

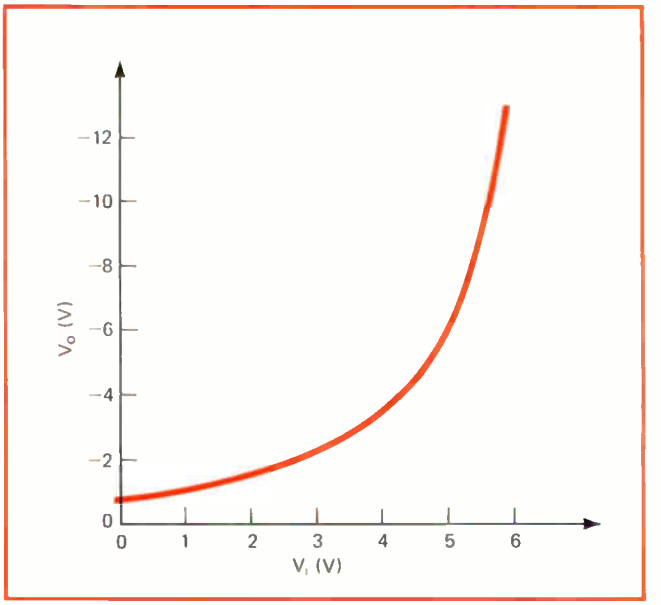
by Michael F. Black
Equipment Group, Texas Instruments, Dallas, Texas

An rf modulator that offers a linear relationship between input control voltage and output rf voltage can be achieved by using a variable-gain amplifier to compensate for the nonlinear characteristics of a p-i-n diode attenuator. Circuit operation remains linear for an input-signal range of approximately 30 decibels.

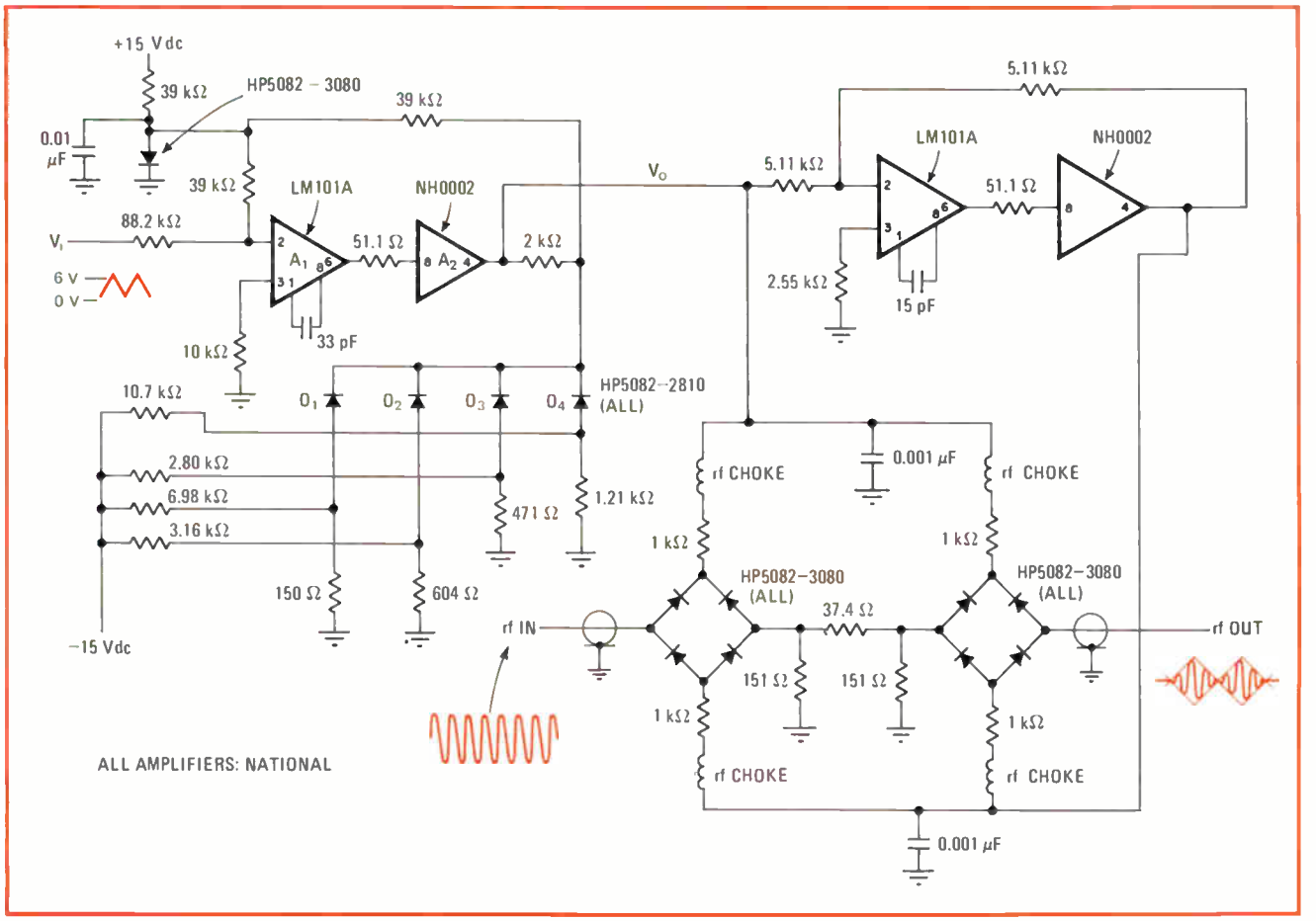
The gain of amplifier A_1 depends on the level of input control voltage V_i. As this modulation voltage increases, diodes D_1 through D_4 conduct, shunting some of A_1's feedback current to ground and raising this amplifier's gain. The resulting voltage-gain curve for both amplifier A_1 and buffer amplifier A_2, adjusted for the varying resistance of the p-i-n diodes used in the modulator, is shown in the diagram.

The p-i-n diodes are connected as a reflective attenuator that has inherent dc balance and offset characteristics to minimize ringing and transient effects. Here, a pad is placed between the two attenuator sections for isolation purposes, but an amplifier can be substituted for the pad if desired.

The values of the attenuator rf chokes are determined by the operating rf carrier frequency and the upper modulation frequency. The circuit performs well from 60 to 150 megahertz, with modulation frequencies as high as 250 kilohertz. □



Linear rf modulator. For 30-decibel signal range, rf modulator provides output rf voltage that varies linearly with input control voltage. Combined gain of amplifier A_1 and buffer A_2 is curved (as shown) to compensate for nonlinear characteristic of p-i-n diode attenuator. Gain is varied by partially grounding feedback current through diodes D_1 and D_4. Operating frequency ranges from 60 to 150 MHz.



Tunable active filter has switchable response

by Philbrook Cushing
La Jolla, Calif.

With a minimum number of components, a positive-feedback active filter that has a continuously tunable cutoff frequency from 20 hertz to 20 kilohertz can be built. Additionally, the inexpensive filter provides switch-selectable low-pass or high-pass responses with either Bessel (RC) or Butterworth (maximally flat) characteristics. The skirt rolloff is 40 decibels per decade.

Basically, the filter consists of amplifier A_1, two equal variable resistors (designated as R), and two equal capacitors (designated as C). A four-pole switch, S_1, interchanges the resistors and capacitors to vary filter response between high-pass and low-pass. The filter's cutoff frequency can be written as:

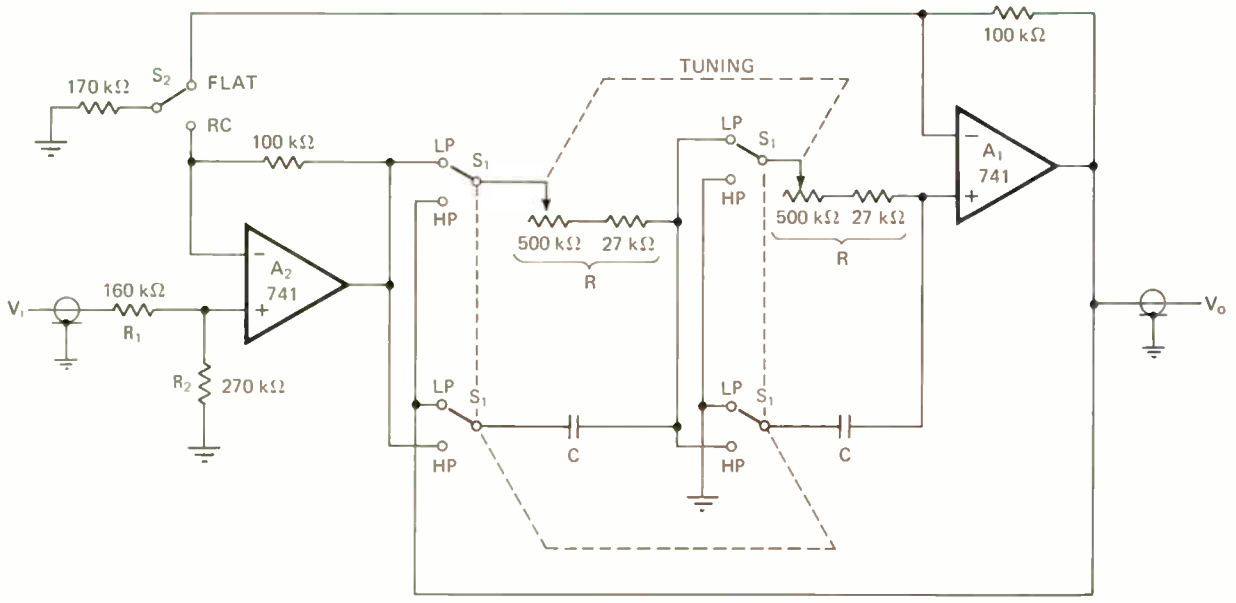
$$\omega_0 = 1/RC$$

Another switch, S_2, changes the filter's characteristic. With S_2 at its RC position, the gain of amplifier A_1 is unity, giving the filter a Bessel characteristic. With S_2 at its "flat" position, A_1's gain becomes 1.59, which produces a Butterworth function. The corresponding gains for amplifier A_2 are 1.59 and unity, so that the gain product from A_2's noninverting input to the output is 1.59 for either setting of switch S_2. Resistors R_1 and R_2 reduce over-all gain to unity for easy cascading.

Output offset voltage, as well as its variation with tuning, may be zeroed out by applying conventional nulling methods at amplifier A_1. The slew rate of the type 741 operational amplifier limits the flat portion of the high-pass response to about 40 kilohertz at a 3-volt peak-to-peak signal level. If two filters are cascaded, bandpass and band-reject responses can be added. □

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.

Versatile filter. Positive-feedback active filter can be tuned continuously from 20 hertz to 20 kilohertz. Two switches provide choice of output—either low-pass (LP) or high-pass (HP) response having either Bessel (RC) or Butterworth (flat) characteristic. Switch S_1 interchanges resistors and capacitors that determine cutoff frequency, while switch S_2 changes gain of amplifiers A_1 and A_2.



CUTOFF FREQUENCY	C (μF)
20 Hz – 200 Hz	0.02
200 Hz – 2 kHz	0.002
2 kHz – 20 kHz	0.0002

R: ALLEN-BRADLEY TYPE J, ±10%
C: POLYSTYRENE, MALLORY TYPE SX, ±5%

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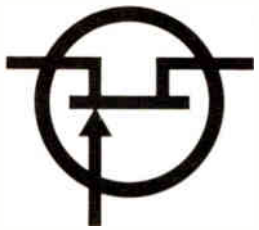

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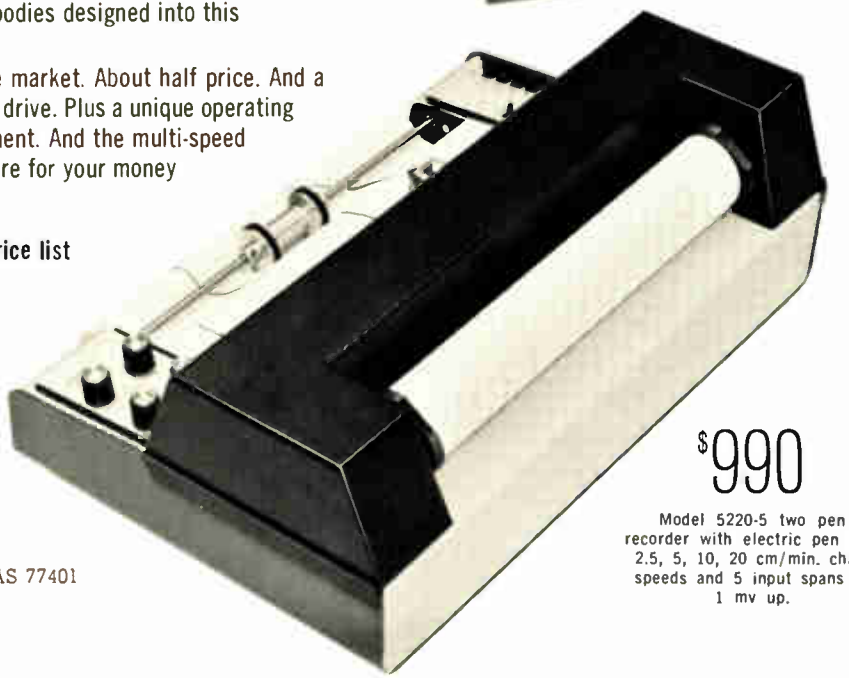

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Evaluating high-energy pulse effects on materials

by J. F. Burgess, C. A. Neugebauer, and R. A. Sigsbee,
R&D Center, General Electric Co., Schenectady, N. Y.

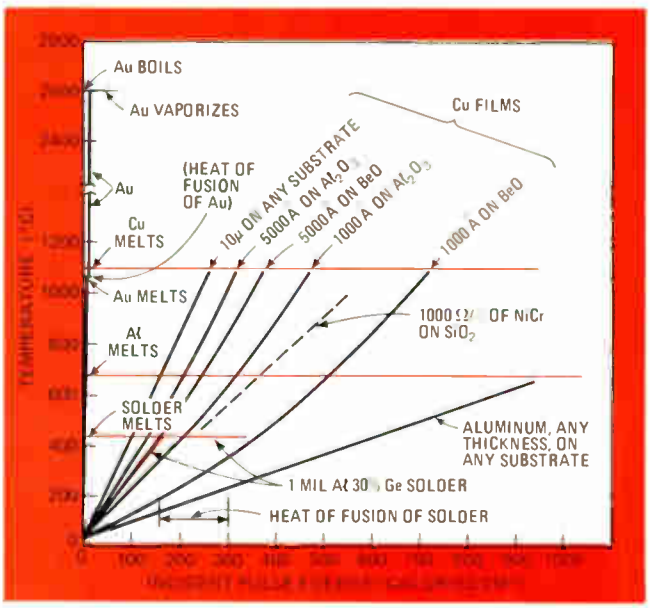
If your circuits may encounter high-energy pulse environments, the choice of material, as well as its thickness, becomes quite important. Some materials are much more tolerant to such environments than others. Gold, for instance, is unsatisfactory because of its high rate of absorption of incident pulse energy, which can cause failures from excessive heating.

On the other hand, aluminum conductors and aluminum-germanium chip-bonding solders behave more favorably. But before any choice is made, the high-energy pulse behavior of the materials likely to be used for hybrid-circuit conductors, resistors, and substrates must be considered.

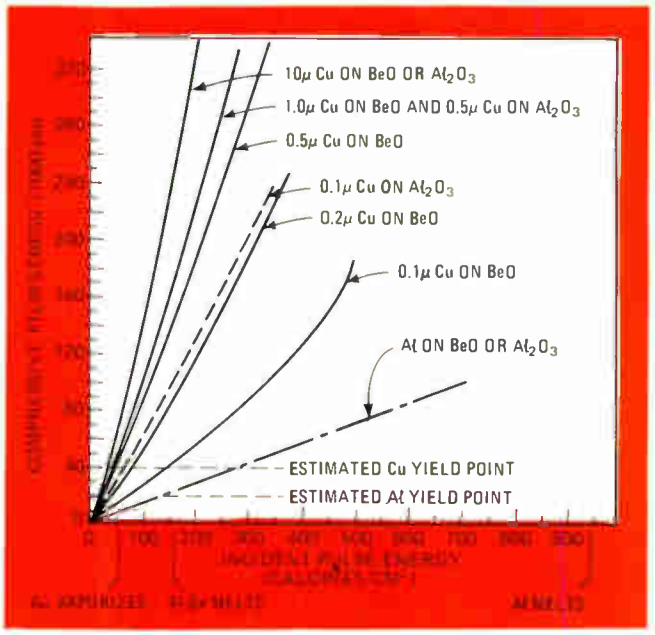
The following charts and summary detail the thermal and mechanical effects of various amounts of short high-intensity energy pulses on aluminum-oxide substrates with gold, copper, aluminum, and nickel-chromium films, as well as a solder alloy of aluminum and 30% germanium, and beryllium oxide. Here are guidelines that span several energy ranges.

Energy range A (highest energy level)

When the energy absorption coefficients of all materials used in a particular circuit are within a factor of 2 or 3, failure usually occurs when the temperature rises to the melting point of the material having the lowest melting temperature, such as chip-attachment solder.



1. How hot? The heat rise of conductive film patterns depends on how much incident pulse energy the material has absorbed.



Energy range B

When the difference in absorption between various materials is great, naturally low-absorption materials are preferred. For this energy region:

- Al, Be, Si, Al_2O_3, BeO, and SiO_2 all experience similar temperature increases. Also the temperature rise in aluminum films does not depend on film thickness.
- For similar energy dosages, transient temperature rise for copper films on Al_2O_3 or BeO substrates is less than 2% that of gold films.
- The transient-temperature rise for copper films depends strongly on its thickness and the thermal conductivity of the substrate, in addition to the pulse duration. The thinnest copper film on the highest-conductivity substrate is optimum. Nevertheless, even 1,000 Angstroms of Cu on BeO experiences twice the temperature rise of aluminum films for similar energy levels.
- If a solder containing appreciable quantities of medium-absorption elements is used, an incident pulse energy of 160 calories per square centimeter may cause melting.

To take full advantage of either an aluminum or a thin (5,000 A) copper conductor, only aluminum or lower-absorption materials should be used in the die attachment. There is, however, no thickness limitation on these materials. Similarly, nickel-chromium resistors on the chip must be replaced by lower-absorption materials, or a better heat sink than SiO_2 must be used. Since stress-induced failures can be caused by shear stresses generated during heating, the interfacial bond strength

is critical. Film thickness, as well as temperature increases, should always be minimized to reduce interfacial shear stresses, even if yielding occurs.

Energy range C

The energy absorption of aluminum and silicon is approximately 33% that of gold, whereas copper and nickel-chromium absorb about 20% that of gold. The transient-temperature rise for medium-absorption materials is greater than for range A, but may be acceptable for medium-energy-density environments.

Energy range D

The absorption by aluminum and silicon is about 10% that of gold, and copper absorption is about 25% that of gold. Also, the absorption by beryllium and beryllium oxide is significantly lower than it is for aluminum or aluminum oxide, which makes Be0 substrates better heat sinks in this energy range. This may be particularly important when the pulse is repetitive. □

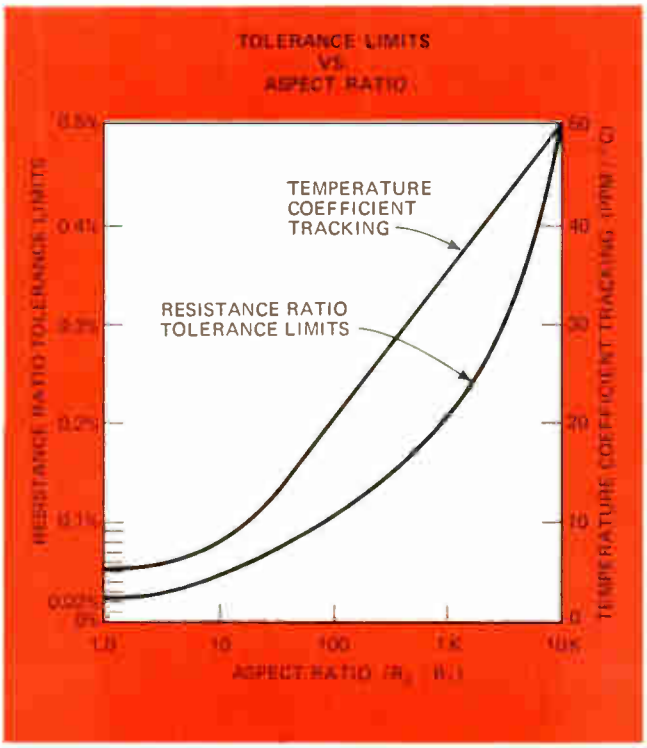
A guide to hybrid-circuit component compatibility

by Lyle F. Pittroff
Helipot Division, Beckman Instruments, Fullerton, Calif.

Hybrid microcircuitry offers the potential of accommodating a wide variety of component types and values, but no process can completely avoid restrictions. Realistically, it is sometimes more economical or better design practice to leave certain devices in discrete form outside of the microcircuit package. Heading the list of discrete components that require special consideration are large capacitors, large power transistors and diodes, specially selected or sorted devices, and large inductive parts. Each application imposes a unique combination of economical, electrical, mechanical, and environmental circumstances. Although evaluation of the complete system is always essential, a convenient starting point is a review of the individual components.

Even though conductor patterns and crossovers may not appear subject to consideration for component compatibility, some applications require analyses of their effects on the circuits. Fine-line screening techniques permit very narrow line widths, but Ohm's law prevails—halving the line width doubles the line resistance between two points. Consequently, paths of high current and lines of low impedance may require special layout consideration, and these should be brought to the attention of the manufacturer. High-conductivity materials with line resistivity of less than 0.01 ohm per square are used for these applications.

Screen-printed crossovers may affect the microcircuit design because the bottom conductor forms a small capacitor of typically less than 2 picofarads. Insulating glass between the two conductors has a dielectric constant of approximately 8, and the actual capacitance value depends on the total area of the crossover design. In most applications, crossover location and design can be controlled so that crossover capacitance does not interfere with circuit performance. However, circuits that are sensitive to capacitive coupling between lines should be noted accordingly. In addition to controlling crossover design, critical circuit areas can be guarded by the optimum arrangement of conductor patterns.



Resistors and resistor networks often provide the "value-added" opportunity for the microcircuit manufacturer specializing in thick-film materials and processing. This is analogous to the manufacturer of monolithic ICs who specializes in combining unique semiconductor geometries into a single component. The basic capabilities of thick-film resistors are shown in Table 1.

Evaluating resistors.

The value of the thick-film resistor is determined by the film resistivity specified in ohms per square. Film thickness is not considered a variable during layout design and manufacture. Key parameters are based upon uniformly screen-printing the film to a specified thickness and sheet resistivity. For example, a film material having a resistivity of 1,000 ohms per square may be used to make a 3,300-ohm resistor and a 500-ohm resistor by using length-to-width ratios of 3.3 to 1.0 and 0.5 to 1.0, respectively.

Resistors made of the same film material can provide close temperature tracking and initial ratio adjustment. Practical limits of production tolerance on initial ratio

and tracking depend significantly on the aspect ratio between resistors. Although other factors, such as absolute value, resistor proximity to each other, and substrate-area restrictions, affect the tolerance limits, the basic relationship between aspect ratio and tolerance limits are shown in Fig. 1.

Generally speaking, the ratio and tracking tolerances shown in the figure are achievable with discrete components only by specifying tighter temperature coefficients and tolerances. Also, choice of resistor values, power ratings, and tolerances for microcircuit applications should be based on circuit requirements instead of the numerical values normally associated with discrete devices. Thick-film resistor tolerances tighter than 0.5% are considered difficult to achieve, and packaging restrictions may further limit initial tolerance.

Capacitor considerations

The most significant consideration for capacitors is physical size, and this is directly related to economics. Screen-printed capacitors consist of screen-printed top and bottom plates and a screen-printed dielectric material. Their characteristics are described in Table 2. The capacitor layout and material considerations allow significant flexibility. The substrate area and packaging constraints normally set the upper value limit. Chip capacitors are available in many shapes and sizes, and size is related to the product of the capacitance and voltage rating. Capacitor values to 0.1 μF and voltage ratings to 200 V are usually compatible with economic considerations and packaging constraints. Commonly used chip capacitors utilize NPO and K1200 dielectric. Note that NPO and K1200 chips differ considerably in capacitance per unit volume. For example, a 2,200-pF NPO chip and a 0.047-pF K1200 chip have about the same dimensions. Tantalum chips allow significantly higher capacitance values but also are larger and cost more.

Hybrid microcircuitry encourages great design flexibility in that nearly any combination of smaller-signal active devices, bipolar, logic or linear ICs, and MOS ICs

TABLE 1 – BECKMAN THICK-FILM RESISTOR CAPABILITIES

Resistance range	5 ohms to 100 megohms
Resistivity range	15 to 330 kilohms/sq.
Resistance tolerance	±0.5% to ±5%
Tempco	
100 ohms to 100 k	±200 ppm/°C
10 ohms to 100 megohms	±300 ppm/°C
Voltco	
0 to 100 V/in.	0.5 to 1 ppm/V
0 to 1,000 V/in.	1 to 5 ppm/V
Resistor noise	
10 to 1,000 ohms/sq.	−20 dB maximum
1 k to 10 k ohms/sq.	−10 dB maximum
10 k to 330 k ohms/sq.	0 dB maximum
Power dissipation	
Precision resistors	20 W/sq. in.
1% stability	100 W/sq. in.
2% stability	500 W/sq. in.

TABLE 2 – BECKMAN CERMET CAPACITOR CAPABILITIES

Capacitance material	12,500 pF/sq. in.
	35,000 pF/sq. in.
	80,000 pF/sq. in.
Capacitance tolerance	
10 pF to 30 pF	±1 pF
30 pF to 2,500 pF	±3%
Capacitance temperature characteristic	(−55°C to +125°C)
12,500 pF/sq. in. material	+1.5%
35,000 pF/sq. in. material	+10%, −30%
80,000 pF/sq. in. material	+2%, −15%
Power factor	2% maximum
Temperature range	−65°C to +150°C
Insulation resistance	10^9 ohms minimum
Maximum working voltage	50 volts

can be combined on the same hybrid substrate. Virtually all passivated semiconductor dice are process-compatible with standard die-mount and wire-bonding techniques. The significant differences between a packaged semiconductor device and the chip version are the criteria for testing and selection.

A key consideration in the conversion to a hybrid design is to determine what parameters the manufacturer will be able to buy in chip form on a production basis. Semiconductor dice are available at a reasonable cost when purchased to dc wafer-probed parameters. Custom-probe testing specifications will have a definite effect on cost and lead time, although this approach is commonly used where breakdown voltage, leakage current, or offset voltage is critical to circuit performance.

The hybrid manufacturer's task, beginning at the inquiry stage, is to evaluate the economies of either specially testing or lot-qualifying semiconductor devices. In some cases, it is far more economical to sample an incoming lot of devices for temperature or ac parameters than to take the yield on the finished hybrids, which have all of the manufacturing cost inputs expended.

Although every rule has an exception, these guidelines should be considered early in the design phase:

- Diode reverse-voltage ratings below 200 V are available in chip form.
- Operational-amplifier offset voltage drift of ±10 V/°C can be guaranteed without special testing.
- Temperature-compensated zeners better than ±50 ppm/°C may have to remain outwide the package.
- Average power dissipation in a single transistor greater than 1 W may require special consideration.

Passivated semiconductor dice are available from most semiconductor manufacturers in a variety of forms. Dice are most commonly shipped after they have been probe-tested, dotted, scribed, and broken from the original wafers. Depending on the type of chip, the individual chips may be shipped in waffle carriers or in vials of 5,000 or more. Most hybrid manufacturers usually stock numerous chip devices in substantial quantities. □

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Engineer's newsletter

British firm issues report on minis

A major report on minicomputer interfaces is being issued by the Electrical Research Association, an independent, government-backed organization at Cleeve Road, Leatherhead, England. Selling for $650, **it examines the techniques available for interfacing each of about 20 minicomputers commonly available in Europe to four different kinds of devices**—another computer, a standard peripheral unit, a nonstandard peripheral unit, and instrumentation. The report joins ERA's previously issued reports on minicomputers and on minicomputer peripherals. The original minicomputer report is a sort of "Consumer's Report" on computers. If one is a bad buy, the report doesn't hesitate to say so.

CCD invades signal processing

Signal processing has a new technology. Matched analog filters and delay lines using charge-coupled-device technology have been built at several laboratories, and the technique appears to be especially valuable for signal processing in radar systems where complicated codes must be retrieved from the noise. **Already CCD filters have been successfully matched to fairly complex codes, among them a 13-chip Barker code.**

The big advantage of CCD filters, which, unlike others, can be built with conventional semiconductor methods, is that the chip rate can be varied easily over a wide range—say, from a few kilohenrys up to a potential of 50 megahertz—and fills the gap in this technology.

RCA pushes trend to programable analog devices

Here's a trend to watch: analog devices that you may program by means of simple pin configurations. **The latest of this type is a power amplifier from RCA; its pin arrangement allows the device to function as an amplifier or a switch.** As an amplifier, it offers an output of 24 to 44 volts dc with currents of 100 milliamperes to 300-mA peak. Add to this the programable op amps and regulators already on the market, and you have a new dimension in flexibility.

GI offers MOSFET data phone service . . .

Are you designing with MOSFETs and have some questions? Try calling General Instrument Corp.'s new MOSFET Information Service via a special toll-free telephone number—800-645-1247—set up by GI's Semiconductor Components division, Hicksville, N.Y. From within New York State itself the phone number is 516-731-3037.

. . . and procedures for Motorola data bank are listed

For those of you who were stymied when trying to follow our instructions to use Motorola's computerized data bank on power transistors on your terminal [*Electronics*, Nov. 6, p. 125], here's the complete procedure we neglected to list for you: simply dial 602-949-7000 (10 characters per second) or 602-949-4221 (30 c/s). Then, when asked for user ID, type USER ID—C113 and press the return key. The computer will request PASS WORD XXXX? Type DPTS on top of XXXX, and press return key. When the computer asks OLD OR NEW: type OLD right after the colon, and press return. The request for FILE NAME should be answered POWER, then the return key pressed again. The computer will say READY. Type RUN, then press return. If there are any problems, contact Mel Kowal at 602-273-6508.

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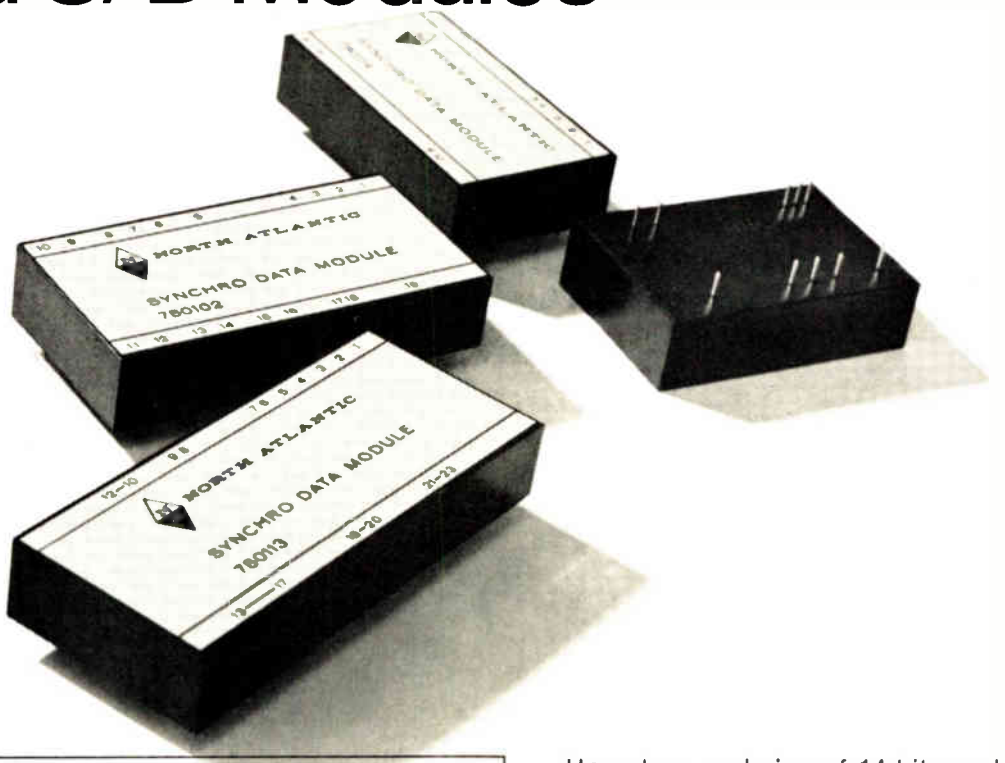

TYPICAL S/D MODULE SETS		
FUNCTION	LINE-LINE	FREQUENCY
S/D or R/D	11.8V	400Hz
R/D	26V	400Hz
S/D or R/D	90V	400Hz
S/D	90V	60Hz

TYPICAL D/S MODULE SETS		
FUNCTION	LINE-LINE	FREQUENCY
D/S or D/R	11.8V	400Hz
D/R	26V	400Hz
D/S or D/R	90V	400Hz
D/S	90V	60Hz

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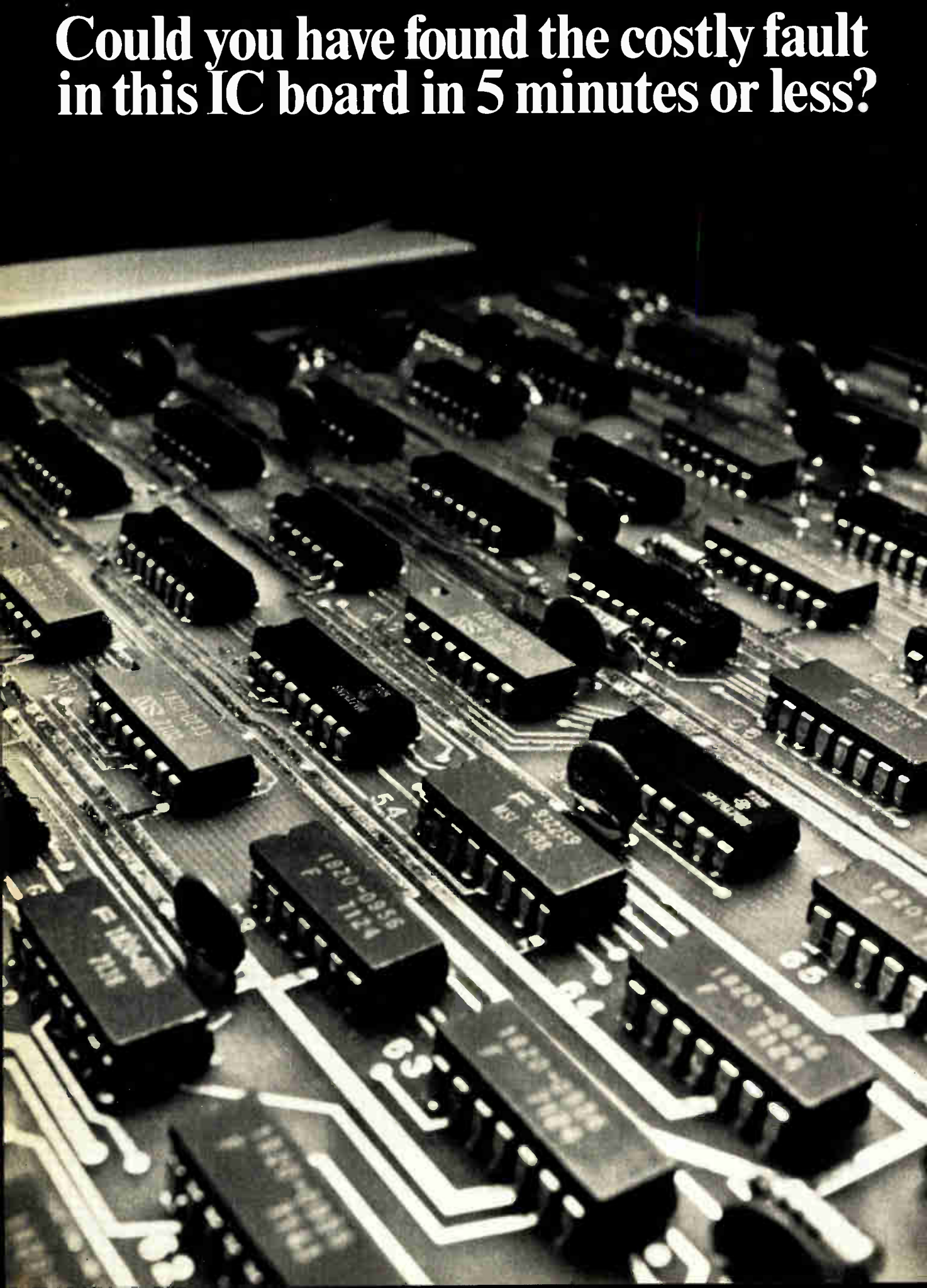

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10526T Logic Pulser — This brand new partner to the Logic Probe and Logic Clip completes a unique stimulus-response team. It injects a pulse into a circuit without trace cutting or unsoldering pins and automatically drives low nodes high or high nodes low for 300 nsec. Over-rides "clamped" conditions with controlled TTL pulse. A single pulse at each triggering, and probe tip impedance is greater than 1 megohm when off. $95.

10528A Logic Clip — Eliminating the cumbersome voltmeter route, this unique device clips directly onto an IC and 16 LED's tell you the state of all 14 or 16 pins instantaneously. No cables, no power connections. Auto-seeking of V_{CC} and ground. Only $125.

10529A Logic Comparator — This device steals stimulus from the circuit under test to exercise a reference IC of the same type. Outputs are compared and differences displayed via LED's in the unit itself, one for each pin, localizing the malfunction to the node. Ten seconds or less completes an IC test, even for dynamic errors as brief as 200 nsec. $375.

5011T Logic Troubleshooting Maxi-kit — Complete in a convenient case. You get all of the above instruments in order to optimize your stimulus-response monitoring and logic analysis for test purposes. Pulser injects signals to be monitored by Probe and Clip. Pulser can provide synchronizing pulses for test and reference IC's when checking tricky sequential circuits with the Comparator. Complete Maxi-kit, including 10% discount on all instrument prices, $625.

Mini-kit 5015T also available (without Comparator) for $285.

Call your local HP field engineering office to get your IC Troubleshooters as quickly as possible. Or write Hewlett-Packard, Palo Alto, California 94304; Europe: P.O. Box 85, CH-1217 Meyrin 2, Geneva, Switzerland; Japan: YHP, 1-59-1, Yoyogi, Shibuya-Ku, Tokyo, 151.

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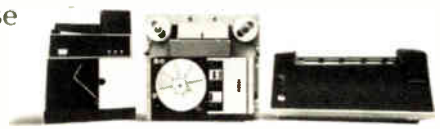

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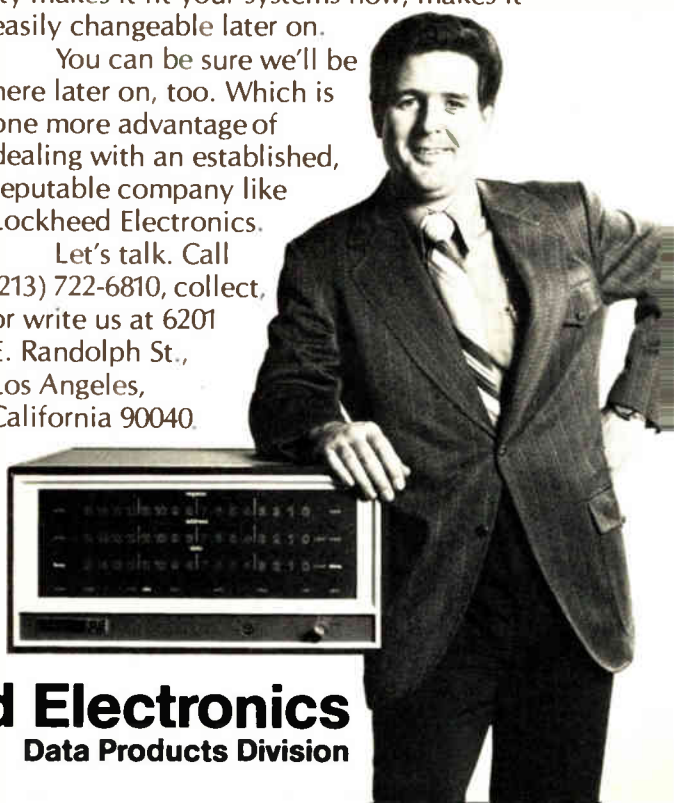

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Programable ROMs take center stage

New 2,048-bit bipolar PROMs will be followed by 4,096-bit devices by year end, propelling field-alterable units into dominance of the read-only market by 1975

by Laurence Altman, Solid State Editor

Less than three years after its debut, the programable read-only memory is fast becoming the superstar of the ROM scene. It's being manufactured by an increasing number of companies—including Harris Semiconductor, Monolithic Memories, National Semiconductor, Signetics, Intel, Intersil, Texas Instruments, Motorola, and Microsystems International—and by 1975 may well account for 75% of a ROM market of $75 million.

Source of the PROM's unforeseen ascendancy is the combination of newly respectable levels of bit density with its old asset of programability. The earlier consensus in the memory industry was that their generally higher prices and lower bit density would limit PROMs to a peripheral role in the design of large systems. Certainly the first field-alterable devices were primarily useful for prototype programing because they offered only 256 bits. But with the emergence of 1,024-bit and now 2,048-bit programable memories, they have become "the wave of the future," says Donald Sorchyk, vice-president and general manager at Harris Semiconductor. Moreover, 4,096-bit PROMs are expected to be available before the end of this year.

Why programable? "Since the customer programs his own unit, he can optimize the design right in the field and then, once it's fixed, continue the same program on the remainder of the parts," says Sorchyk. This maximizes program flexibility for the user, saves him program lead time, and also simplifies his inventory considerably, since he need store only one type of unit, instead of as many different ROMs as he has programs.

The first to introduce an electrically programable ROM was Harris Semiconductor—indeed, it named the device. Most recently, the Melbourne, Fla., company succeeded in packing 2,048-bits onto a chip of the same size as the one it uses for its 1,024-bit PROM [*Electronics*, Nov. 20, 1972, p. 31], and so joined the 2-kilobit PROM club started by Monolithic Memories of Sunnyvale, Calif. The doubled bit-density of the Harris PROM is the result of a unique passive-isolation technique, called Polyplanar, and is important because smaller chips mean high yields and better product deliverability.

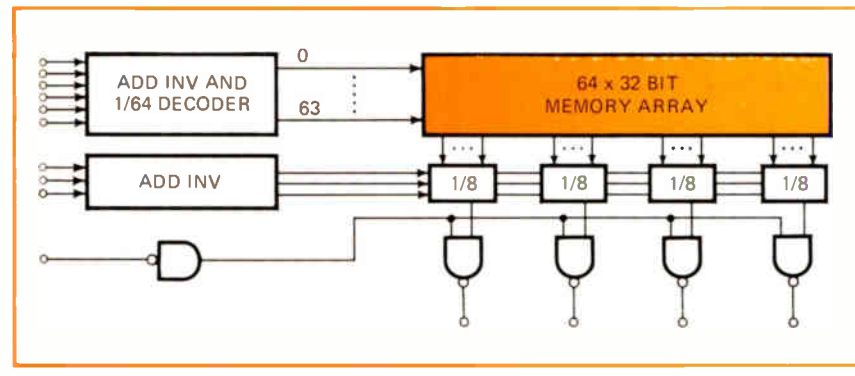
Both the Harris and the Monolithic Memory 2,048-bit products are bipolar, as are most PROMs now in production. (Intel makes MOS units, too.) Also like most currently available units, the Harris and Monolithic devices are programed by electrically blowing out fusible Nichrome links. (But faster programing methods have been developed by Intel and Intersil.)

Besides the 2,048-bit PROM, Monolithic Memories also makes a 1,024-bit model, introduced two years ago. This and the Harris 1,024-bit device have specifications that are typical for PROMs today: access time about 60 nanoseconds; program time generally from 2 to 10 seconds (depending on the program pulse power), and a unit price range of $30 to $40 in quantities of 100.

Two kilobits versus one. Given a standard memory organization, clearly the 2-kilobit product has the advantage of reducing the number of packages required to build the memory console, and so saves on board space and wiring costs. The Harris 2,048-bit memory also lowers system power requirements, since it dissipates the same total power as presently available 1,024-bit devices, in effect halving the power required per bit.

The Harris unit, which is available with either tri-state or open-collector outputs, is organized as 512 4-bit words, and is pin-for-pin compatible with the earlier Monolithic Memories 2-kilobit unit. Significantly, however, the Harris PROM can also be used in existing 1,024-bit ROM sockets by converting

High density. Using passive isolation, Harris Semiconductor packs 2,048 bits on a chip that's no larger than 1,024-bit type, thus paving the way for inexpensive, low-power PROMs.



one chip-select pin on the 1,024-bit product to an address pin on the 2,048-bit unit. It has an access time of 50 ns, requires an input address current of only 0.25 milliamperes, dissipates 0.25 milliwatt per bit, comes in a 16-pin DIP, and is programed by applying 11 volts to the appropriate output pin and 25 volts to the appropriate chip-select input.

Another early competitor in the PROM market was Intersil Inc., Cupertino, Calif. which makes two bipolar PROMs, a 256-bit and 1,024-bit product. Coming in the second or third quarter is a 4,096-bit PROM. All of Intersil's PROM products have a unique programing feature: instead of having their output interconnections blown out to form zeros, the blank Intersil units are initially full of zeros, and are programed with ones by having the emitter-base junctions of their transistors blown. This is done simply by application of a voltage exceeding the junction breakdown level. The beauty of the method is its speed—it takes only milliseconds because, unlike the fusing of Nichrome links, it does not depend on heat.

Intel of Santa Clara, Calif., which until recently made only MOS PROMs, has entered the bipolar competition with a 1,024-bit device (256 words by 4 bits) that also uses a unique fusing process. This time the difference is in the link, which is manufactured from polycrystalline silicon with the same technique as the firm uses for its MOS PROM. The unit has a guaranteed access time of 70 ns (the 50 ns quoted by some other makers is not always over worst-case conditions). The memory cell is a combination of two Schottky diodes, a process that Intel has pioneered for all its bipolar memory devices.

Mike Markkula, U.S. North American marketing manager at Intel, says that "with the polysilicon fuse we have no problems of the link growing back together (as you do with Nichrome), and we have no problems of dissimilar materials at a junction—it's silicon on silicon, not Nichrome on silicon." The Intel Polyfuse, like Intersil's blown junction, is fast to program: the Intel 3601 can be programed in 1 second per 1,024 bits; the Nichrome parts take from 20 seconds to a full minute.

Performance is another front on which PROMs compete with ROMs. Signetics, for instance, while making a 1-kilobit bipolar PROM that comes with either tristate or open-collector output, is also working on a 256-bit Schottky PROM. According to Jerry Marcus, the company's marketing manager for bipolar memories, it will be one of the fastest read-only products yet: its target access time is 40 ns worst case.

What's next

Not content with increasing bit density and performance, makers are adding to the ways in which it is possible to program PROMs. For example, Motorola, long a major factor in the PROM business, will broaden the scope of the market with a factory-programable ROM. Intermediate between mask and field units, it will be programed at the wafer-probing stage. According to Jack Burns, memory product planner at Motorola, this device "eliminates the need for a lot of auxiliary circuitry, and has higher yields." The first such part, a 256-by-4-bit product that's pin-for-pin compatible with a 1-kilobit field-programable unit expected in March, will be about half the cost of the field unit. It will be available about two weeks after order, as against 4 to 6 weeks for a masked PROM. Significantly, it will be the first PROM built with MECL 10,000 technology—and it will be fast: its access time will be only 20 nanoseconds.

National is innovating with its very first PROM. Called a board-programable unit, the memory can be programed after it has already been connected in a system. Says Tom Thorkelson, digital bipolar marketing manager at National: "The outputs can be forced to all zeros (the normal state is all ones) by applying 9 volts on the most-significant-bit address line. Thus the user can test the memory before he programs it."

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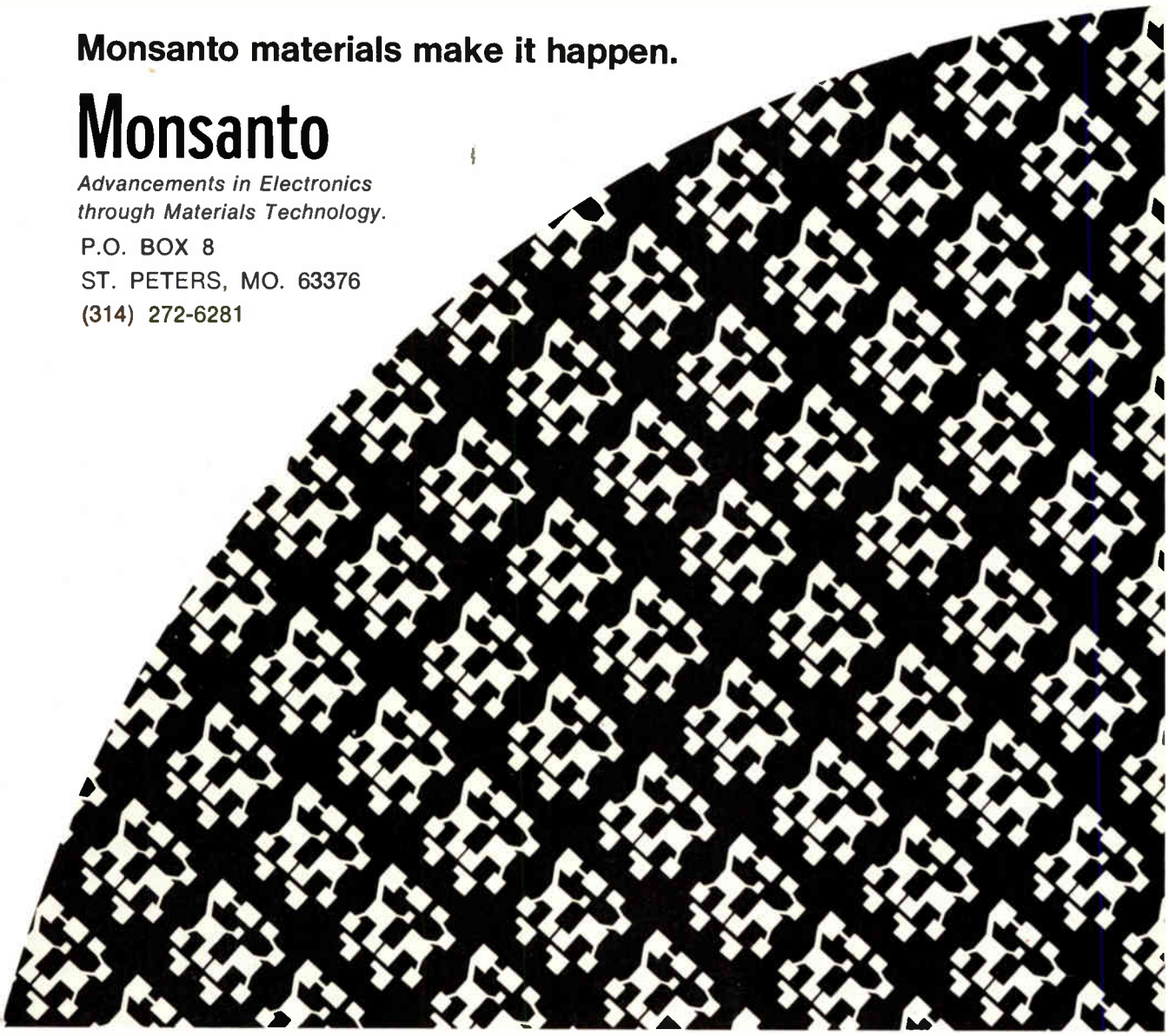

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The dc-coupled unit is expected to find applications where a log response to pulses is needed along with fast recovery. "Most log amps are ac-coupled, and have terrible problems with stretched tails," says Norman H. Vogel, general manager of American Astrionics.

The amplifier was developed originally as a custom device for a Hughes Aircraft Co. program and is now available in a series of models.

Priced from $500 to $1,000, the amplifiers have dynamic ranges up to 80 decibels, depending on the model. There are two types in the AL4005-DC series, one with inputs up to 2 volts (200 microvolts to 2.0 v, for example), and the other for lower inputs, down as low as 70 μv. The output range is 0–2 or 0–5 v, also depending on the model. All have a 0–90% rise time of 70 nanoseconds and recovery time of 1.5 microseconds.

As an option, the company offers special temperature compensation that provides error under 0.04 dB per degree centigrade for inputs over 200 μv. The amplifiers have an operating temperature range of 0° to 70°C.

The unipolar input signal can be either single-ended or differential, and standard input impedance is 50 ohms (higher impedances are available). The output impedance is 50 ohms minimum. Both types use OSM jacks, with other connectors optional.

Noise is 20 v rms referred to the input, and log linearity is ±0.5 dB, with closer linearity and matching to ±0.5 dB available. Power supply requirements are +12 v at 200 milliamperes and −12 v at 100 mA. Regulation should be ±0.1%. Size is 4⅜ by 8¾ by 1¾ inches. The company will also supply the units with matched front ends (diode detectors).

American Astrionics, Division of Technicolor Inc., 291 Kalmus Drive, Costa Mesa, Calif. 92626 [341]

Design permits automatic tooling, cuts relay price

Reduction in price in a series of reed relays results from a process whereby flanges are molded directly

onto the glass reed capsule, eliminating the coil bobbin and making possible automatic tooling. Price ranges from 80 cents each in 1,000-lots to 29 cents in quantities of a million. The relays offer 1-ampere or 20-watt switching to 250 volts, and coil voltages are available for 1, 3, 5, 6, 10, 12, 15, and 24 v. The units measure 0.275 inches in diameter by 0.950 in. long and can be mounted on pc boards with 1-inch centers and 0.100-in. or 0.150-in. spacing.

Electronic Applications Co., 2213 Edwards Ave., S. El Monte, Calif. [343]

Slide switch offers any length up to 100 positions

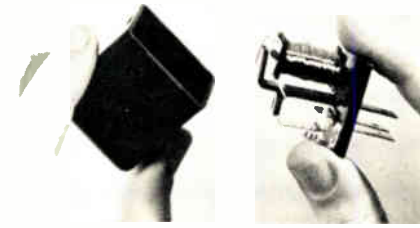
More than 100 positions can be incorporated into a single-slide or multiple-slide switch. Series SL can be positioned either vertically or horizontally. Applications include CATV channel-selection and high- and low-limit switching. The units are rated at 200 megohms minimum insulation, 1,000 volts minimum dielectric strength, 2 A at 115 vac current-carrying capability, and 125

mA at 115 vac current-breaking capability. Switch life is over 1 million detents.

Chicago Dynamic Industries Inc., Precision Products Div., 1725 Diversey Blvd., Chicago, Ill. 60614 [344]

Relay will switch up to 40 amperes dc

Measuring half the size of comparable units, an electrical relay is designed for circuits using 12 or 24 vdc in continuous operation and will switch up to 40 amperes dc. Dimensions are 0.9 by 1.3 by 1.4 inch. A low-profile version, for use on printed-circuit boards, measures 1.3



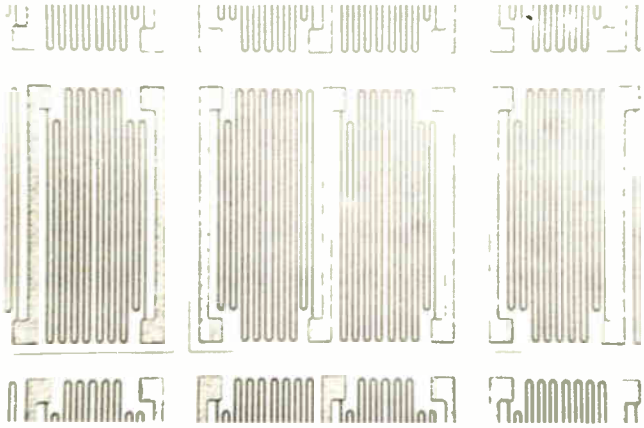
by 1.3 by 0.850 in. The unit is suitable for appliance, radio, and television applications. The relays have nylon snap-on cans, which provide insulation and are thus also suited to automotive applications.

United-Carr Canada, Stoney Creek, Ont. Canada [345]

Thin-film resistors are 100% probe-tested

The S series of glass-passivated thin-film resistors offers temperature coefficients of less than ±50

ppm/°C. The units, which are 100% probe-tested and visually inspected, provide resistance values from 10 ohms to 511 kilohms with 1% tolerance; from 10 ohms



to 510 kilohms with 5% tolerance; and from 10 ohms to 470 kilohms with 10% tolerance. All have a power dissipation rating of 250 mW. Price in quantities of 100 to 499 is 59 cents each for 10% units and 68 cents for 5% units.

Hybrex, a Division of Burr-Brown, International Airport Industrial Park, Tucson, Ariz. 85706 [346]

Solid tantalum capacitors are rated to 330 μF, 4 Vdc

Two cylindrical, dipped solid-electrolyte capacitors have been added to the Sprague type 196D solid-tantalum capacitor family. The units have a 0.350-inch diameter by 0.650-in. seated height, and 0.4-in. diame-

ter by 0.750-in. seated height. The smaller is rated at 220 microfarads at 4 Vdc or 15 μF at 50 Vdc, while the larger is rated at 330 μF at 4 Vdc or 250 μF at 50 Vdc.

Sprague Electric Co., 35 Marshall St. N. Adams, Mass. 01247 [348]

Variable resistors pack 3 watts in small package

The type R resistor line features a 3-W commercial rating in a 2-watt MIL-R-94B package. A perimeter-cooling method makes available three times the radiating

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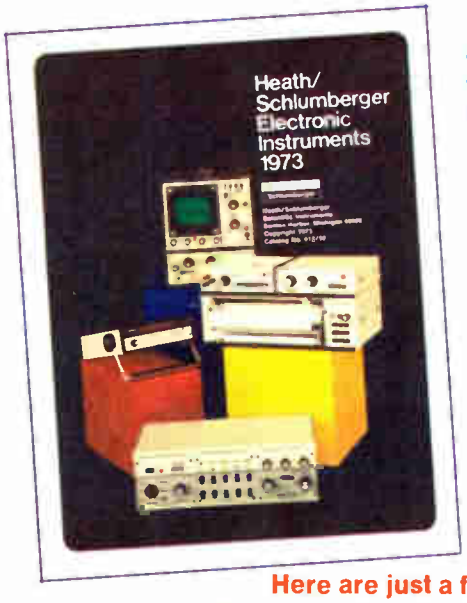

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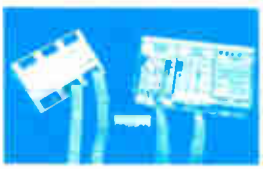

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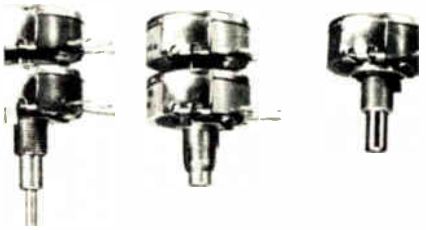
area found in other variable resistors. This permits good thermal efficiency; and in cases of short-time

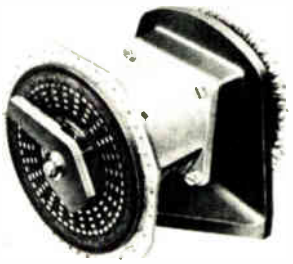


overload, excess heat is quickly drawn away, keeping localized hot spots at low thermal levels. The technique also helps keep resistance values stable.

Reon Resistor Corp., 420 Lincoln Highway, Frazer, Pa. 19355 [347]

Multiplex switch eliminates contact bounce

A rotary multiplex switch, designated type MS, uses high-precision slip-ring technology. Heavy gold contact segments are electro-deposited onto nylon material, and the two materials have almost the same characteristics with respect to wear rate and coefficient of thermal ex-



pansion. Brushing across this essentially flat surface are multiple-finger wiping contacts, which eliminate thermal emf. The design also assures break-before-make action without contact bounce. Price for a three-wire, 25-channel configuration is $1,068.

Zi-Tech Corp., 223 Forest Ave., Palo Alto, Calif. 94302 [349]

This problem should take you about 17 minutes to solve.

Four shapes make a perfect square.† So do five.
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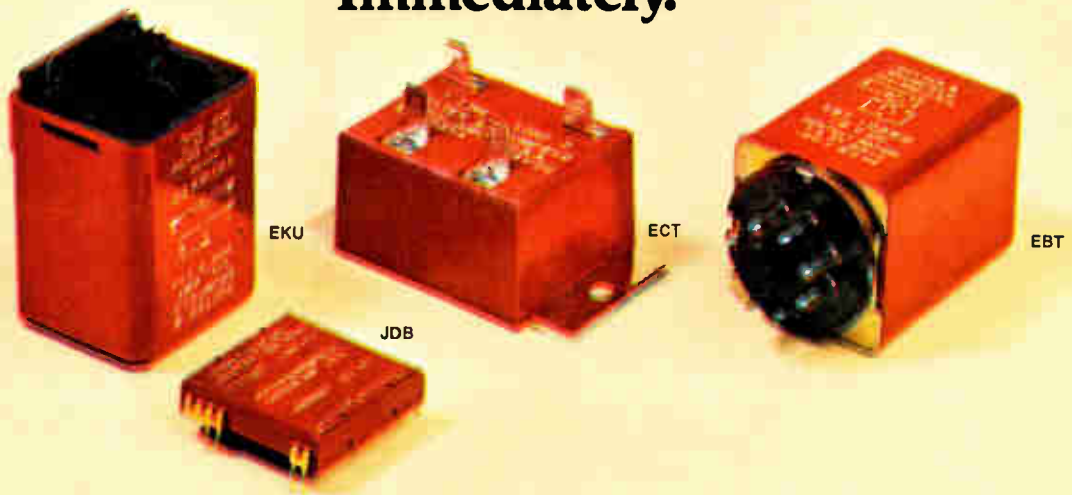
With P&B's Reed-Triggered Triacs you solve critical switching, longevity and mounting problems. Immediately.



Controlled and isolated by a reed relay, these solid state AC switches provide a modern means for interfacing DC logic signals and AC-powered loads such as motors, relays, solenoids and lamps. Expected life exceeds 1 million operations so they are especially suited to highly repetitive applications.

Switching capabilities range from 1.7 to 20 A rms, 60 Hz depending upon type of package and mounting method. All have a 1 Form A (SPST-NO) "contact" as well as an internal RC network that provides dv/dt suppression. All feature the inherent long life and the ability to switch high inrush loads that characterize thyristors.

ECT Series. Steady-state rms current ratings (at 25°C) range from 2 to 20 amperes depending upon the method of mounting. Coil voltages are from 5 to 48V DC. Power requirements are 290 mW for 120V, 60 Hz operation and 450 mW for 240V, 60 Hz. .250" quick-connect terminals are standard with .187" and .205" also available.

EBT Series. The solid-state "contact" is designed to carry a maximum load current of 7A rms, 60 Hz at 25°C ambient. This series provides the convenience of octal plug-in terminals and may be mounted in a socket having screw terminals.

JDB Series. This fully-encapsulated, low-profile (.350" height) hybrid will switch 1.7A AC loads. It is being used in modern machine tool controls, food packaging equipment and similar applications requiring DC input and AC out-put switching.

EKU Series. Rated at 7 amperes, 60 Hz at 25°C, the EKU is housed in the versatile KU-style case and has .187" quick-connect terminals. It may be mounted direct to a chassis or in a socket having screw, solder or printed-circuit terminals. A wide variety of P&B relays and solid state time delays are housed in this same case.

For complete information, call your local P&B representative or Potter & Brumfield Division AMF Incorporated, Princeton, Indiana 47670. 812 385 5251

**Like to try your hand at solving the puzzle shown above? Ask your P&B representative for one.*

Solving switching problems is what we're all about.

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†"Madagascar Madness". Copyright Behavioral Sciences, Inc.

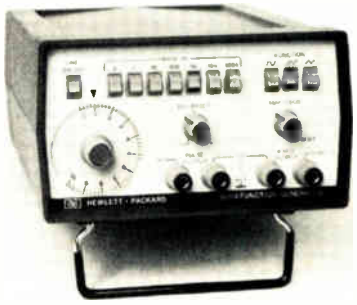
Circle 124 on reader service card

Instruments

Generator has $249 price tag

H-P's 0.1 Hz–1 MHz unit provides sine, triangle, or square-wave output

Computer-aided testing and innovations in the mechanical design are credited with major roles in development by Hewlett-Packard Co. of a $249 function generator. The instrument, called the model 3311A,



covers the range from 0.1 hertz to 1.0 megahertz in seven decade ranges. It offers sine, triangle, or square-wave output, plus a separate pulse output suitable for synchronization or clocking TTL circuits.

Other features of the 3311A include an external VCO input for phase-locked-loop and swept-frequency applications; a continuously variable 30-decibel attenuator on the main output; and an internal dc offset capability of ±10 volts open circuit, or ±5 V into 600 ohms. Another feature is the complete electrical isolation of the instrument from the chassis, which insures floatability to ±500 Vdc.

Printed-circuit boards for the 3311A are computer-tested after wave soldering to locate solder splashes, opens, out-of-tolerance components, defective components and reversed diodes. In addition, the complete instrument—pc board with front and rear panels attached—is computer-tested, so that the test technician responsible for turn-on and calibration receives an instrument virtually free of these common defects. Test, troubleshoot, and calibration time averages about 30% to 50% less than without computer-aided testing.

The instrument is constructed on one double-sided printed-circuit board, to avoid the higher cost and lower reliability of multilayer boards. The board is designed for automatic insertion of components, and front and rear panels are attached directly to the board.

Another economy is in the case, which is designed for fast assembly and disassembly. It takes only 5 seconds to remove one half of the aluminum case and expose all calibration and test points. For servicing, another 5 seconds is required to completely release the instrument from the rest of the case. The use of a pc-mounted function and range switch reduces wiring costs, and also eliminates lead dressing as a variable from instrument to instrument.

Price of the model 3311A is $249, and delivery time is 60 days.

Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [351]

Specifications

Output: 10 volts pk-pk into 600 ohms or 20 V pk-pk open circuit.
VCO: dc control of a 10:1 frequency range or ac voltage control to fm the function generator.
Pulse output: TTL-compatible, can sink 20 TTL loads; the pulse has a 15/85 aspect ratio with a 25-ns rise time.
Dial accuracy: ±5% of full scale.
Output impedance: 600 ohms, ±10%.
Sine wave amplitude flatness: ±3% of 10 kHz reference (maximum-output amplitude) up to 100 kHz; ±6% to 1 MHz.
Sine wave total harmonic distortion: 3% (at max output amplitude).
Triangle linearity: deviation less than 1% from best straight line at 100 Hz.
Square-wave time axis symmetry: ±2% max to 100 kHz.

Spectrum analyzer display provides variable persistence

Designed to be particularly useful in audio and baseband spectrum analysis where high resolution requires a slow scan rate, a spectrum analyzer variable-persistence display unit marketed by Systron Donner offers a persistence range of 300 milliseconds to 100 seconds. In addition, the model 711 can store an image for up to six hours or it can be used in a conventional, non-storage mode.

The display unit gives the user an opportunity to study intermittent or varying signals, as well as to monitor circuit performance as conditions change. All scans can be retained on screen and subsequently reviewed, analyzed, compared, or they can be recorded photographically.

The model 711 uses plug-in tuning modules covering the audio, video and baseband frequency ranges. Operation in the communications and single-sideband regions of the spectrum is possible with the use of an external frequency converter. External X-Y inputs permit use of the display with any of the Systron Donner spectrum analyzers that cover the range from 10 Hz to 40 GHz. Price of the model 711 is $2,600.

Systron Donner Microwave Division, 14844 Oxnard St., Van Nuys, Calif. 9409 [352]

Panel meter does not need a regulated supply

A digital panel meter that runs off a 5-volt unregulated supply offers a full-scale range of 0 to ±1.9999 v.

The 4½-digit instrument offers a floating, optically isolated analog section that accepts differential inputs and generates outputs to a data processing system, eliminating ground loops. The unit, designated the AD2004, is priced at $269 for one to nine units and $189 in 100-lots. It is the fourth in a new line of small 5-volt-powered DPMs, and the

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The C-21 is designed for airborne, deep space, shipboard, and undersea applications in a wide range of sizes.

No other connectors with crimp-removable size 16 contacts approach the C-21 in sealing capabilities, versatility, or long life. Yet prices are competitive.

More information? Write: Hughes Connecting Devices, 500 Superior Ave., Newport Beach, CA 92663. Or call (714) 548-0671.

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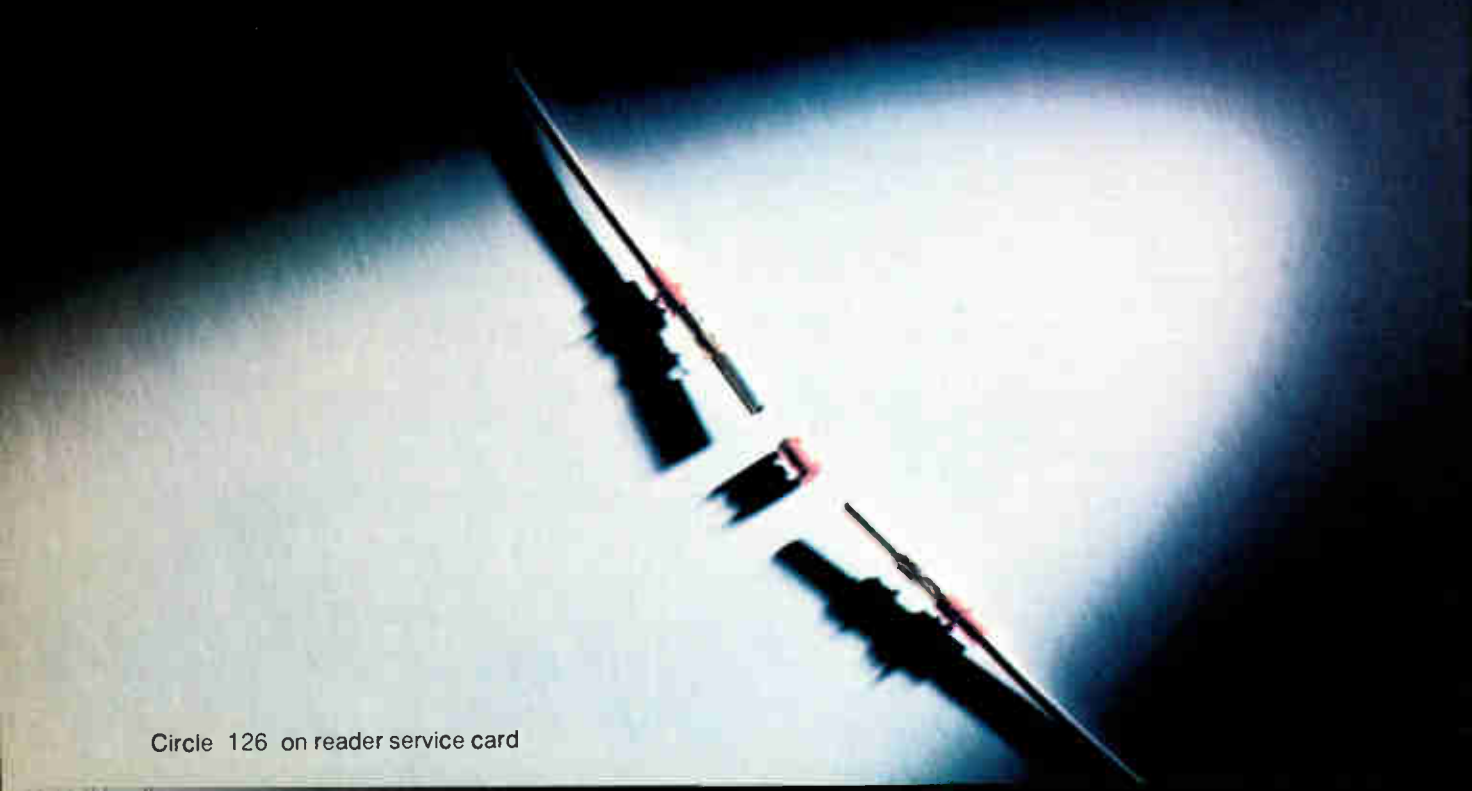
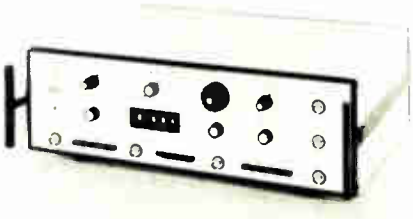


Circle 126 on reader service card

first in the series to use a light-emitting-diode display.
Analog Devices, Route 1, Industrial Park, P.O. Box 280, Norwood, Mass. 02062 [353]

Phase generator has resolution of 0.2°

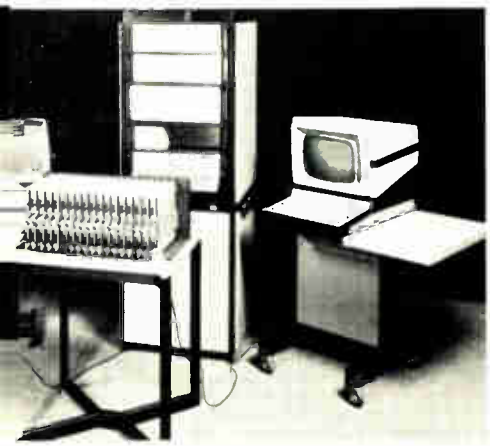
The model 337 digital phase generator consists of two function generators with separate outputs: a reference output, and a variable-phase output. The phase lead of the variable output with respect to the reference output may be set from 0° to 360° in increments of 0.2°. Each generator has sinusoidal, square, and triangle outputs in addition to a sync output. Pulses and ramps can also be generated. Price is $2,495.



Exact Electronics Inc., 455 S.E. 2nd Ave., Hillsboro, Ore. [354]

Backplane test system is self-programing

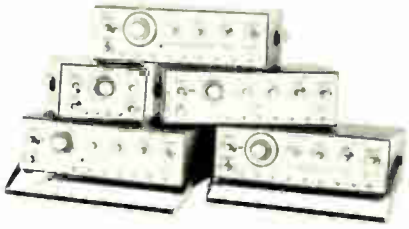
Requiring only a two-cable interconnection to the backplane under test, the model N151 backplane test system is a computer-operated unit that is self-programing. The instrument will record all shorts and opens, in the user's nomenclature, on either a CRT display or a printer. Operation of the system includes the use of five keyboard commands to analyze, test, print out a master connection list, store programs in memory, and edit. A prototype or backplane known to be good is first connected to the system, which automatically "learns" the network. A "run list" can then be printed for comparison against engineering drawings. Price is $35,000 plus $5 per point for fixture cards. A version with teletypewriter instead of CRT costs $25,000.



Teradyne Inc., 183 Essex St., Boston, Mass. 02111 [355]

Line of function generators covers 0.001 Hz to 11 MHz

A line of function generators called the series 50 A offers a frequency range extending from 0.001 Hz to 11 MHz, with usable frequencies down to 0.00001 Hz. The units produce 30 volts peak-to-peak output with voltage-controlled frequency range of 1,000:1. Features on selected models include phase-lock, multiple sweep with shift and burst cycles, and gate controls. The units produce sine, square, and triangle waveforms, ramps, fixed-duty-cycle pulses, and variable-width pulses adjustable down to 75 ns. Price ranges from $595 to $1,195.



Interstate Electronics Corp., 707 E. Vermont Ave., Anaheim, Calif. 92803 [356]

Sweep generator covers 100 kHz–100 MHz range

A new model in the 1200 series of sweep generators is designated type 1202 and covers the range from 100

New products

kHz to 100 MHz. The unit provides full-range sweep with a flatness of ±0.25 dB, linearity to within 2%, and

1-volt output. Up to seven plug-in markers are available and the unit has a built-in 102-dB attenuator. Price is $895.

Telonic Industries Inc., 21282 Laguna Canyon Rd., Laguna Beach, Calif. 92652 [358]

4½-digit multimeter offers 10-microvolt resolution

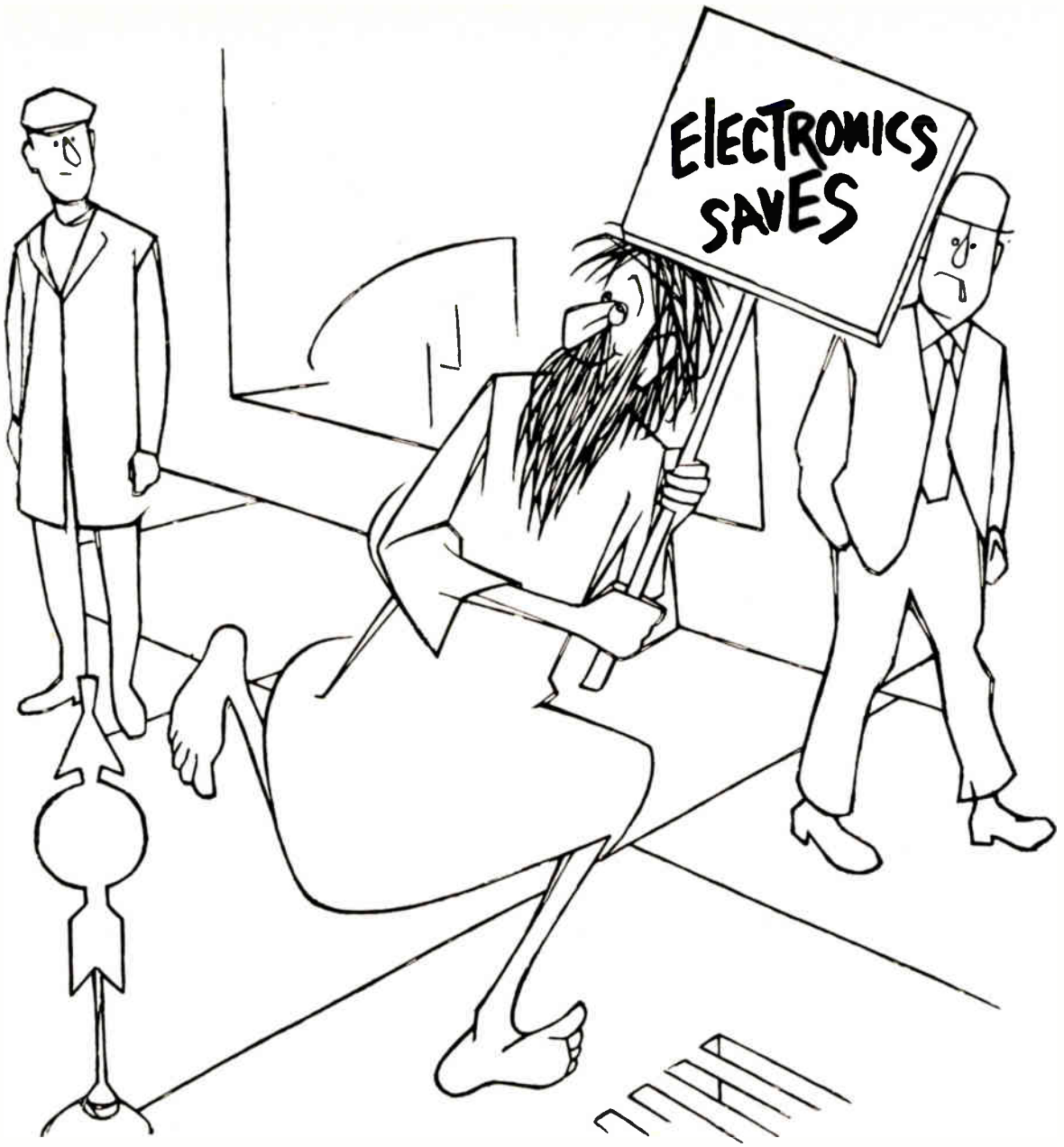
Fourteen ac, dc and ohms ranges with 0.02% and 0.03% maximum error are provided in a 4½-digit mul-

timeter, the model 40. Resolution is 10 microvolts, and dc measuring speed is 0.2 second. Ac speed and ohm speed are 2 s and 500 ms respectively. A 200-v overload, ac or dc, on any range prevents damage under all but the most severe conditions. Price is $495.

Data Technology Corp., 2700 S. Fairview St., Santa Ana, Calif. 92704 [359]

Storage oscilloscope is priced at $1,095

A new addition to the Telequipment line, the model DM64, a 10-MHz bistable storage oscilloscope, is a



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New products

dual-trace unit. Priced at $1,095, the instrument offers the advantages of a conventional oscilloscope plus

those of a bistable storage CRT with a maximum writing rate of 250 centimeters per millisecond, variable from 25 cm/ms. The instrument is converted to a standard-display scope by a single control.

Tektronix Inc., P.O. Box 500, Beaverton, Ore. 97005 [357]

K-band signal generators provide 1 mW up to 21 GHz

A series of calibrated microwave signal generators provides 1 mW from 10.0 to 15.5 GHz. The models 1709A, 1710A, 1809A, and 1810A each provide extended-range fm,

pulse and square-wave modulation from 10 Hz to 10 kHz, and ±0.5 digital frequency readout. Each unit includes a C- or X-band signal source that provides at least 25 mW output. A modulator and a frequency-doubler module are also included. Price ranges from $3,760 to $4,000. Delivery time is stock to 30 days.

Polarad Electronic Instruments, 5 Delaware Dr., Lake Success, N.Y. 11040 [360]

ac, dc, volts, amps, ohms

25 ranges

0.01% dc accuracy

$650 complete

Systron-Donner's new all-function 7004 Digital Multimeter. Measures **everything**—dc and ac voltage, dc and ac current, and resistance. Built-in shunts for current measurements. Fully guarded input for highest common mode isolation. Dual-slope integration design. 1,000 megohm input impedance on three lowest ranges. Optional battery pack with recharger ($95) **mounts internally.** For lab, field or systems use (with DTL/TTL compatible BCD outputs $45). Ask your local Scientific Devices offices for technical data or contact: Concord Instruments Division, 888 Galindo St., Concord, CA 94520. Phone (415) 682-6161.

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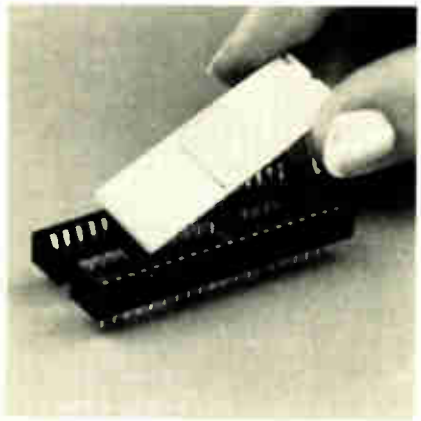
Another S-D instrument first! Electronic counters / Digital voltmeters / Pulse generators / Data generators / Time code generators / Sweep generators / Spectrum analyzers / Digital panel meters / Digital clocks / Signal generators Oscillators / Laboratory magnets / Precision power supplies / Analog & analog-hybrid computers / Data acquisition systems.

Packaging & production

LSI receptacle has low profile

Connector for side-metalized leadless package is 0.225 in. above board, requires no lid

When AMP Inc. introduced its zero-insertion-force receptacle for leadless side-metalized LSI packages last year [*Electronics*, March 27, 1972, p. 119], the receptacle included a lid which, when it is swung into place,



seats the receptacle contacts against the package contacts. Now, AMP has taken the lid off. The new version extends only 0.225 inch above the printed-circuit board. The lidless unit permits end-to-end and side-by-side stacking on a board.

The receptacle for 40-contact dual in-line packages "will accommodate all leadless side-metalized ceramic packages that are now available or have been proposed," says William Pauza, manager of microelectronics engineering at AMP.

The package is pressed into the receptacle until it clicks into place. Insertion force is approximately 6 pounds. Apertures at the ends of the socket enable the customer to extract the package, using a dislodgement force of approximately 2 pounds. An optional hold-down strap can be provided for cases of severe vibration. Such a strap, molded from a material like polypropylene, also would secure the package in place in applications where the receptacle would encounter vertical or inverted attitudes.

The size of the receptacle, 2.115 by 0.830 inches, is only slightly larger than a typical 0.080-in.-thick ceramic package, which measures 2.02 by 0.578 in. The receptacle is molded in thermoplastic polyester or in glass-filled nylon, but for applications where operating temperatures exceed approximately 150°F, the customer may opt for phenolic.

On production units, the contact surfaces will be selectively gold-plated. The pins are the standard dual in-line configuration: 100-mil centers with 600-mil spacing. When the package is in place, the exposed contacts serve as test points. Companion ceramic packages designed by Kyoto, Plessey-Frenchtown, Metceram, and American Lava have chip cavities ranging from 250 to 350 mils square.

Price is 40 to 60 cents for the thermoplastic polyester and glass-filled nylon versions, slightly higher for the phenolic version.

AMP Inc., Harrisburg, Pa. 17105 [391]

Header board assembly helps load discrete components

A header board assembly facilitates loading discrete components in a packaging system designed primarily for mating with dual in-line sockets. Discrete components are assembled on the headers of the 6100 series component mounting boards, and their leads are connected by solder cups or posts, and then inserted directly on the circuit-board pads. Quantity price for 14-pin models is $1; 16-pin, $1.10.

Stanford Applied Engineering Inc., Advanced Packaging, 2165 S. Grand Ave., Santa Ana, Calif. 92705 [393]

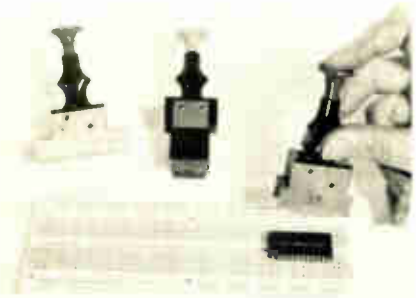
Photomask camera provides six reduction ratios

A fixed-reduction microphotography camera system provides the capability for producing both large printed-circuit photomasks and high-resolution, microminiature IC and LSI master reticles. Called the Microkon Mu, the system offers reductions in up to six standard ratios through the use of interchangeable lenses, and accommodates either cut film or plates up to 24 by 24 inches.

HLC Manufacturing Co. Inc., 700 Davisville Rd., Willow Grove, Pa. 19090 [395]

Insertion, extraction tools are designed for DIPs

Two tools, an insertion unit called Dip-a-Dip and an extraction tool called Pul-a-Dip, are designed for dual in-line packages on 0.600-inch centers. The insertion tool comes in a 24/28 pin and 36/40 pin configu-

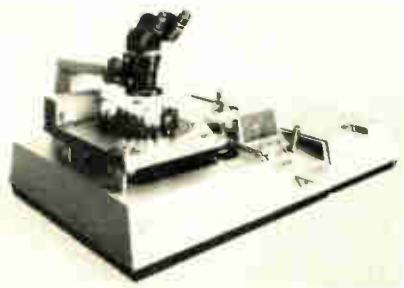


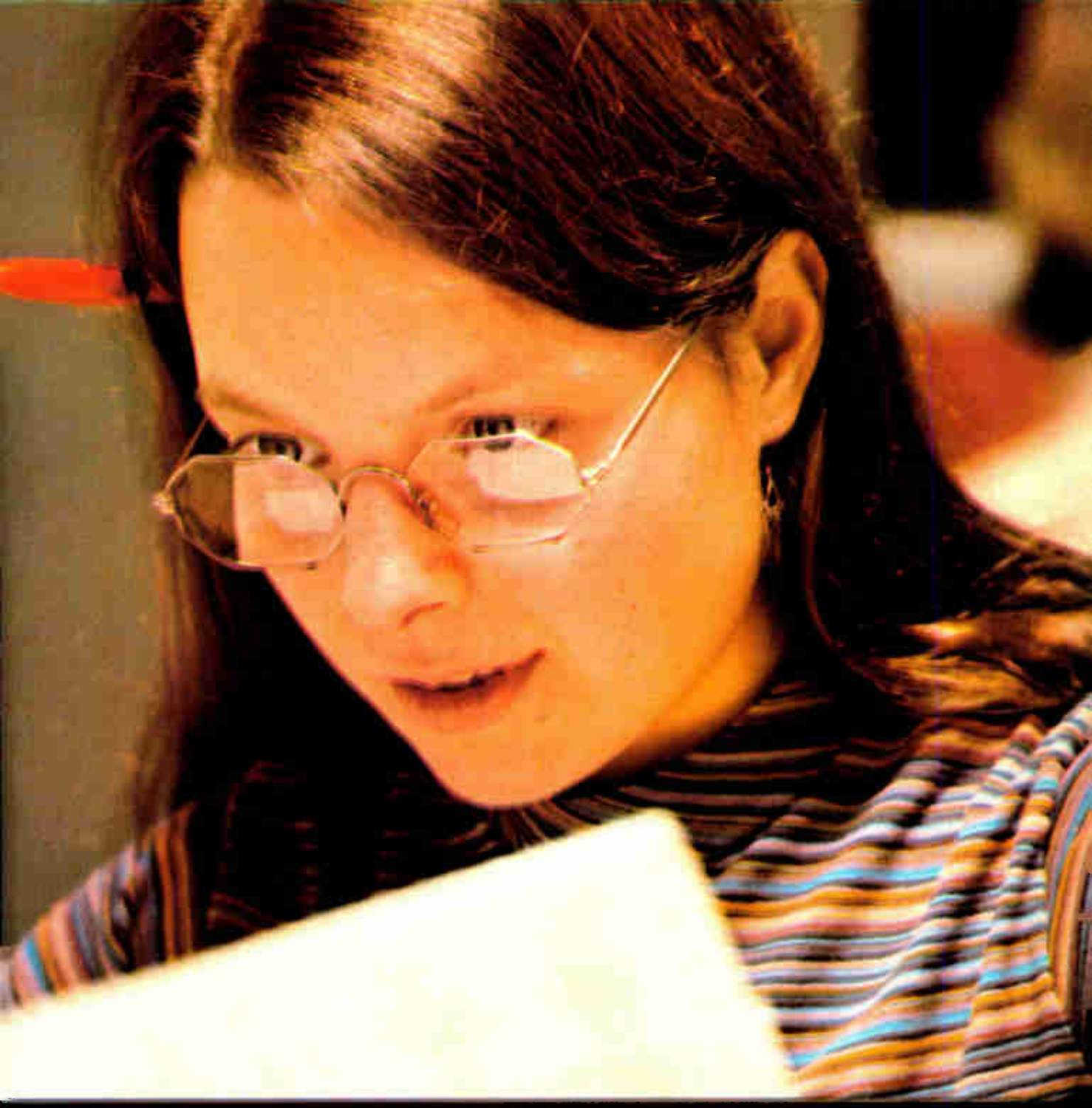
ration (larger on special order), and the extraction device comes in a single 24/40 pin size. Price is $12.75 in small quantities.

Micro Electronic Systems Inc., 30 Lawson Lane, Ridgefield, Conn. 06877 [397]

Wafer prober loads, unloads outside the probe area

An automatic wafer prober for integrated circuits and semiconductor devices is designated the model





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you can work on new applications without interrupting on-going jobs.

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If you don't need RDOS now, we have compatible Operating Systems for smaller configurations.

The one that runs in your Nova computer is available for that system. Free.

For more information on the Operating Systems, contact Data General, Southboro, Mass. 01772, (617) 485-9100.

DATA GENERAL

Southboro, Massachusetts 01772

New products

1034. Wafers are loaded and unloaded outside the probe area without disturbing the probe ring or optics. The unit returns to the load/unload position at the end of each cycle. Once wafers are loaded, they are aligned on any device in the matrix by an automatic-scan theta alignment and a multifunction joystick.
Electroglas Inc., 150 Constitution Dr., Menlo Park, Calif. 94025 [396]

Insertion machine permits use of bulk-packaged pins

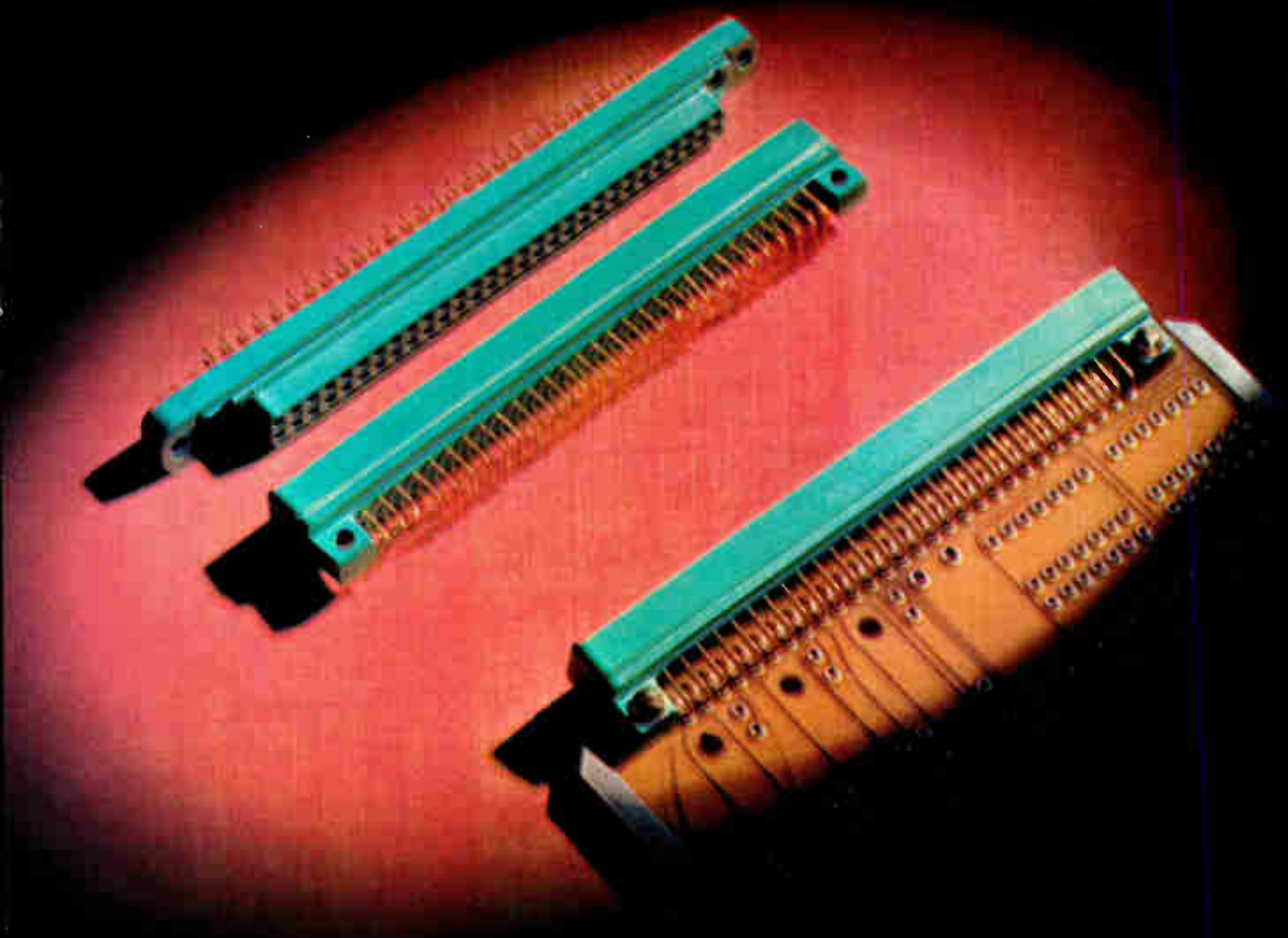
A line of insertion machines that puts wire-wrap-type terminal pins into circuit boards allows the use of bulk-packaged pins rather than reel-fed pins, thus reducing the cost of producing circuit boards. The unit is

available in a pin-at-a-time version or in multiple- or cluster-pin configurations capable of inserting one to eight pins at a time.
Synergistic Products Inc., 1902 McGaw Ave., Irvine, Calif. 92705 [399]

Mounting machine handles 400 to 500 chips per hour

Developed especially for use with chip capacitors and chip resistors, an epoxy die-mounting machine called the model CM-630 handles typically from 400 to 500 units per hour. It automatically dispenses dots of epoxy at two points on a substrate, in addition to providing mechanization of die pickup, location and placement. The machine

Bendix printed circuit board connectors put an end to close order drilling.



You know close order drilling. It's what's called for to produce ultraprecise hole locations in printed circuit boards. Eliminate this need and you'll cut costs for sure. Bendix P.C.B. connectors help you do precisely that. Their optional floating pin terminations "give" enough to make it easier to align pins with the printed circuit board holes.

Bendix boasts other features, too. Options like solderless wrap or solder terminations. Straight or right angle. Insertable crimp contacts.

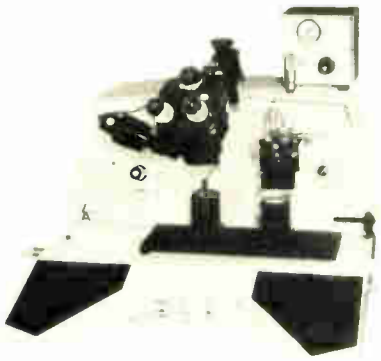
Applications? Wherever printed circuit boards are used, such as switching circuits, computers, business machines, process controls, etc.

Chances are, Bendix Printed Circuit Board connectors can help you. Why not find out. The Bendix Corporation, Electrical Components Division, Sidney, New York 13838.

Bendix

New products

can be used with one- or two-component epoxies, solder, and bronze compositions. Micrometer adjustments are provided between points

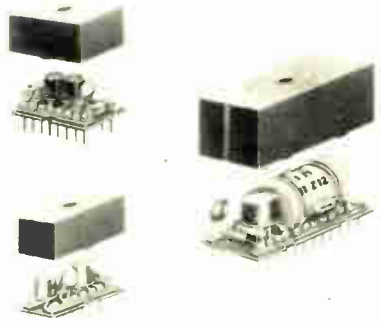


on the substrate and on the height axis. Chips from less than 0.050 inch to 0.50 inch can be handled. Price less optics is $2,950. An adapter for the company's older machines is priced at $400.

Laurier Associates, 2 Vose Rd., Westford, Mass. 01886 [398]

Tall-cover pin headers accommodate large ICs

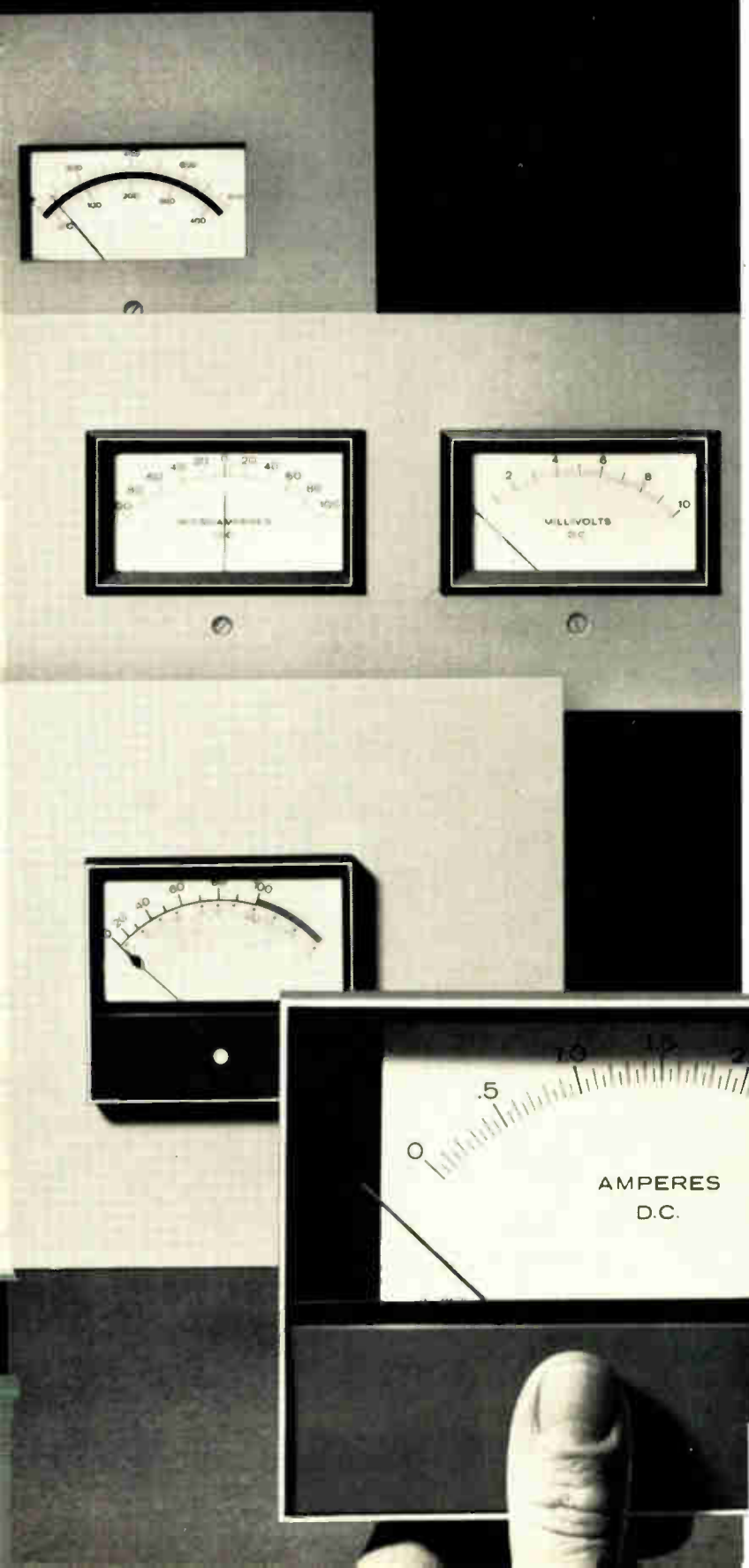
A range of pin headers provides tall covers that enable larger ICs and discrete components to be soldered between the contact extensions and so form a plug-in package. The snap-on covers enclose the circuitry, except for a small hole through



which the potting compound can be ejected. Fourteen- and 16-pin versions house components up to 0.3 inch high, and the 24-pin type accommodates components up to 0.5 inch high. Price of the 14-pin unit ranges from 81 cents in small quantities to 55 cents for 250 pieces.

Jermyn, 712 Montgomery St., San Francisco, Calif. 94111 [400]

api PANEL METERS



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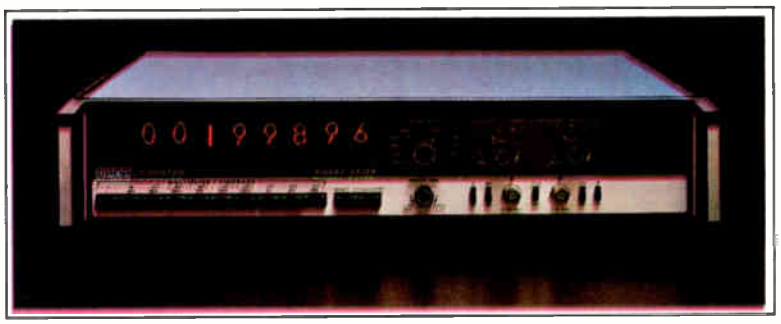
A counter offer from Dana.

Compare H-P's 5326A to our 8010B. If you don't buy ours, we'll help you buy theirs.



Comparing the two won't take you very long. Dana's frequency is three times better. 150 MHz vs. 50 MHz.

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Dana gives you 8 digits. H-P gives you 7. Their eighth costs another $75.

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Semiconductors

4 comparators put on a chip

Quad device for industrial, logic interface applications operates off single supply

In the world of linear integrated circuits, the multidevice chip is gaining increased attention. First there was the quad op amp, introduced last spring by both Motorola and National Semiconductor [*Electronics*, May 22, 1972, p.132]. Now National is marketing a quad comparator.

Called the LM339, the comparator offers to linear designers the cost and convenience benefits that have been available for some time to designers of digital equipment. Besides putting four functions into one package, the quad design makes "extra" devices available for later circuit changes.

The LM339 contains four independent voltage comparators, which operate from a single power supply over a wide range of voltages. Split power-supply operation is also possible. Each of the four comparators is similar in function to the LM311, but there are significant differences. Probably most significant, the LM339 can compare voltages at, or even below, ground potential. The LM339 also operates over a wider power supply range—from 2 to 36 volts—and it is somewhat slower—800 nanoseconds, one-fourth the speed of the 311.

Both the single-supply and low-voltage operation "are very important in industrial applications where you normally don't have more than one supply voltage available," says Joe Byerly, a marketing manager at National. Other applications include the interface market, where the LM339 can interface transducers with logic and interface one logic level with another. In logic-level translation, the LM339 is versatile, since the output saturation point is 0.3 v, sinking about 5 milliamperes. And the device can swing from 0.3 to 36 v and sink a maximum of 20 mA. The output is taken from an open-collector transistor so that it can be tied via a pull-up resistor to a higher voltage than the input for such applications as a TTL-to-MOS converter.

The LM339 drains very little power. The total current requirement for all four devices is only 8 A; thus at 5 v, each comparator requires only 1 mW. Other specs include an input-bias current of 35 nA, input offset current of 3 nA, and a 3-mV input offset voltage.

The LM339, rated 0°C to +70°C in a plastic (epoxy-B) 14-pin DIP, sells for $3.80 each in 100-lots.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. [411]

IC chip fits snugly between sensor and SCR

With a sharp eye on the industrial-control market, RCA's Solid State division has developed a monolithic integrated-circuit amplifier with an output large enough to gate silicon controlled rectifiers and Triacs directly, and its input amplifier is sensitive to even the low-level signals supplied by thermocouples. In addition, a bias current applied to an input pin programs the device to act as either a power amplifier or switch.

Bob Rauth, assistant marketing administrator for the Linear Integrated Circuit group, says that the CA-3094 power amplifier/switch is the only monolithic device on the market that can act as a single circuit element between a low-level sensor and a high-level SCR or Triac. The monolithic bipolar chip incorporates an operational transconductance input amplifier, similar to RCA's CA-30800T unit, with a Darlington power-output stage. The gain of the differential-input stage is proportional to the amplifier bias current, which permits a programmable variation of the sensitivity with either digital or analog programing signals.

Take a bias current of 100 microamperes as an example. At that level, a 1-millivolt change in the input-voltage level will cause the output of the CA-3094 to vary over the range of 0 to 100 milliamperes.

Average output of the CA-3094 is 100 milliamperes, with a peak of 300 mA. It operates from single supplies of 24, 36, and 44 volts dc, or from dual supplies. The device is supplied in TO-5 packages with either straight leads or with leads shaped in a dual in-line configuration.

In quantities of 100 to 999, price ranges from 75 cents to $1.67, depending on the supply voltage.

RCA Solid State Division, Somerville, N.J. 08876 [412]

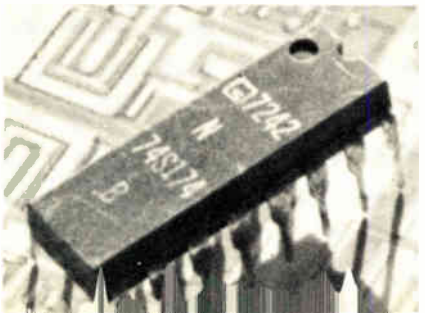
2,048-bit erasable PROM programs in two minutes

A 2,048 bit static MOS PROM can be programed in two minutes using the Intel model 7600C tape-actuated programer. The program of the 1702A PROM can be erased by shining an ultraviolet light through a transparent quartz cap on the package. The PROM may be erased and reprogramed as often as necessary without impairing performance. Maximum access time of the 1702A is 1 microsecond. Price is $45 each in 100-piece quantities.

Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 950551 [413]

Flip-flops use Schottky TTL to implement D-type logic

Available for use in high-performance buffer and storage registers, counters, and pattern generators, the S54S174, N74S174 hex flip-flops and the S54S175, N74S175 monolithic quad flip-flops respond to positive-edge triggering. The units



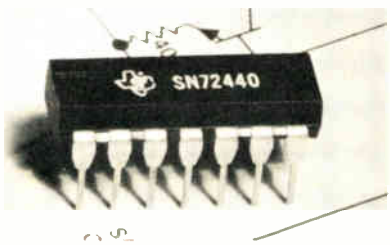
New products

use Schottky TTL technology to implement D-type logic. All have direct "clear" inputs, and the S54S175 and N74S175 units feature complementary outputs from each flip-flop. The units are identical to the series 54/74 counterparts and can be used to upgrade existing system performance with improvements in speed. They are fully compatible with other TTL circuits. Price is slightly more than $5 each in lots of 100.

Signetics, 811 E. Arques Ave., Sunnyvale, Calif. 94086 [415]

Zero-voltage switch IC is for ac power circuits

A combined threshold-detector and zero-crossing-trigger integrated circuit is designed for ac power-control circuits. The IC allows a Triac or SCR to be fired when the ac input signal crosses through zero volts, thereby minimizing electromagnetic interference. In this manner, the



load uses full cycles of line voltage, as opposed to partial cycles typical of SCR phase-control power circuits. Price in 100-lots is $2.24 each for a plastic version or $2.44 for a ceramic DIP version.

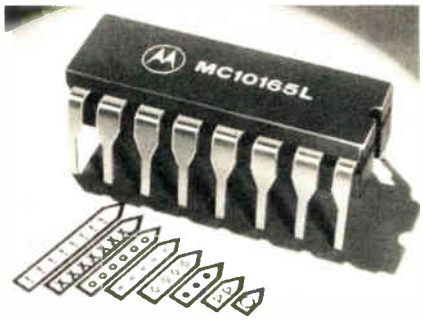
Texas Instruments Incorporated, P.O. Box 5012, M/S 308, Dallas, Texas 75222 [416]

Eight-input priority encoder has delay of 7 ns

A medium-scale-integration logic circuit for the MECL-10,000 logic family, called the MC10165, is an eight-input priority encoder. Typical propagation delay from data input to coded output is 7 nanoseconds. Priorities are assigned to each of the eight inputs by the logic circuit. In operation, an output code is pro-

New products

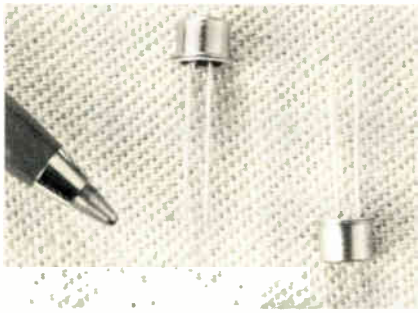
duced, corresponding to the highest-priority input which is at a logic high state. Simultaneous inputs of lower priority are ignored. Price



ranges from $9.20 to $11.50 depending on quantity.
Motorola Inc., Semiconductor Products Division, Box 20924, Phoenix, Ariz. [417]

Thermal switch offers cutoff protection at 185°F

A high-temperature thermal switch offers overheating cutoff protection at 185°F, making it suitable for SCR and Triac protection. Small size of the unit, which has no moving contacts, also makes it suitable for such



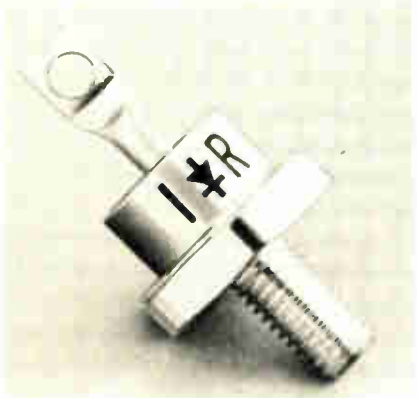
electronic circuits as those used in walkie-talkie transmitters and mobile power-output stages. Price is $1 or less, depending on quantity.
Multi-State Devices Ltd., 1330 Trans-Canada Highway, Dorval 740, Quebec, Canada [419]

Schottky barrier diode has low forward-voltage drop

A 50-ampere, 15-volt hot-carrier Schottky barrier diode provides a low forward-voltage drop of 0.87 v

New products

at 157 A and 25°C. This makes it possible to design higher-efficiency rectifiers, which result in savings in power costs, heat sinking, package size, and cooling-system requirements. The type 50HQ015 has a low



reverse-recovery loss, making it suitable for high-frequency (over 20 kHz) rectifier circuits. Price in 100–999 quantities is $9 each.

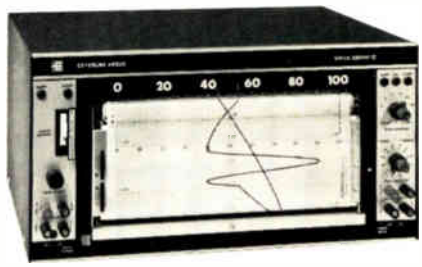
International Rectifier Corp., Semiconductor Division, 233 Kansas St., El Segundo, Calif. 90245 [418]

Driver lets coaxial switch be driven from TTL gate

A miniaturized switch driver, packaged in a TO-5 transistor can, permits any coaxial or waveguide electromechanical switch to be driven from TTL gates. The relay driver, model SD-1601, drives switches by either providing a low-or high-impedance path to ground for the switch solenoid. Because of the small size of the SD-1601, it is possible to incorporate the driver directly into the solenoid housing. Price is $22 each for one to nine units.

LRC Inc., 11 Hazelwood Rd., Hudson, N.H. [420]

NEW
inkless recording



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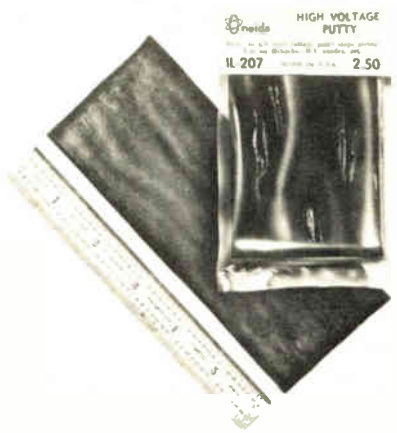

A high-voltage putty that molds around uneven objects eliminates arcs in high-voltage television transformers, anodes, tube sockets, filament wire, and any application to 40 kv where arcing is a problem. The putty is packaged in six-inch lengths.

Oneida Electronic Manufacturing Inc., Meadville, Pa. 16335 [476]

Power-to-size ratio of wirewound and film resistors can be improved and resistance shift reduced by using Berlox beryllia resistor cores in place of alumina or steatite. The thermal conductivity factor of the material is said to be eight to 10 times that of alumina and almost 60 times that of steatite.

National Beryllia Corp., Greenwood Ave., Haskell, N.J. 07420 [477]

A copper laminate with a factory-applied positive photoresist allows the use of positive master-circuit artwork, thereby eliminating negatives and processing steps. The R series uses flame-retardant copper-clad phenolic and epoxy glass material that is supplied either plain or drilled for DIPs. Delivery is from stock.

Vector Electronic Co. Inc., 12460 Gladstone Ave., Sylmar, Calif. 913042 [478]

A polishing compound improves epitaxial deposition on gallium-arsenide wafers. The material gives the polished wafer surface greater stability and produces a mirror finish that is more conducive to deposition. The material is available in one- and five-gallon containers.

Strate Physics Inc., 975 Comstock Ave. Santa Clara, Calif. 95050 [479]

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New literature

Microwave circuits. A technical information folder from Sperry Rand, Electron Tube Division, Dept. 9002, Waldo Rd., Gainsville, Fla., profiles five microwave integrated circuits, providing block diagrams, parameters, and photographs. Circle 421 on reader service card.

Telephone relay. Magnecraft Electric Co., 55575 N. Lynch Ave., Chicago, Ill. 60630. A guide to the application and selection of telephone-type relays includes information on accessories, enclosures, specifications, and dimensional drawings. [422]

C-MOS gates. A technical bulletin outlining the functions and circuitry of C-MOS expandable gates has been released by Solid State Scientific Inc., Montgomeryville, Pa. [423]

Motors. Specialty Motors Inc., 12863 Foothill Blvd., San Fernando, Calif. 91342. A capabilities brochure describes universal, shunt, and permanent-magnet-type fractional-hp motors and gear motors for use with such devices as SCRs. [424]

Power supplies. Power supplies for integrated-circuit logic and operational amplifiers are described in a four-page brochure from Acopian Corp., Easton, Pa. 18042. [425]

Transformers. A set of five technical bulletins from Anzac Electronics, 39 Green St., Waltham, Mass., provides information on the models TP-101 through TP-105 flatpack rf/pulse transformers that cover the range from 500 kHz to 1.5 GHz. [426]

Logic family. Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, Ariz., is offering for $2 a 466-page book on the MECL logic families. The fact book and design guide also provides software-support information.

Connectors. U.S. Components Inc., 1320 Zerega Ave., Bronx, N.Y. 10462. A series of comprehensive connector catalogs feature specifications, basic configurations, mate-

New literature

rials, finishes and auxiliary information covering rack-and-panel and screwlock connectors. [427]

Digital panel meters. An eight-page catalog available from Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021, contains electrical and mechanical information, plus applications data on a line of differential, isolated, and buffered digital panel meters. [428]

Inverter. A 710-ampere plastic inverter SCR, featuring a 10-microsecond turnoff time, is described in a brochure from the Semiconductor Division, International Rectifier Corp., 233 Kansas St., El Segundo, Calif. The brochure includes ratings, graphs, and a dimensioned outline drawing. [429]

Card connector blocks. Berg Electronics Inc., New Cumberland, Pa. 17010. Right-angle card connectors molded to mate with 0.100- or 0.150-inch grids of 0.025-inch-square wire-wrapping pins are described in a bulletin designated number 112. [430]

Laser trimming. Teradyne Inc., 183 Essex St., Boston, Mass. 02111, has published a 20-page brochure describing the W311 laser adjustment system for trimming thick- and thin-film circuits. [431]

Cermet trimmers. Nine industrial 360-series single-turn cermet trimmers are detailed in a four-page catalog put out by CTS Corp., 625 N. Michigan Ave., Chicago, Ill. 60611. [432]

Transducers. A technical bulletin providing information on accurate pressure transducers for industrial, process, and other applications is available from Robinson-Halpern Co., 1 Apollo Rd., Plymouth Meeting, Pa. 19462. [433]

Diodes. Raytheon Co., Microwave Devices Operation, 130 Second Ave., Waltham, Mass. 02154. A bulletin describes the company's line of low-noise gallium-arsenide avalanche diodes. [434]

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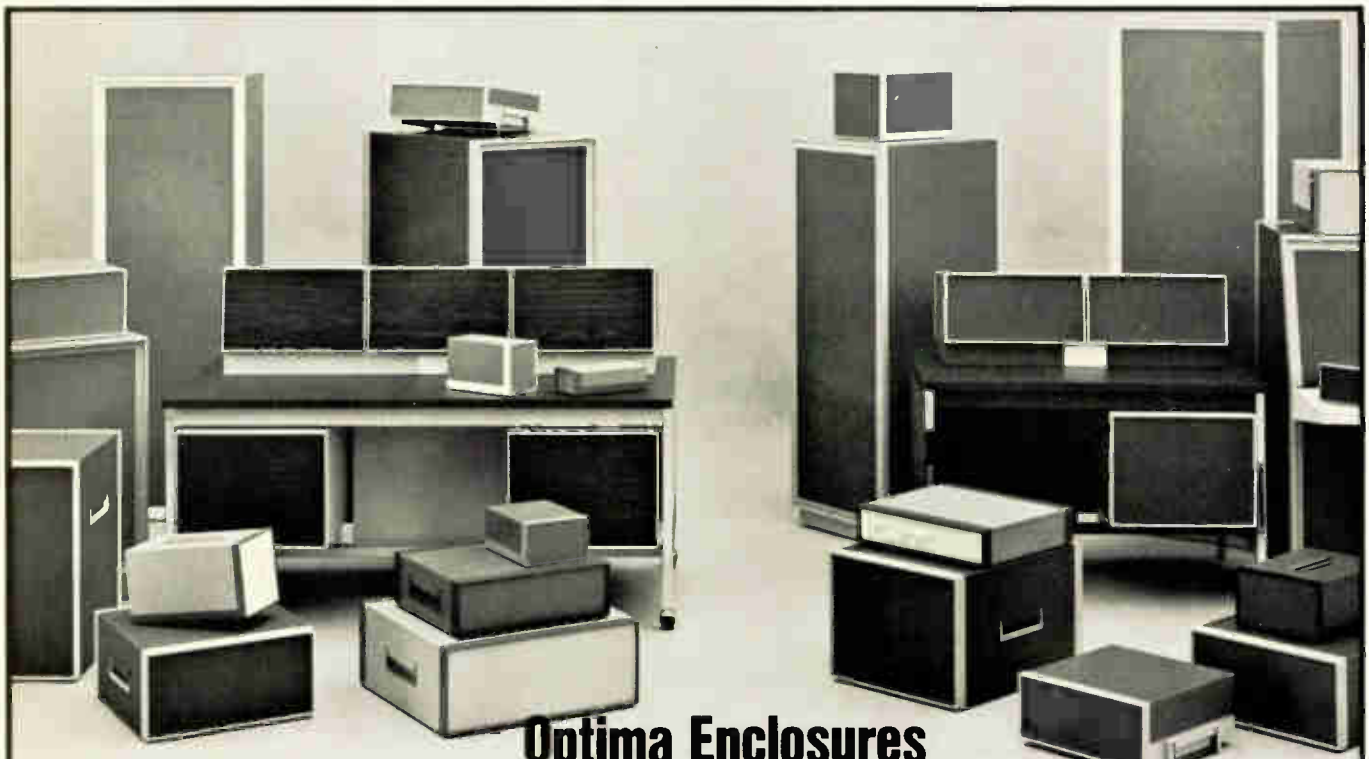

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Joan Sydlow

Wall Street: Are the funds the way to enter?

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IN THIS SECTION:

INVESTMENTS

The mutual funds are calling—should we listen?

The mutual funds, many still licking their recession wounds, are flexing their muscles for a comeback. They have poured some $1.5-million into a kitty which the Investment Company Institute, the industry's trade association, is using this fiscal year to sell the mutual fund story. If the average "little guy" investor hasn't heard from them yet, he will. If he has any intention of venturing beyond the savings bank with his roll, he will listen.

The funds, despite their detractors and their recent disappointing history, still offer probably the best long-range investment opportunity for the man with a modest nestegg and an itch to participate in the growth, if any, in the economy. Savings accounts are safe, but don't satisfy that itch. Playing the market, so dominated nowadays by the institutional professionals, can prove to be more scratching than it's worth for the amateur; it's fulltime work, even for the professionals. The best alternative would seem to be the funds, where an amateur can put his money in professional hands—at relatively small cost—and put his time and energy into making a living.

But, if funds are such a logical choice, why is it taking $1.5-million to get your attention? One big reason is the memory of the market crunch of 1970-71. "For the average small investor," says Michael Lipper of Arthur Lipper Corp., a top fund-watcher, "the market failure was as traumatic as the crash of '29. It will be years, if ever, before they return in droves to equity investing." From the small investor's point of view, another reason is the mind-boggling scope of the industry itself. There are some 550 funds, each with its own stated goals, quality of management, record of performance and, oftentimes, such specialization of investment interest that it makes it all sound nearly as dicey as the market itself.

Here, then, are some tips from top money managers on points to check in sifting the funds:

- Record of performance. How has the fund behaved, *not in the last quarter*, but over the past 10 years? Although it discriminates against infant funds, the pros say three years is about the minimum to establish a meaningful record—particularly the past three years. Further, they should be judged not only in comparison with the market averages but particularly against other funds of similar size, goals, and experience.
- Management. Has it been constant through the performance period? If there has been turnover, how long has the current management been in charge? Again, the experts set a three-year minimum for tenure—enough to unmask a flash-in-the-pan. Note: A healthy expenditure on research compared to sales and promotion is an earmark of sound management.
- Size. Here the funds vary widely, from below $1-million in assets into the multi-billion-dollar range, and so do the

This PERSONAL BUSINESS section is written by McGraw-Hill editors to give you helpful information on the better management of your leisure time and money. Personal Business covers everything from taxes and investments to education and travel. We feel that today, more than ever, personal-business planning is of prime concern to businessmen and professionals.

experts's opinions. An appreciable number, however, favor funds with assets between $20-million and $500-million. Bigger funds can be sluggish, and smaller ones too volatile—modest ups and downs in a tiny fund's assets can make startling percentage changes and a restless nest for one's nestegg.

■ Portfolio. While some specialized funds have done remarkably well—heavy investment in gold issues last year, for instance, proved a winner—the pros believe the average investor is better off, in the long run, in a diversified fund. In the current conservative mood of the market, they favor a portfolio heavy in blue-chips. The concensus is that funds which are value-oriented rather than scratching for quick gains will perform well this year.

As for load funds (which usually charge an 8½% sales commission) versus the no-load funds, the pros say it probably matters little in the long run which you buy; management and performance are what count. Although a number of funds have recently switched to no-load status, load funds still outnumber them 5-to-1. Chief reasons for the switch have been buyer resistance to the commissions and changes in the rules which made selling *contractual* plans (installment investment programs extending over a period of years) less profitable. These had been the staple of the fund salesmen, many of whom have now lost interest in the field.

If you ask a broker's guidance, he is most likely to steer you toward a load fund—a $10,000 investment there could mean as much as $380 in his pocket (45% of the full $850 fee). No-load funds are typically bought by mail order, directly from the fund, at no commission. With either, you will pay a small management fee (typically .5% of the value of your assets in the fund). Note, too, that the SEC has recently moved to hold the front-loads to the 8½% ceiling on their charges, and to assure that the investor gets a full measure of service for his money.

A more meaningful investment decision must be made in selecting funds with goals in accord with your own. Funds are usually ranked (sometimes including it in their titles) in four major categories: *growth*, meaning they seek asset appreciation; *growth-income*, which strive for a blend of appreciation and return; *balanced*, meaning they look to the bond market as well as stocks for their gains, and *income*, for which yield is the important factor.

Unhappily, many funds do not fulfill their own or their investors's intensions. Indeed, through most of 1972, income funds as a group "grew" somewhat faster than the self-described growth funds—due, in large part, to the appreciation of solid, dividend-paying stocks in a conservative market. There are, however, some fairly accurate observations to be made.

Growth funds characteristically either do far better or much worse than other types. The best performer last year gained nearly 52.5% in net asset value; the weakest lost more than 21¼%. While the best growth-income fund nearly equalled the best growth fund, with a 52% rise, the worst was only off 9.7%. Among income funds, the best climbed 27%, the worst fell 4%. The balanced funds described an even tighter range: the best was up only 14%, the worst was off 4%. The old rule still seems to obtain: The greater the chance of gain, the greater the risk.

As a substitute for prescience, Lipper suggests: "Most investors should own a group of funds—not just one—with different objectives, if for no other reason than they are likely to pay more attention to details of the economy, of the future, and of the funds themselves."

In the past year, more investors seemed more intent on getting out of the funds than getting in, most intensely last April when redemptions outstripped sales of $405-million by some $250-million. Nonetheless, Lipper and others in the field consider funds the cheapest, least hazardous and most professional way that the small investor can participate in his country's growth. "If you have $10,000," says Lipper, "you ought to have 80% in funds. If you spot a real situation and want to take a flyer, risk 10% or 20% on it, no more."

The beauty of funds, from the small investor's point of view, is that he doesn't need $10,000—or anything like it—to get in. A few hundred will do for a start—a lot less than most brokers would like to see (or even accept) in a straight trading account. At this level, the most economical bet is obviously a no-load. A minimum amount of research at the local business library—or a check of the ads on the financial pages of major newspapers—will turn up names and addresses.

If this is your time to invest, write for details and an application form. If the first response doesn't answer all your questions (such as some cited here), write again and ask—it's worth the 8-cent stamp. A fund that is less than straightforward is not for you.

Above all, remember that fund investing should be for the long haul. Chances are that investment in any well-managed fund, despite an off season here and there, will increase in net asset value over the years far beyond the 5% or 6% return of an equivalent amount in the bank. Of course, not many can hope to equal the past decade's record of T. Rowe Price's New Horizons (Baltimore, Md.), a no-load growth fund which has nearly quadrupled the money of its 1962 investors in that time (if they left dividends and capital gains to be reinvested). Nor are they all likely to top the decade's champion load fund, Ivest, which has nearly tripled in the same period of time.

Nearly any respectable fund, however, can be expected to weather a market crunch, even one as severe as 1970-71, with considerably less damage than a small investor, acting alone, is likely to suffer. "Brokers don't make a point of telling you," says one Wall Street veteran, "but there's not one of them who doesn't have a stack of individual disasters hidden away in his files from that period." Lipper adds the comment: "The funds took a beating too, but not one of them could properly be called a real disaster." Indeed, during the 1970-71 period when some 100 brokerage houses either folded or were rescued by mergers, only a couple of funds ran solidly aground.

That is not to say that business for the funds has been good, either. Last October, for instance, monthly sales among ICI members totalled $310-million—not very much, particularly when you consider that their clients redeemed $442-million worth of shares during the same time. Except for January, when sales reached $520-million and redemptions held at $476-million, the industry spent most of 1972 in net liquidation, with redemptions outpacing sales by an average of $180-million a month.

One major recent criticism of the fund industry has been directed against the competitive emphasis on short-term growth that seems to consume many fund managers. The impulse is understandable; it's a lot easier to sell shares (and keep your job) by displaying graphs with a sharply rising curve than those that are flat. But the critics contend that grabbing for quick gains is not only risky but quite possibly harmful to the investor's long-term interests. It makes one more point for an investor to check: Does the operation smack of solid value, or does it smell of self-aggrandizement?

The funds, it must also be remembered, are not the only way the relatively small investor can get professional help. Banks, such as New York's Marine Midland, now offer advice on portfolios as small as $8,000. Outfits like Danforth Associates (Wellesley Hills, Mass.) take clients with as little as $5,000. However, their charges, though small, are usually well over the .5% charged by the funds. While a fund's management fee on a $10,000 account would be only $50 a year, the fee at Danforth on the same amount would be $200.

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Yes, there is a New York worth visiting

"It's a nice place to visit, but you wouldn't want to live there." You've heard it a million times, and you know just where they mean. New Yorkers have been living down that old chestnut for generations. While this is hardly the time to debate whether or not living is advisable—or even possible—in New York, the fact remains that the city is still one of the really fascinating places in the world to visit.

Reams of newspaper and magazine copy and countless anti-New York jokes on late night TV talk shows have combined to give the nation's commercial hub something of a black eye. It is true that the Big Apple has some worms in it. But for a businessman bound for Manhattan on a business trip, New York can be an exhilarating rather than traumatic experience, simply by observing a few rudimentary precautions.

The myriad neighborhoods of Manhattan—ranging from seamy to chic—offer a diversity that has thrown many a visitor for a loop. In addition to about 80 hotels that could serve as a base of operations right in the Midtown business district—from 34th to 57th streets—there are also a few acceptable hostelries on the west side of Manhattan—in the Theater District and the Upper West Side—as well as East Side neighborhoods such as Gramercy Park, Murray Hill, Tudor, Sutton, and Turtle Bay.

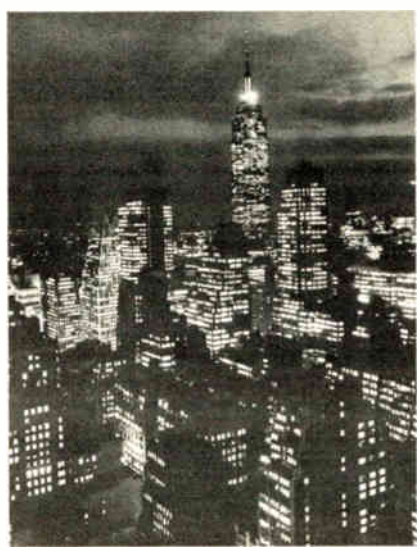
Lately it has been a good idea to stay away from the so-called Theater District, the area ranging on either side of Broadway and surrounding Times Square, except at show time. The entire area has become so sordid, with peep shows and "massage parlors" that fly by day as well as night, that the neighborhood can only be recommended to visitors with X-rated curiosity. Quite apart from the offensive sights, sounds and smells, this section of Manhattan is reported by the New York City police to have the highest incidence of crime in the entire city. If you wish to attend a Broadway show, take a cab. Then see your show—and depart fast.

Yet while the tattiness of Times Square makes it an ordeal to walk through, it is testimony to the diversity of Manhattan. On the other side of the island—the area ranging eastwards of Central Park between 57th and 96th streets—there is a neighborhood that still combines the chic with the raffish, expensive shops with bargains, a glut of cultural attractions with a minimum of unpleasantness that made New York famous as a place to visit in the first place. Though it comprises several neighborhoods, let's simply call it the Upper East Side.

The second rule in planning a visit to Manhattan, if you want to get something out of it, is to do just that—plan your visit. Do not—repeat, do not—leave your hotel selection up to your secretary, a business associate or a travel agent. Odds are you will wind up trudging the endless corridors of a convention hotel, or in any case in some other location than where you really want to be—in any one of the truly fine hotels on the Upper East Side.

Among those would be the famed Carlyle, hostel to the Kennedys, at Madison and 76th St.; the magnificently situated Stanhope on Fifth Avenue opposite the Metropolitan Museum of Art; the Westbury, 840 Madison Ave.; and such smaller hostelries as the Adams and the Croydon (both on E. 86th St.), Volney (23 E. 74th St.), Lowell (28 E. 63rd. St.), Mayfair House (Park Ave. and 65th), or the Alrae Hotel, on 64th next door to the Chateau Henri IV, which houses a bar with a unique—for Manhattan—air of privacy. Prices at these smaller houses range from $25 single to $35 double per night.

From an operating base such as any one of these, you are in a good position to start off on walks that lead past some of the most interesting sights New York has to offer. The entire length of Madison Avenue from 57th to 86th may well be the most urbanely fascinating stroll in the city, with the side streets between Fifth and Madison bristling with the townhouses and mansions that make the area one of the world's densest concentration of wealth. Here also are some of the nation's greatest cultural treasures, including the Metropolitan, Whitney and Guggenheim museums, and—ranging down Madison and off to both sides—the greatest concentration of art dealers and galleries. Whether or not you want to buy, visitors are always welcome, and the experience can be a balm to the eye.



Another elementary precaution in planning your visit to New York is to leave your penchant for steak and potatoes at home. They're available, but expensive beyond all reason. If you must have red meat and damn the cost, The Palm Restaurant, Christ Cella and Bruno's Pen and Pencil all have their devotees along "Steak Row," which stretches eastward along 45th and 46th streets from Grand Central Station near the heart of corporate headquartersland in Midtown. Instead of beef, plan to sample some of the incredible variety of foods of other lands New York offers in boundless profusion. The latest paperback edition of *The New York Times Guide to Dining Out in New York* (Atheneum) will give you some idea of the cornucopia of goodies available.

The Upper East Side is rich in international cuisine. For Czech fare, try Vasata, 339 E. 75th, or the improbably named Duck Joint, 1382 1st. Ave. For Hungarian food—minus the fiddles—there is the Tik Tak, 1477 2nd Ave. There's the Chardas, 307 E. 79, should you crave the violins. For German viands, plus excellent imported beer, go to Forester's Rendezvous, 146 E. 84. Cafe du Soir, 322 E. 86, is a pleasant little French bistro with reasonable prices. And, for one of the glories of Manhattan dining, be sure to make reservation well in advance and try Casa Brasil, 406 E. 85, where there is no written menu but the food is an experience.

For the unattached, one of Manhattan's most widely touted attractions is its "swinging singles" territory, centered more or less along First Avenue in the mid-sixties. Here dwell the likes of Maxwell's Plum and Friday's, two of the better known boy-meets-girl bars. Unfortunately, the area lately seems to have outlived its publicity, and an air of mediocrity prevails. Food and drink, such as it is, merely exists in such "swingles" country as a prop for easy socializing.

Broadway, as some critics say, may have passed its Golden Era. Yet, at least a score of good shows await the winter visitor.

While Broadway producers have striven to hold the prices in line, going to the theater can still make an evening expensive. Best-seat prices range from $12 (for shows like *Superstar*) to $8 (for *Creation of the World*). One assurance for out-of-towners: Broadway is a competitive arena, and any show that has survived its infancy is likely to be worth the money.

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IRS '73: Sweeping up those nuggets around the house

An excellent New Year's resolution—say the savviest pros in the world of taxes—is to begin sweeping together all the tax savings that likely as not are scattered about your own house, from liquor cabinet to filing cabinet. The point they raise can make a cleancut entry on anybody's form 1040, and quite a profitable one at that: It's rare these days, say the pros, to find a businessman, from company president to branch manager, who seldom if ever entertains business associates at home, who has no business-book shelf in his library, or hasn't set apart even a corner of his den for office work at night.

And—and here's the dollar-saver—it is just about as rare to find the man who picks up *all* the possible tax deductions allowed for such expenses. These days deductions of this type are more important than ever, since both the Internal Revenue Service (IRS) and the federal courts have lately eased up a bit in these at-home areas. "Your office-at-home alone," says a Washington tax lawyer with a carriage-trade clientele, "might easily buy your wife's next Christmas present. That is, if you take the full tax deduction."

There are two sensible rules, at the outset:

■ For 1973, be sure to keep a clear diary of all business entertaining at home, with receipts, *plus* other records covering all manner of business-related obligations that trail all the way to the front door. In taxes, much depends on records—and even a smart CPA can't win anybody money from the IRS with barebones estimates of business entertainment expenses. To a lesser degree, the same holds for such things as the home-office and library.

■ For 1972—and here is where many people will slip up—it is possible to *reconstruct* needed records for taking deductions. It is not possible, of course, to create a tax diary; but it is quite possible to recover lost records or those that have never been collected, to fill out incomplete ones in many cases, and come up with the paperwork needed by next April 16 (filing day in 1973).

To deduct for any entertainment at home, the taxpayer—if challenged by IRS—must be able to show that his guests were business associates who were there for business purposes. "Associates," incidentally, has a broader meaning than many realize. It covers customers, clients, suppliers, employees, advisers such as management consultants or company lawyers, plus fellow managers and executives. The term even includes prospective associates, in a section of the tax law that is unexpectedly liberal. For example, a possible customer, or a young man invited to your house for an informal interview for a job in your department, fits the definition. "Associates" includes the wives of business contacts, too—and one's own wife, as well—*if* it's a party with a clear business purpose behind it.

"Goodwill" entertaining at home deserves a special note. It clearly counts in toting up deductions, notwithstanding its pure informality and indirect connection to a particular business deal. It needn't be shown, for instance, that after dinner the men at the party departed to the den to talk business. Here again, the underlying business purpose is what counts.

"Home entertainment deductions can be worth more than the cost of salted peanuts," reminds the Manhattan CPA. "Let's say that at Christmas you gave a cocktail party for 25 business contacts and their wives, but haven't the receipts to show for it. By phoning the local gourmet shop, party store, bakery, *and* your liquor store, you come up with bills totaling, say, $175 for 50 people ($1 a person for food, $2 for drinks, 50¢ for extras). Attach the bills to your cancelled checks (if you've lost the checks, explain it), have your secretary list the 25 men and their business relationships—and you should have the makings of a cleancut $175 tax deduction."

Oftentimes a man's wife can solve some records problems where there is a good deal of casual business entertaining at home. Her help in recalling guest lists, dates, items purchased, and such, might turn up a surprisingly sizable deductible-entertainment calendar for 1972. Note especially that records need to be crystal clear where business or professional associates are mixed with personal friends at parties. This can trip a taxpayer.

The evening itself may be more readily mixed. If, for example, you have business people and their wives to, say, dinner at home, then drive them to your country club for dancing, the evening's club expenses are as clearly deductible as the cost of the dinner—even the drive can be written off at 12¢-a-mile.

A taxpayer may run into trouble over deducting his club dues, however—the rules are sticky. First, more than 50% of *total* club use must be for business; then only expenses *directly* related to business may be figured in determining the percentage of dues that may be deducted. This means that goodwill entertaining can be counted in arriving at the 50%, but not in deciding how much of the annual dues bill can be written off.

The office-at-home is another place where business expenses enter the house, and there are few sections of the tax law that cause as much confusion. Lately, the U.S. Tax Court, especially, and to some degree the IRS, have taken a reasonably soft line on the home-office deduction. Today it boils down to this: If you (1) regularly do office work at home (and there's no fixed rule on how many hours a week), and (2) have a room, or at least a space, set aside solely for this purpose, you may be able to take what is sometimes a sizable tax deduction.

Much has been made in the tax press recently of the question of whether the company *requires* the work at home—the point being that IRS requires that such be the case. To erase any doubt, the man who repeatedly burns the midnight oil at home might wisely have on hand a very brief statement from the company explaining that, indeed, the after-hours work is necessary by virtue of pressures of the job. "It's true—so why not put it on paper?," asks the New York CPA.

A crucial point is to be able to show—should an IRS man appear at the house—that the office-at-home is, in fact, just that, and not a den or library (unless business library). This means some visible signs: desk, files, typewriter, dictating equipment, a separate-line business phone, and the like. Not that the home-office can't be fancied up. If an antique desk, say, and an ancient breakfront for business books, are used, the deduction won't be lost—*if* it proves to be a working office.

A floorspace formula is generally used to figure the deduction. If it is a sizable room that takes up 10% of the total living space, the taxpayer deducts 10% of his house depreciation (or rent), insurance costs, heat and light expense, and wages of a domestic hired to clean the house. (This is, of course, in addition to realty taxes and mortgage interest which are fully deductible anyway.) Also deducted is the cost of painting and repairing the home-office, plus the cost of all business furniture and equipment (via depreciation). On top of these items, the overall deduction is revved up by writing off the cost of business books, magazines, tapes, and such—and here, again, good record-keeping is what the IRS people want to see.

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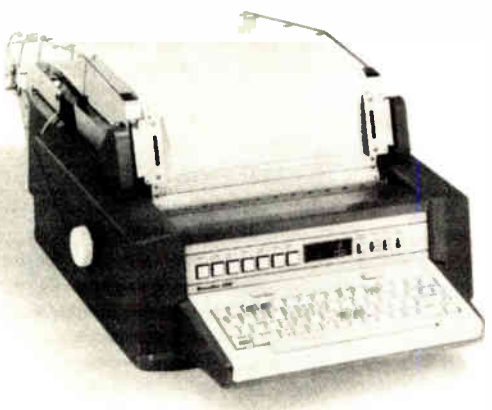

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A townhouse costs in sweat and cash, but it can be fun

If you are among the hordes of confirmed city dwellers dismayed at the prospect of paying more and more for less and less apartment, you might investigate some of the old row house neighborhoods in your town. A closer look may turn up some architectural treasures in now-faded areas which are prime candidates for restoration.

Before one gets too starry-eyed, there are some harsh realities to face. Even "bargain" houses will cost more and take longer than expected before you are through remodeling. There are no economies-of-scale in renovating just one house. The headache of dealing with local government red-tape, elusive sub-contractors, and immovable tenants can be as enormous as if you were renovating the entire block. But you'll find very few people who are not tremendously pleased with the results.

In the end, town-house renovators get not only convenient in-town location, but also a lot more house for their dollar—and a far more interesting house than most new ones at the same price. "People are becoming genuinely concerned about the lack of personality in contemporary architecture," says Washington architect James Ellison, whose own remodeled row house on Capitol Hill was included in a house tour last spring. "Many people will find these old houses are the way they want to go." (Ellison already has purchased his second row house on Capitol Hill, and is looking at a third.)

Buyer interest is higher than ever—and so are prices in some of the better-known neighborhoods. But this still is a good time to look. Mortgage money is easy to find. Interest rates probably are as low as they are going to get. And there still are bargains to be had in some surprisingly well-located neighborhoods only beginning the upward transition.

Look especially in areas surrounding major new center-city redevelopment projects still under construction. The trick is to get there before the crowd.

Admittedly, it takes imagination, foresight and a pioneering spirit to buy into some of these Cinderella areas. The risks are high. Security often is a real problem in the early years. And there have been some failures. But for every such aborted attempt there are a dozen success stories.

Most people are familiar with such blue-chip historic restoration areas as Washington's Georgetown. Boston's Beacon Hill, Philadelphia's Society Hill, New Orleans' Vieux Carre, and San Francisco's Russian Hill.

But these now-fashionable neighborhoods are not the places to look for bargains. On Russian Hill, for example, few homes are available, and most have already been remodeled; they sell for $80,000 to $125,000 and more. There's little to be had in Georgetown under $100,000, and even that would be very tiny. And the prospective buyer in Society Hill can expect to pay between $75,000 and $250,000.

The best buys, to repeat, are in the transition neighborhoods. In New York, for example, one can still pick up good houses for as little as $25,000 or $30,000 in Manhattan's Chelsea area, or in Brooklyn's Fort Greene, Clinton Hill, or Crown Heights sections. There are some homes at the edge of Chicago's select Lincoln Park area for only $20,000 to $30,000.

Philadelphia's Society Hill is a prime example of what can happen in a few years. Some 250 "shells" were sold over the past eight years, according to James Martin, executive director of the Old Philadelphia Development Corp. Those that were restored five or more years ago probably cost $30,000 to $50,000 to buy and remodel. Today, those houses would sell for $50,000 to $75,000. Real estate values have doubled in some cases.

In Washington, D. C., one of the hottest new areas now is Cleveland Park, a section between Connecticut and Wisconsin Avenues where houses never really deteriorated the way they did on Capitol Hill. These are mostly big rambling duplexes that rarely need the extensive rehabilitation being done to the ones on the Hill. But don't overlook Capitol Hill. It's a charming area, and there still are some blocks just starting their renaissance. You can pick up some good units for $16,000 to $30,000.

San Franciscans are finding good buys in the area north of California Street, on Sacramento or Clay Streets. Victorian-style houses in these areas are avidly sought and hard to get, however, and remodeled houses command top dollar. There's a lot of interest also in Buena Vista, upper Market Street, and in houses near the Western Addition Redevelopment Area.

In Boston, there's a virtual stampede on in row house renovation. Some turn-of-the-century brownstones have tripled or quadrupled in value over the past five years, as demand accelerates from both individuals and investor groups. Row houses that went for $25,000 to $30,000 five years ago are being gobbled up for apartment conversion at $75,000 to $100,000 and higher. The hunt extends as far as Roxbury.

A lot of the fun—and the education—in row houses comes in the shopping period. This is one point where it is essential to seek expert advice—not only from

In Manhattan's Chelsea district, once drab streets bloom with renovations like this.

Richard Knapp

real estate and architectural and engineering specialists, but also from people who have been through it.

An excellent starting point is *A House in the City: A Guide to Buying and Renovating Old Row Houses* by architect H. Dickson McKenna, who is executive director of the New York State Assn. of Architects. The book, published last year by Van Nostrand Reinhold, is a mother lode of financial, architectural and historical savvy in this field. And it includes a sequence of procedures for typical row house renovation that could prove invaluable to the novice.

Your best guides, however, may be your future neighbors. Most of the emerging areas have home owner associations or historical preservation groups. Attend their meetings and get acquainted with neighborhood problems. These people also can help find a real estate broker or architect who specializes in row house properties. Often, they also know of houses soon to be offered for sale.

If you find something that is more house than you need, of course, you might consider creating an extra apartment or two. What you sacrifice in privacy may be worthwhile for a rental income that will help carry the financial load and offer some attractive tax advantages as well. Check first, however, to see if a third apartment would put you into the multi-family class; this could be expensive, and fire codes might require some unattractive additions.

When the choice narrows down to one or two houses, bring in an architect and a professional engineer to inspect the property. Some architects will give you a brief but knowledgeable inspection for $50 to $100, and their practiced eyes may spot some choice or problem features that escaped yours. The local chapter of the American Institute of Architects can help direct you to architects who have done this type of work. The engineer will zero in on the home's structural and mechanical qualities. For a fee of $60 to $100, he may spare you some very costly mistakes.

Unless you know a lot about construction and design, and can do some of the work yourself, don't try to be your own architect or contractor. Hire one with a good track record in this type of work. And be sure you get at least two, and preferably more, bids on all major work.

If possible, try to avoid living in the house while the work is going on. It's more economical and less traumatic. Finally, curb your impatience—allow at least 12 to 18 months for the whole procedure.

How not to crack up before TV's little red eye

Do you come on TV like a Brinkley or Cronkite—or with the jumpiness of a 1935 late late movie? One point seems sure: For the businessman or professional, the chances today are greater than ever that he will, indeed, come on television's airwaves as a stand-up speaker, panel guest, or interviewee.

"The man of attainment sooner or later will face the camera's little red eye, and he ought to be ready for it," says a Chicago station manager whose air-time is more and more loaded with amateur performers. Talk-show emcees such as Dick Cavett, David Frost and NBC's Barbara Walters have "discovered" the novice and made him big-time. TV station news and special events departments, keen for confab on anything from price controls to vasectomy, increasingly are turning to doctors, lawyers, merchant chiefs, and even experts on breeding bees. Local stations, with an extra half-hour of prime time to fill courtesy of the FCC, are cooking up their own Cavett-Frost type shows. "The appetite for knowledgeable bodies," says a New York network pro, "is ravenous. The pity is that too many of these people are unable to put it over when they get on camera."

Closed-circuit TV, more and more a must at business and professional gatherings, has helped many a novice. "At least you learn not to freeze up," adds the network executive. "But if I had one word of advice to give all amateurs, it would be 'Be yourself—don't try to be like a network newscaster, and for heaven sakes don't try to be a Bob Hope'. " There's nothing quite so flat, he warns, as the pun or joke delivered by somebody who lacks a particular knack for timing and drawing laughs.

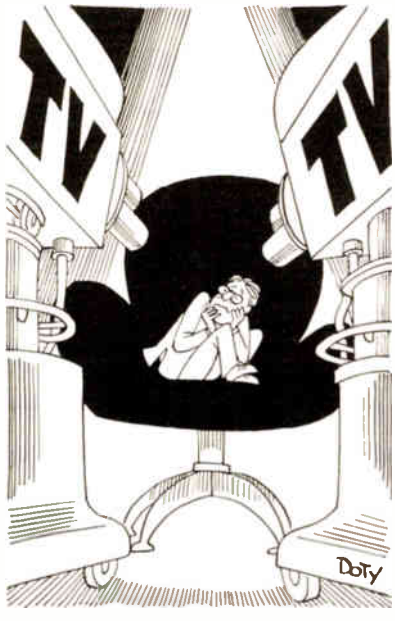
Posturing and stentorian voice, a crumbling style in any medium, is especially hammy on TV. The camera magnifies, so you should underplay—flick an eyebrow instead of waving an arm, or let a two-second pause emphasize a point instead of pounding on the table.

TV's camera-conscious pros add an admonition: Stay put. "A little emphasis is okay," says one studio cameraman. "but bobbing and weaving makes you look bad and kills what you're trying to say if it's a talk show."

The audience sets the proper tone and technique for any performance. "If you're talking before a live audience while the camera covers you," notes a top network director, "and you want to reach the people in front of you, then talk to *them* and let the camera do the best it can to pick you up. Forget there's TV in the room. But if you're trying to reach the *TV* audience, then work to the camera—and if there are people in front of you, forget 'em."

Some inexperienced performers, say the pros, get awfully uptight in a bare studio facing nothing but a camera. One idea is to treat the camera as though it were a person sitting a few feet away.

Timing—precise timing—is one of TV's demands, of course, and the studio pros have a right to expect that anybody called upon to make a TV talk will carefully tailor his material to the alloted time slot. So, if the appearance calls for a nine-minute speech on the air, a 10-minute speech simply won't do. Preparation is a must. But once the red light on the



camera turns on, the pros advise the beginner to leave timing to the show's director—he will signal when to speed up or slow down.

"Have a couple of thoughts at the end of a talk that can be left in or dropped—for time's sake," says a New York director who has handled scores of business-VIP type telecasts.

As with voice and manner, low-key is the word for attire for a TV appearance. Muddled patterns, flashy stripes and color mixes are best avoided, especially if it's to be a color telecast. A pastel blue shirt is still advisable for a black-and-white TV show, and any off-white hue is good for color cameras. Eye glasses should be left at home, if possible, but they aren't as much of a liability on camera as many people think.

"The best make-up for the non-professional on TV," says a director, "is a good suntan. If you've no tan, though, let the studio people apply makeup, especially if the show is in color. Without it, you'll look washed-out and unshaven."

For the company executive or professional man who figures he will be making more and more on-camera appearances, studio pros say that the best way to master the art is to spend some time and money with a private tutor. The local university in town may well have a speech instructor who can be of help, and at the better schools of speech arts, such as at Northwestern, UCLA and Boston's Emerson College, faculty members often do TV coaching on the side. So do some local television directors, and their competence can be judged by the shows they have directed. Tutoring fees vary widely, but six or eight one-hour sessions of competent coaching working with a closed-circuit TV set-up can usually be arranged for $250 to $300, sometimes more.

There's a technique for script handling that too often eludes the amateur. Among other things, say the pros, the novice who uses a script and tries to hide the fact is only fooling himself. "Your darting glances and tense performance," says one director, "will be a dead giveaway. Keep the script in the open and refer to it naturally."

Two marks of the novice speaker rankle TV directors. One is memorizing a script—this almost guarantees a frozen, dull delivery. There is also the danger that the speaker may lose his way, forget a phrase, and collapse into a state of silence, anguish and sweat.

The other is to hold to a script for dear life, reading word for word or nearly so. This produces what the pros call bald-spot delivery—the speaker is in a bent-over reading position much of the time, so that the camera catches little more than the top of his head.

By far the best idea, the pros agree, is to underline key ideas, words and phrases, and use the script as a guide for making the speech. Marginal notes showing paragraphs to stress, those that can be touched lightly, and some that can—if time demands—be dropped, can be a big aid toward smooth delivery.

Recommended reading: *Speak Your Way to Success*, by Arthur W. Sager, in which the author, a leading speech coach for businessmen, stresses that a prime requisite for profitable platforming anywhere is to achieve ease and naturalness (McGraw-Hill).

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by Joseph Wiltsee

Estate Planning: Why drawing a will is no dead issue

Now, at the start of a new year, *reviewing your will* might make good sense—*if* you have one to review. "Too darned many people ignore wills," says a top estate planning officer of a leading New York trust company. "They balk at the idea as though making a will might hasten their demise. It's a costly mistake—even for a man who is on his way up the line and hasn't much property." . . . Two prime reasons for a will, even without heavy assets: (1) A man who dies intestate has his affairs handled by a court-appointed administrator, and among other things, the case can drag on for two or three years while the family lives on a meager stipend allowed by the court. (2) A will gives a parent a chance to provide a guardian or alternate guardian for the children, oftentimes someone other than the executor.

Updating a will is a must, with a three-year check-up suggested. Even without a death in the family, or a birth, marriage, divorce, inheritance, or such—that might well call for changing your will—a dusting off is needed. "Some items calling for change aren't so apparent," notes the New York estate planner, "and missing them can cause trouble." Moving to another state (or having your executor or lawyer move), a change in inheritance law of your state, or seeing a marked change in the value of securities or other property you own, are important items. . . .


Joan Sydlow

Gorgeous, yes —Investment, no

With distrust of the stock market driving would-be investors into more exotic fields—diamonds, coins, antiques, fine art, and such—Gerald M. Loeb, the author, lecturer and Wall Street consultant, has some words of caution: "Two vitally important qualifications of a good security investment are liquidity and the narrowest possible spread between what it costs to buy a security and what one would get if he turned around and tried to sell it." Exotic investments don't seem to fill the bill . . . a diamond may be appraised for $4,800 for insurance purposes, one expert notes, but bring as little as $700 if you suddenly must unload. Says Loeb: "You hear some fabulous percentages of gains. These must be taken with some understanding. It is not important that something doubles or triples in price, but how long it takes it to do it, what the *annual* rate of appreciation is." Another drawback: Costs of insurance and storage can eat up a lot of your investment interest. Loeb's comment: "Exotic things of this type should be bought for pleasure. If one happens to stumble onto a good thing financially as well, fine—but don't count on it."

Of sons and wives and limited partners

Is the student in the family lost in the college-hunting maze? The College Entrance Examination Board now offers help with a computerized service (College Locater Service, Box 2602, Princeton, N. J., 08540). It matches information on 2,200 institutions with the student's preferences in curriculum, location, atmosphere and the like, registered on a prepared checklist. . . . The insurance industry is coming up with some solid disability income coverage for *working wives*. Formerly, such coverage was scarce and short-term. Now a leading insurer offers disability-income for working women up to age 65 with a payout period of up to five years. It's worth investigating, particularly where a wife's earnings rank high in the family income. . . . In evaluating *real estate partnership* investments, doublecheck that operating expense estimates have not been shaved to inflate profit potentials; expenses listed at *much less than 40%* of expected rents should get a second look.

And now a word. . .

Taped TV for the home: It's now on the market—RCA and Cartrivision are the leaders. The systems play video cartridges of sports events, movies, even a cooking lesson from Julia Child (there are already 400 tapes to choose from) into any TV set. They also record programs while you're out, for viewing later. The cost, however, is high—about $700. But note: The industry expects prices *will be dropping later on*. If you buy, be warned that playing the gadget is not cheap, either—one half-hour cartridge will cost about $12; even one-use rentals will run $3 to $6.

January 4, 1973
Electronics
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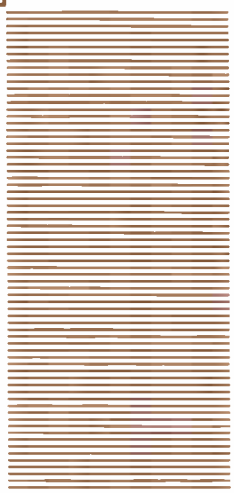

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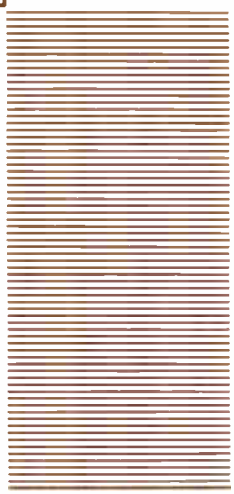

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