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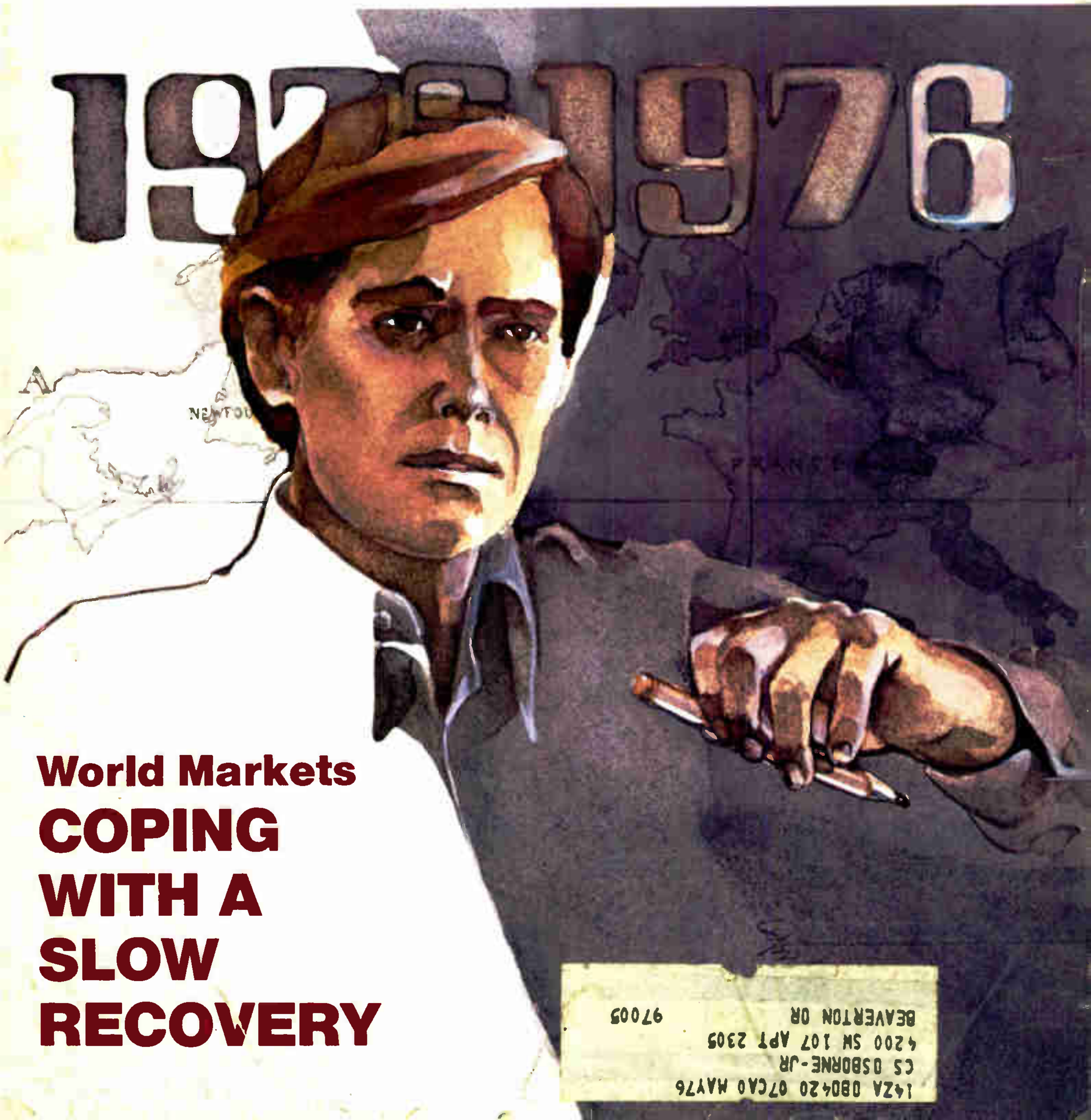

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The 3476A is backed by HP's service organization ...another big plus for a low-cost DMM. With these prices and features, why not put your hands on the 3476A for your 3-1/2 digit measurements? Your local HP field engineer can tell you how.

*Domestic U.S.A. prices only.

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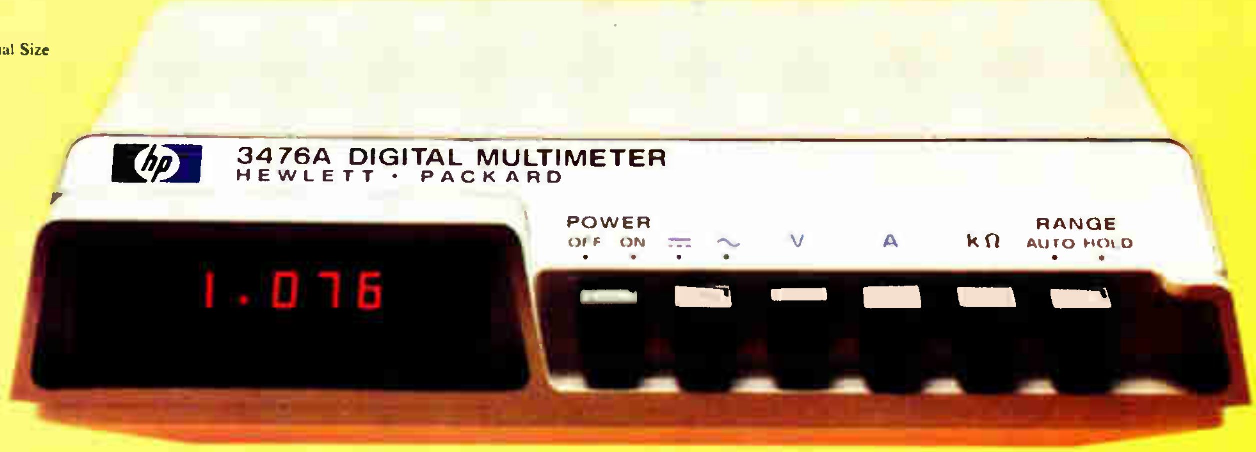
095/52



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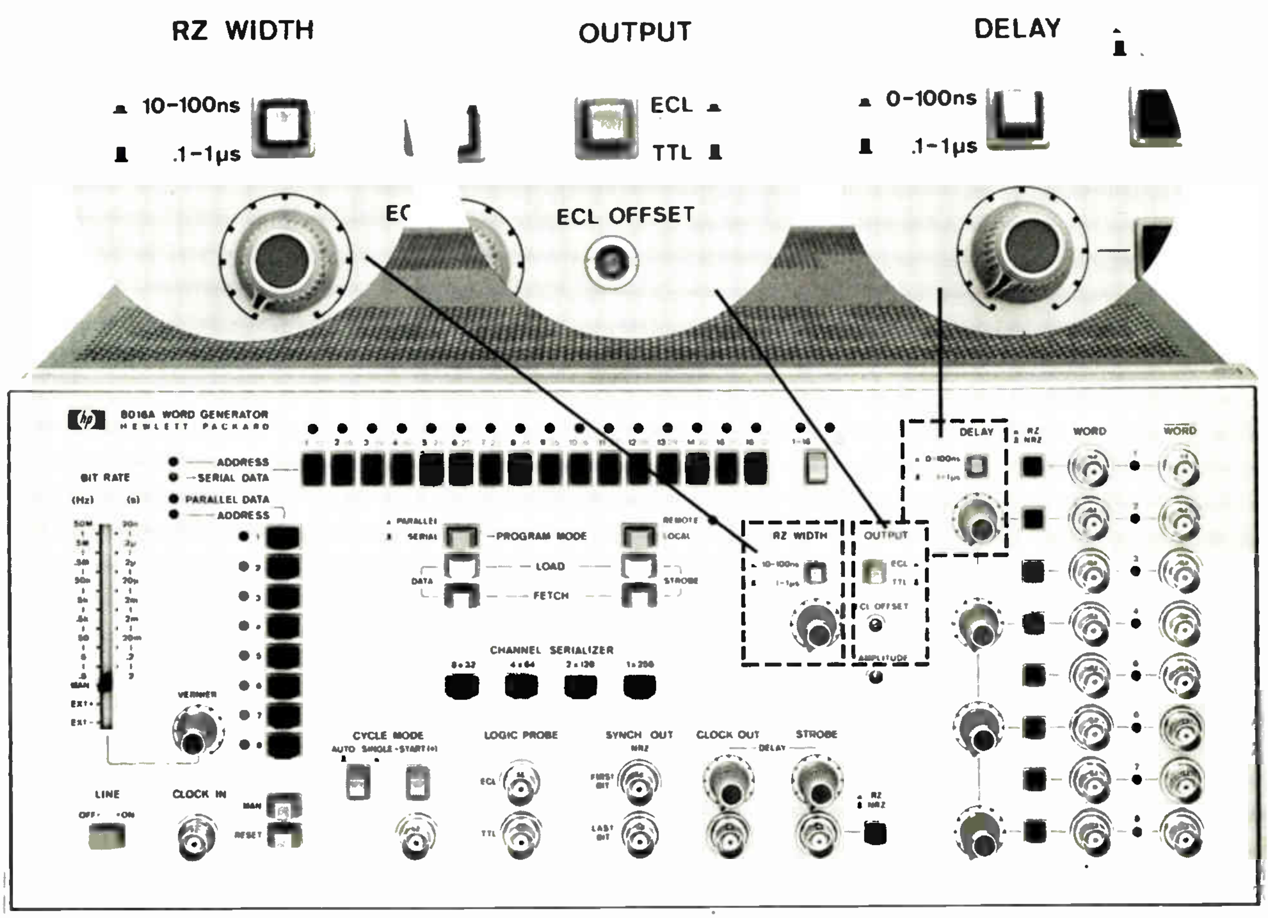
Circle 900 readers service card

HP announces pulse-parameter control in a word generator



That means an end to building arrays of pulse and word generators to do complex digital testing in the lab or production. HP's new 8016A gives you the digital stimuli you need for IC development or testing, for digital circuit evaluation, for microprocessor system troubleshooting, and for interface evaluation —at data rates to 50 MHz.

Now you can vary pulse width, height, and delay for worst-case or parametric testing such as set-up and hold—time measurements, as well as functional testing. Add HP's new 1600A Logic State Analyzer to your system and you have the ideal combination for observing your logic circuits in action.

Parallel and serial data selection. In the parallel mode, output is 32 bytes, each 8-bits wide. In the serial mode you get up to eight 32-bit words. Or you can serialize outputs for word length up to 256 bits. You have complementary outputs and a selection of RZ/NRZ formats on each channel.

Programming options. Manual data loading is simple with the pushbutton matrix and LED indicators. And a remote programming option allows fast loading with an HP Interface Bus compatible card reader, calculator, or minicomputer—a valuable option for on-line testing where speed and accuracy are important.

There's still more. The 8016A includes manual clocking for single step testing; a strobe channel to use as a ninth data channel or serial qualifier; clock and sync outputs; ECL and TTL logic-probe power outputs; and other features to provide flexibility and ease of use.

Your local HP field engineer can give you all the details on this powerful new word generator, which is priced at $6,400*. Or, write for our 10-page data sheet. It gives all the specs, output timing diagrams, and includes application information.

*Domestic U.S.A. price only.

085/13

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For technical information circle 2 on reader service card

For immediate applications assistance circle 3 on reader service card.

Electronics

The International Magazine of Electronics Technology

Vol. 49, No. 1 • January 8, 1976

Highlights

Cover: Outlook for 1976—how fast a recovery? 83
Electronics markets seem certain to pick up this year—but at rates that will vary from sector to sector and country to country. After surveying many companies around the world, *Electronics* concludes that color TV will be critical in the U.S. (p. 84) and West Europe (p. 96), computers critical in Japan (p. 101), and that the U.S. will lead the way out of the slump.

Cover picture is by illustrator Lynn Sturm.

How U.S. technology leaks into the Soviet Bloc, 68
Despite U.S. Government embargoes on the export of "strategic" electronic equipment to certain countries, Eastern Europe manages to buy it anyway—sometimes with ridiculous ease. Months of investigation by *Electronics* uncovers the ruses and routes.

Illustrations are by Lynn Sturm.

What's on executives' 1976 worry lists? 79
Unemployment, the slow rate of recovery, and—for Americans—the failure of overseas markets to rebound more quickly: these are the preoccupations of electronics executives as they face the New Year. Add to those the drying up of capital sources, and the New Year optimism becomes more guarded than usual.

Mid-career crisis troubles readers of all ages, 112
Electronics' questionnaire on the over-40 EE's job crisis provoked an unusually large number of readers to express virtually unanimous anger. But as a cure for the problem, neither collective action nor further education attracted a clear majority.

And in the next issue . . .
The latest generation of microwave semiconductor devices . . . two techniques for testing microprocessors . . . measuring system performance with gated noise.

Electronics

Publisher's letter

In all of the nearly two decades that *Electronics* has been preparing its annual reviews of the electronics marketplace, economic conditions have never been so, let's say, delicately balanced. Uncertainty over what even the next six months will bring, let alone how 1976 will turn out, is pervasive among the leading officials of electronics companies around the world.

Indeed, never before in our yearly research and reporting for the market forecast have there been such clear-cut indications that electronics is a world-wide market, with fluctuations in Europe's national economies, say, upsetting the economic health of American electronics companies. What's more, European executives are becoming increasingly vocal in their assertions that recession, stagnation, and the other ills that are impacting the U.S. industries—and some of the measures being taken to overcome them—are having an impact on business in other countries in a rapidly shrinking world.

So it is fitting that this year we have combined our three annual market reports—on the U.S., Western Europe, and Japan—into one big world report. You'll find the report starting on page 83, with details of the U.S. market on page 84, Europe on page 96, and Japan on page 101. Charts giving market breakdowns start on pages 92 for the U.S. and 105 for Europe and Japan.

In addition to the market roundup, we have put together another report that has become an annual tradition: our first-of-the-year survey of how executives view economic trends. That article appears on page 79 in Probing the News.

For the past six months, Ron Schneiderman, our New York bureau manager, has been heading an investigation into illegal trade with the East Bloc. Ron and *Electronics* staffers have talked to executives in Europe and the U.S., as well as distributors and government officials in both Eastern and Western countries.

The trail of illegal shipments is an elusive one. But with advanced electronic hardware finding its way around the security barriers that the U.S. and its Western allies have erected, the story of East-West trade is beginning to read like a spy thriller. So turn to page 68 for the details on how strategic equipment that is banned for sale to East is getting there anyway.

"An overwhelming majority of EEs over and under 40 years old recognize a mid-career crisis in their work. Moreover, they believe that age discrimination in industry contributes to the seriousness of the crisis." Those are the disturbing results of our questionnaire survey of readers on the problems facing the veteran engineer. In fact, 92% of the unusually heavy number of responses said they were aware of the EE's mid-career crisis, and 90% said they believed age discrimination was a fact of life in hiring and firing. For the complete summary of the questionnaire's unsettling results, see page 112.

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Circle 5 on reader service card

Readers' comments

ICs liberate the engineer

To the Editor: Regarding the comments on the EE profession appearing in *Electronics* lately, one of your readers observed that the object of any profession is to obsolete itself. However, I don't agree that the advent of compact prepacked electronic functions portends the end of the electrical engineering that we all know and love. Rather, I see in this circumstance the liberation of the EE from the tyranny of the circuit.

Gentlemen, let's admit it: circuit design is a bore. It is not a fit topic for cocktail-party conversations. That is why the all-engrossed circuit designer has nothing to talk about at such functions. This merely confirms the presentiments of the other guests as to his basic eccentricity. I say that EEs the world over should raise a glass in salute and welcome to ICs. And arise! You have nothing to lose but your loops and nodes, and, if you're very fortunate, the poles and zeroes too.

William Dooly
Philadelphia, Pa.

'Inaudible' jitter strikes discord

To the Editor: I'd like to comment on Peter A. Stark's and W. Adriaans' remarks about jitter [Sept. 4, p. 6]. One of the more common criticisms of electronic organs relates to the condition Stark describes as counting down from a master oscillator and dividing by two to get octaves. This sort of generation results in harmonically related and phase-constant tone generation.

Meanwhile, a pipe organ with more than one pitch generator per pitch (i. e., more than one rank of stops) exhibits rather minuscule random phase and unstable harmonic relationships. In fact, the large electronic-organ companies have sought ways of inexpensively generating tones in which octaves and individual pitches were not exactly related. Ever since Everett with the Orgatron in the '30s, designers have sought to do something that Adriaans says is "normally inaudible."

John W. Shaver
Sierra Vista, Ariz.

HiNIL Interface

Prevent CMOS latch-ups and failures with a high noise immunity logic I/O.

CMOS systems are subject to latch-ups and failures in the field because of high voltage transients, static charge and improper field maintenance procedures. Moreover, due to their increased output impedance, CMOS is more susceptible to transient errors than corresponding bipolar logic.

A simple solution to these problems is to use Teledyne's bipolar High Noise Immunity Logic (HiNIL) as the system I/O interface. The I/O design approach shown in Figure 1 has solved these problems in applications such as business equipment, industrial controls and electronic games. The HiNIL interfaces protect the delicate CMOS inputs with a rugged bipolar "front end" not susceptible to CMOS failure modes. Also system noise immunity is maximized, and the HiNIL output devices provide direct, high current logic drive of relays, displays and long lines.

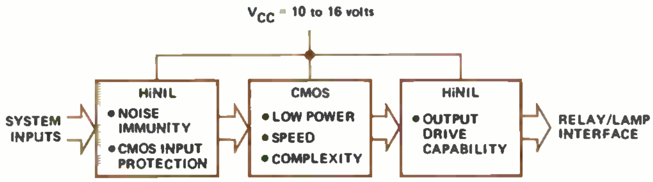

Figure 1. HiNIL input interface protects CMOS inputs while HiNIL outputs directly drive long lines and peripheral devices

The two families are directly compatible at the 10 to 16 volts V_{cc} range. The designer can take full advantage both of HiNIL's capabilities and of CMOS' low power dissipation, supply voltage flexibility and improved noise margin at higher supply voltages.

Parasitic SCR latch-up is an all too common CMOS malfunction. Large noise transients and DC input levels below ground or above V_{cc} could force CMOS input diodes into forward conduction, causing SCR action in the four-layer diodes formed by the diode and parasitic p-n substrate junctions. This condition leads to device latch-up, increased I_{cc} current and, when current is not limited, to gate destruction. Maximum protection can be obtained by using

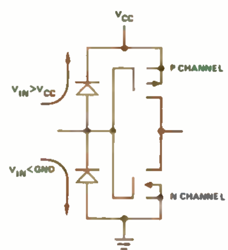

Figure 2A. CMOS latch-up causes

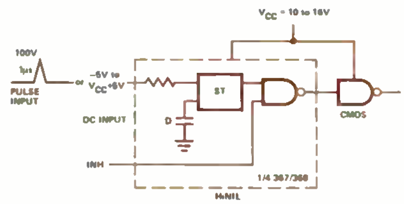

Figure 2B. HiNIL input protection

HiNIL Schmitt triggers. They prevent latch-up at DC input levels from −5 volts to V_{cc} +5 volts and suppress 100 volts transients as wide as 1µsec (Figure 2).

HiNIL inputs on plug-in cards will protect a CMOS system from problems associated with "on power" fault isolation, a widely used TTL system maintenance method. Plugging CMOS into powered connectors has led to latch-up failures because it allows inputs to see logic "1" signals before V_{cc} rises on the card. The failure is frequently catastrophic if input current is not limited.

HiNIL's lower output impedance and DC noise margin of 3.5 volts ignore large voltage noise transients that can cause CMOS logic errors. Also, static charges large enough to rupture CMOS oxide regions are often generated in dry environments by movement of materials and users. A HiNIL input gives more immunity to static and maximizes noise protection.

Examples of HiNIL Interface Devices

301 Dual 5-Input Power Gate 302 Quad Power NAND Gate (OC)	65mA relay or lamp driver
323 Quad NAND Gate (OC) 332 Hex Inverter (OC) 334 Strobed Hex Inverter (OC)	Input noise protection plus open-collector pullup to other logic levels
350 8-Bit Multiplexer 351 Dual 4-Bit Multiplexer	Drive longer lines than TTL with 10X noise immunity (I_{OH} = 12mA)
361 Dual Input Interface 362 Dual Output Interface 363 Quad Output Interface	361 directly connects HiNIL to DTL, RTL/TTL 362 and 363 connect DTL/RTL TTL to HiNIL
367 Quad Schmitt Trigger 368 Quad Schmitt Trigger (OC)	Suppress 100V/1µs spikes, protect CMOS decode switches etc
380 BCD to Decade Decoder 381 BCD to Decade Decoder (OC) 382 BCD to Decade Decoder 383 BCD to 7-Segment Decoder	Provide decode/drive for lamps LEDs gas discharge displays etc
390 Interface Buffer Series	250mA HiNIL driver series will be available soon

HiNIL reliability insurance costs little since the I/O circuits—unlike filters and shielding—generally replace other logic and drive circuits. So, don't wait until your new CMOS system runs into costly problems in the field. We'll show you how to build foolproof low-power systems. Call or write today for HiNIL application notes and specifications.

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Circle 7 on reader service card

News update

■ Since November 1974, when it filed a $237 million lawsuit against its major contractors—including Westinghouse Electric Corp. and Rohr Industries—the Bay Area Rapid Transit District (BART) has doled out a considerable sum in legal fees for a case that has yet to reach the trial stage. In fact, the primary movement in the suit has been from Federal court, back to a state court, and then to the state supreme court. The supreme court finally gave the defendants the go-ahead on a long-sought change-of-venue hearing: they do not want the case to be tried in any of the three counties where BART runs.

Westinghouse, which built BART's electronic train-control system, is the biggest target in the suit [Nov. 28, 1974, p. 36]. BART, in seeking $55 million from Westinghouse, accuses it of failing to provide equipment that continually detected presence of trains on tracks among other shortcomings. Westinghouse has repeatedly denied the allegations, and has sent BART a claim for $15.7 million which it says represents back pay for construction delays.

■ Gene M. Amdahl, chairman of Amdahl Corp., Sunnyvale, Calif., says sales of his model 470 computer have gone "exceedingly well" in 1975. The sixth copy of the large system is due to go to Massachusetts Mutual Life Insurance this month. The 470, designed to compete with International Business Machine Corp.'s System/360, costs about $4.5 million for a typical 4-megabyte configuration.

Amdahl's machine, hailed as super-fast but architecturally simple, was delayed by the company's financial troubles [Nov. 28, 1974, p. 39]. The problem was that IBM came out with a higher performance computer than the one Amdahl expected to have to compete with. The upshot was that additional capital was needed, forcing renegotiation with Japan's Fujitsu Ltd., a major investor. It then took over a major portion of Amdahl's manufacturing and inventory.

Circle 9 on reader service card

Editorial

The prospects for electronics

Executives in the usually ebullient electronics industries are approaching the new year in a new role—that of the conservative. The optimism is still there, but a healthy dash of caution is there, too. As our annual electronics market survey shows, 1976 will be a growth year, but there are a number of questions involving economic recovery, inflation, inventories, price pressures, and high unemployment levels that are causing concern.

These worries are reflected in cautious predictions for the new year. Many predictions are similiar to that of Robert L. Boniface of Hewlett-Packard, who doesn't foresee a boom-type economy, but expects a gradual, paced recovery. Even so, the recovery so far hasn't been as strong as many companies had earlier expected. Boniface notes, "We had planned on a stronger domestic recovery."

To Wilfred J. Corrigan of Fairchild, "The surprising thing today is the lack of long-term business." He says, "Since mid-1975, 80% of Fairchild's business has been 90-day orders." This makes it hard for the supplier to keep inventories down, since what the customer usually wants isn't in inventory.

On the plus side, inventory adjustment seems substantially over, with no likelihood of shortages. However, as Walter L. Cherry of Cherry Electrical Products Corp. points out: "There may be short-term apparent shortages—the process of gearing up and going again is a faltering one."

But with key industry segments predicting growth that ranges from 10% to the 20% or more for semiconductors, the year ahead looks like a good one, and the restraint shown by industry executives may bode well. One who believes that all of the effort will pay off is Charles E. Sporck of National Semiconductor Corp., who says "We're all going to be wearing smiling faces this time next year."

Let's be more realistic about East-West trade

The U.S. Government and America's electronics industries are growing increasingly at odds over the subject of East-West trade. Needless to say, it is a very complicated and highly political issue. But it is also frustrating to the many American companies who have to stand by while their Japanese and Western European competitors pick off growing shares of a massive yet largely untapped market—the East Bloc countries.

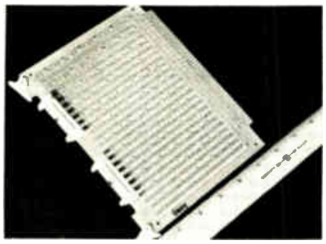
But U.S. firms are stymied. The Export Administration Act of 1969, among its other purposes, calls on the Government "to exercise the necessary vigilance over exports from the standpoint of their significance to the national security of the United States." In the eyes of many industry executives, the Government may be a little too vigilant.

Unfortunately for U.S. suppliers, many of their products are considered to be of strategic value to the East and, thus, are embargoed from sale to the Eastern Bloc. However, much of the equipment and components that the U.S. embargoes are available from Japan and Western Europe.

The trouble is that the U.S. may be over-embargoing high-technology products. The Free World Coordinating Committee maintains a list of products that, because of their strategic value, cannot be sold to the East Bloc. In addition to those proscribed items, the U.S. bars a number of other products from East-West trade. However, other countries do not disallow as wide a range of products as does the U.S.

It's time for the U.S. Government, if it really intends to promote international trade, to take a realistic look at the controls on East-West trade. Since so much appears to be getting through to the East anyway, why doesn't American industry get its fair—and the emphasis is on fair—share?

WIRE-WRAPPABLE PACKAGING ASSEMBLY ACCEPTS INTEL 8080 AND 8080A MICROPROCESSORS



NEW BRUNSWICK, N.J. —A wire-wrappable packaging assembly for interfacing with Intel 8080 and 8080A microprocessors is now available from Garry Manufacturing Co., of New Brunswick, N.J. This new board fits the standard Intel processor rack. It is UL approved and includes two Input/Ouput connectors to mate with flat conductor cable wiring.

The new packaging assembly has wide application in computerized automation equipment for the machine tool industry and it will be useful in developing special or custom CPU's with associated RAM and PROM chips.

Garry also manufactures boards to interface with microprocessors made by National Semiconductor, Data General, Texas Instrument, and Digital Equipment Corporation.

For complete information, use the Reader Service Card, or contact: Garry Manufacturing Co., 1010 Jersey Avenue, New Brunswick, N.J. 08902; telephone: 201-545-2424.

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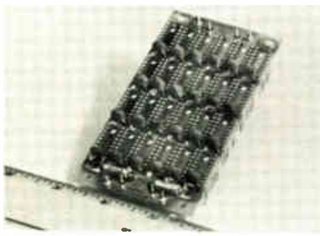


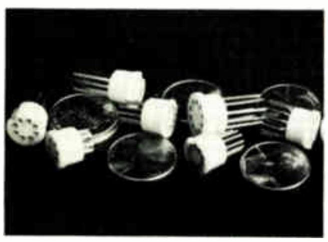
NEW BRUNSWICK, N.J. —A full range of Modular IC Pluggable Packaging Assemblies is now available from Garry Manufacturing Co., of New Brunswick, N.J.

These new packaging assemblies are available with both committed and noncommitted power and ground places. All come equipped with low-frequency tantalum capacitors as standard, and with options of 0.01 uf ceramic capacitors adjacent to each IC position.

The boards are UL approved and are manufactured with one, three, or six groups of either 20 or 24 IC positions, for 14- or 16-pin ICs. One-, two-, or three-level wire-wrappable posts are available, as are a variety of platings including various thicknesses of gold or tin over nickel.

For complete information, use the Reader Service Card, or contact: Garry Manufacturing Co., 1010 Jersey Avenue New Brunswick, N.J. 08902; telephone: 201-545-2424.

PACKAGING SOCKETS FOR TO-5 ICs NOW AVAILABLE IN VARIOUS STYLES



NEW BRUNSWICK, N.J. —Packaging sockets that will permit TO-5 case size ICc to plug into a variety of circuits are now available from Garry Manufacturing Co. of New Brunswick, N.J. The new sockets come with 6, 8, 10, and 12 contacts, in standard pin circles They accept leads from 0.016 to 0.019 in. diameter.

The sockets are available with terminals for most applications: printed circuit, turret, solder pot, and wire-wrappable. Bodies of the sockets are resilient Teflon for snug push fit into circuit-board mounting holes. Terminal sleeves are brass, contacts are beryllium copper, plating is gold over nickel. Sockets are also available with recessed contacts, for "hot case" applications.

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That s the goal. And we're closer to it than any other supplier. Our cumulative history across ten million RAMs is 0.03%/1000 hrs; and the current rate is a whacking 0.01%/1000 hrs. But don't call and berate your old supplier; it takes a mountain of RAM production to build the expertise that makes a reliability figure like ours possible. Don't call him at all. Call us.

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Our new 200 NSec 4K RAM, the AMS 7280, is 4096 bits of N-Channel fully decoded MOS RAM. TTL compatible. Single MOS clock. A big, fast mover for high performance memories and priced to move fast, too. 22 pins. Plastic or ceramic packaging. And available now, in production quantities.

How we got there.

Systematically. As the largest independent memory producer in the world, we've worked through every conceivable RAM related problem (and some inconceivable ones as well!). No one else in the RAM business has even a fraction of our systems experience. Testing alone is a science in its own right; and we have perfected it. And now the benefits are yours...in advanced components, in technology, in device performance, in production, in testing, and above all, in systematic thinking.

Information is free.

The price of our parts is competitive; the price of our RAM Roster and Technical Papers is Free. Our "Ram Cost Analysis," a systematic review of all of the elements of cost in building RAM memories, is the definitive work on the topic. Write today for an inside look at the quiet giant in the RAM industry. Or call collect for immediate requirements. Advanced Memory Systems, 1275 Hammerwood Avenue, Sunnyvale, California 94086. (408) 734-4330. Ask for OEM Marketing.

All the popular numbers in 1976.

Dynamic RAMs	16 pin	18 pin	22 pin
1024X1		6002 (150ns)	6002 (150ns)
2048X1			6003 (350ns)
4096X1	7005* (250ns) Mostek 4096	7270 (200ns) Nat'l 5270	7280 (200ns) Intel 2107B TI4060 Nat'l 5280
		7271** (240ns) TTL Clock	7281** (240ns) TTL Clock
8192X1			7008* (125ns) Pin for pin with 7280
Static RAMs			
256X4	7112* (250ns) Intel 2112	7111* (250ns) Intel 2111	7101* (250ns) Intel 2101
1024X1			7001 (60ns)
2048X1			7003* (60ns)

*Second quarter 1976 Access time in ( )
**Second half 1976

AMS Advanced Memory Systems.
Memories with a future.

People

He's out to make National *the* microprocessor company

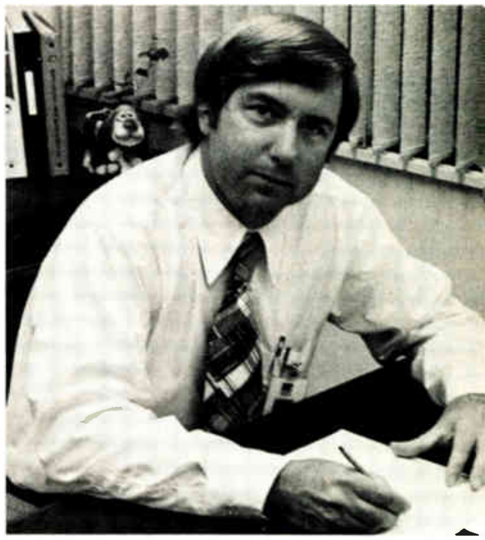
William D. Baker last month became group director of microprocessor operations at National Semiconductor Corp. for a good reason. "National is planning the broadest line of microprocessor products and systems in the industry," Baker declares, and directing the effort is where the 37-year-old engineering graduate of Stanford University wants to be.

"I see my job as bringing all the various present and future microprocessor efforts together under one cohesive strategy," he says. And, although he doesn't say so directly, he implies that the aim in the coming months is for National, in Santa Clara, Calif., to become the leading microprocessor company with 4-, 8-, and 16-bit units in p-channel and n-channel MOS, as well as bipolar.

Only a month. The soft-spoken Baker comes to National after less than a month as vice president of nearby Monolithic Memories Inc.'s year-old MOS operations. Before that, he was vice president and general manager of Fairchild Camera & Instrument Corp.'s bipolar-memory division, where he was instrumental in moving the company's Isoplanar process out of the laboratory and into the marketplace in the highly successful 1-kilobit bipolar random-access memory, the 93415.

It is precisely such technical expertise, built up over the last 15 years at Fairchild, Raytheon Semiconductor, General Microelectronics, and HP Associates, that National was looking for when it hired Baker. So was his reputation for being able to market a product successfully after translation from prototype to production.

Startup. Explaining his quick departure, Baker says, "When I really looked closely at my new job at Monolithic Memories, I found it was essentially another startup job—specifically to put a bipolar house into the MOS business," Baker explains. "That made it my fifth startup in 15 years. I wanted a little more out of my career than that."



Myriads. William D. Baker will exploit MOS and bipolar technologies at National.

At National, he'll be responsible for design, fabrication, testing, and marketing of all microprocessor components, printed-circuit boards, and systems. In addition, he will set up a fabrication area devoted exclusively to microprocessors. Systems will get a lot of attention.

"As with memory-system chips, systems are a great way to sell components," Baker points out. Also under assessment, he says, are possible agreements with other companies.

Roux: changing electronics in France

Substantial changes are coming this year in France's computer and telecommunications industries. And Ambroise Roux, the rotund, cigar-puffing 54-year-old head of Compagnie Générale d'Electricité, the largest electrical-electronics group in France, has a lot to do with them happening.

The application and exploitation of foreign technology, anathema during the proud years of Gen. Charles de Gaulle, now has official blessing under a new industrial policy that Valéry Giscard d'Estaing's government has worked out over the last year or so. As a result, industrial and political planners are not as interested in bankrolling

Gallic touch. Roux wants computer and telecommunications products that sell well.

prestige items like the supersonic Concorde airliner. As Roux puts it, "We want products that sell well in world markets."

Computer viability. In the computer industry, Roux has managed to persuade Europe-oriented Giscard to pull out of the money-losing French-Dutch-German Unidata combine. "It was never viable," Roux maintains. Instead, he has coaxed Honeywell Information Systems to sell control of its subsidiary Honeywell-Bull, to CGE and has won the government's support to merge it with the Compagnie Internationale pour L'Informatique, the French "national" computer firm. Details of the merger still have to be settled, but with CII-Honeywell-Bull, Roux hopes to build a French-controlled company that can compete worldwide.

In telephones, Roux has convinced the French government that space-division electronic switching is needed to bring the overloaded French telephone system up to date in a hurry. He doesn't want to wait for the time-division technology championed by the Post and Telecommunications Ministry's research agency. Roux proposes to bring in foreign technology—Japanese or Swedish—to build big space-division urban exchanges. In the meantime, Roux is maneuvering to forge an integrated telecommunications industry that can market switching, transmission, and components hardware worldwide.

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AL: 3 — 18 V, −55 to +125°C, ceramic package
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CP: 3 — 18 V, −40 to +85°C, plastic package
L: Limited voltage range, limited temp. range, ceramic package
P: Limited voltage range, limited temp. range, plastic package
EFL: 3 — 18 V, −55 to +125°C, ceramic package
FL: 3 — 18 V, −40 to +85°C, ceramic package
FP: 3 — 18 V, −40 to +85°C, plastic package
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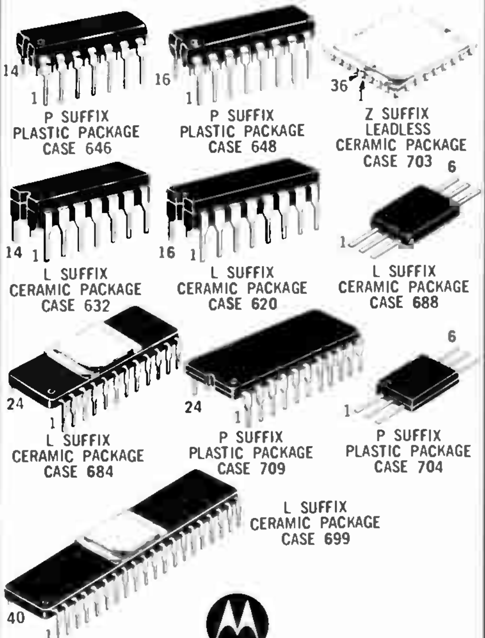
Chips are available for all McMOS types. Consult your Motorola Sales Office or Authorized Motorola Distributor.



PART NUMBER	FUNCTION	SUFFIX	PINS	SECOND SOURCED
MC14000	Dual 3-Input NDR Gate/Inverter	AL,CL,CP	14	✓
MC14001	Quad 2-Input NDR Gate	AL,CL,CP	14	✓
MC14001B	Quad 2-Input NDR Gate	AL,CL,CP	14	✓
MC14002	Dual 4-Input NDR Gate	AL,CL,CP	14	✓
MC14002B	Dual 4-Input NDR Gate	AL,CL,CP	14	✓
MC14006B	18-Bit Static Shift Register	AL,CL,CP	14	✓
MC14007	Dual Pair and Inverter	AL,CL,CP	14	✓
MC14008B	4-Bit Full Adder	AL,CL,CP	16	✓
MC14011	Quad 2-Input NAND Gate	AL,CL,CP	14	✓
MC14011B	Quad 2-Input NAND Gate	AL,CL,CP	14	✓
MC14012	Dual 4-Input NAND Gate	AL,CL,CP	14	✓
MC14012B	Dual 4-Input NAND Gate	AL,CL,CP	14	✓
MC14013B	Dual D Flip-Flop	AL,CL,CP	14	✓
MC14014B	8-Bit Static Shift Register	AL,CL,CP	16	✓
MC14015B	Dual 4-Bit Static Shift Register	AL,CL,CP	16	✓
MC14016	Quad Analog Switch/Quad Multiplexer	AL,CL,CP	14	✓
MC14017B	Decade Counter/Divider	AL,CL,CP	16	✓
MC14018B*	Presettable Divide-by-N Counter	AL,CL,CP	16	✓
MC14020B	14-Bit Binary Counter	AL,CL,CP	16	✓
MC14021B	8-Bit Static Shift Register	AL,CL,CP	16	✓
MC14022B	Dctal Counter/Divider	AL,CL,CP	16	✓
MC14023	Triple 3-Input NAND Gate	AL,CL,CP	14	✓
MC14023B	Triple 3-Input NAND Gate	AL,CL,CP	14	✓
MC14024B	Seven Stage Ripple Counter	AL,CL,CP	14	✓
MC14025	Triple 3-Input NOR Gate	AL,CL,CP	14	✓
MC14025B	Triple 3-Input NDR Gate	AL,CL,CP	14	✓
MC14027B	Dual J-K Flip-Flop	AL,CL,CP	16	✓
MC14028B	BCD-to-Decimal Decoder	AL,CL,CP	16	✓
MC14032B	Triple Serial Adder (Positive)	AL,CL,CP	16	✓
MC14034B	8-Bit Universal Bus Register	AL,CL,CP	24	✓
MC14035B	4-Stage Shift Register	AL,CL,CP	16	✓
MC14038B	Triple Serial Adder (Negative)	AL,CL,CP	16	✓
MC14040B	12-Bit Binary Counter	AL,CL,CP	16	✓
MC14042B	Quad Latch	AL,CL,CP	16	✓
MC14043B	Quad NOR R-S Latch	AL,CL,CP	16	✓
MC14044B	Quad NAND R-S Latch	AL,CL,CP	16	✓
MC14046B	Phase-Locked Loop	AL,CL,CP	16	✓
MC14049B	Hex Inverter/Buffer	AL,CL,CP	16	✓
MC14050B	Hex Buffer	AL,CL,CP	16	✓
MC14051	8-Channel Analog Multiplexer	AL,CL,CP	16	✓
MC14052	Dual 4-Channel Analog Multiplexer	AL,CL,CP	16	✓
MC14053	Triple 2-Channel Analog Multiplexer	AL,CL,CP	16	✓
MC14066	Quad Bilateral Switch	AL,CL,CP	14	✓
MC14068B	8-Input NAND Gate	AL,CL,CP	14	✓
MC14069B	Hex Inverter	AL,CL,CP	14	✓
MC14070B	Quad Exclusive-DR Gate	AL,CL,CP	14	✓
MC14071	Quad 2-Input DR Gate	AL,CL,CP	14	✓
MC14071B	Quad 2-Input DR Gate	AL,CL,CP	14	✓
MC14072B	Dual 4-Input DR Gate	AL,CL,CP	14	✓
MC14073B	Triple 3-Input AND Gate	AL,CL,CP	14	✓
MC14075B	Triple 3-Input DR Gate	AL,CL,CP	14	✓
MC14076B	Quad D-Type Register	AL,CL,CP	16	✓
MC14077B	Quad Exclusive-NOR Gate	AL,CL,CP	14	✓
MC14078B	8-Input NDR Gate	AL,CL,CP	14	✓
MC14081	Quad 2-Input AND Gate	AL,CL,CP	14	✓
MC14081B	Quad 2-Input AND Gate	AL,CL,CP	14	✓
MC14082B	Dual 4-Input AND Gate	AL,CL,CP	14	✓
MC14160B	Decade Counter (Asynchronous Clear)	AL,CL,CP	16	✓
MC14161B	Binary Counter (Asynchronous Clear)	AL,CL,CP	16	✓
MC14162B	Decade Counter (Synchronous Clear)	AL,CL,CP	16	✓
MC14163B	Binary Counter (Synchronous Clear)	AL,CL,CP	16	✓
MC14174B	Hex D Flip-Flop	AL,CL,CP	16	✓
MC14175B	Quad D Flip-Flop	AL,CL,CP	16	✓
MC14194B	4-Bit Universal Shift Register	AL,CL,CP	16	✓
MC14408	Binary-to-Phone Pulse Converter	L,P	16	
MC14409	Binary-to-Phone Pulse Converter	L,P	16	
MC14410	2-of-8 Tone Encoder	L,P	16	
MC14411	Bit-Rate Frequency Generator	L,P	24	
MC14412	Universal Low-Speed Modem	FL,VL	16	

PART NUMBER	FUNCTION	SUFFIX	PINS	SECOND SOURCED
MC14415	Quad Precision Timer/Driver	EFL,FL, FP,EVL, VL,VP	16	
MC14419	2-of-8 Keypad-to-Binary Encoder	L,P	16	
MC14431*	12-Bit A/D Converter	L,P	24	
MC14433*	3½ Digit A/D Converter	L,P	24	
MC14435	3½ Digit A/D Logic Subsystem	EFL,FL, FP,EVL, VL,VP	16	
MC14440	LCD Watch/Clock Circuit	L,Z	40,36	
MC14450	Oscillator 2^6 Divider	L,P	6	
MC14451	Dscillator/Divider/Buffer	L,P	16	
MC14490	Hex Contact Bounce Eliminator	EFL,FL, FP,EVL, VL,VP	16	
MC14501	Triple Gate	AL,CL,CP	16	
MC14502B	Strobed Hex Inverter/Buffer	AL,CL,CP	16	✓
MC14503B	Hex Bus Driver	AL,CL,CP	16	✓
MCM14505	64 x 1 Static RAM	AL,CL,CP	14	
MC14506B	Dual Expandable A.D.I. Gate	AL,CL,CP	16	✓
MC14507	Quad Exclusive-DR Gate	AL,CL,CP	14	
MC14508B	Dual 4-Bit Latch	AL,CL,CP	24	✓
MC14510B	BCD Up/Down Counter	AL,CL,CP	16	✓
MC14511B	BCD-to-7 Segment Latch/Decoder/Driver	AL,CL,CP	16	✓
MC14512	8-Channel Data Selector	AL,CL,CP	16	✓
MC14514B	4/16 Line Decoder (High)	AL,CL,CP	24	✓
MC14515B	4/16 Line Decoder (Low)	AL,CL,CP	24	✓
MC14516B	Binary Up/Down Counter	AL,CL,CP	16	✓
MC14517B	Dual 64-Bit Static Shift Register	AL,CL,CP	16	
MC14518B	Dual BCD Up Counter	AL,CL,CP	16	✓
MC14519B	4-Bit AND/OR Selector	AL,CL,CP	16	✓
MC14520B	Dual Binary Up Counter	AL,CL,CP	16	✓
MC14521B	24-Stage Frequency Divider	AL,CL,CP	16	
MC14522B	BCD Divide-by-N Counter	AL,CL,CP	16	✓
MCM14524	256 x 4 Read Only Memory	AL,CL,CP	16	
MC14526B	Binary Divide-by-N Counter	AL,CL,CP	16	✓
MC14527B	BCD Rate Multiplier	AL,CL,CP	16	✓
MC14528B	Dual Monostable Multivibrator	AL,CL,CP	16	✓
MC14529	Dual 4-Channel Multiplexer	AL,CL,CP	16	✓
MC14530B	Dual 5-Input Majority Logic Gate	AL,CL,CP	16	
MC14531B	12-Bit Parity Tree	AL,CL,CP	16	✓
MC14532B	8-Bit Priority Encoder	AL,CL,CP	16	✓
MC14534B	Real Time 5-Decade Counter	AL,CL,CP	24	
MC14536B	Programmable Timer	AL,CL,CP	16	
MCM14537	256 x 1 Static RAM	AL,CL,CP	16	
MC14538B*	Dual Precision Monostable Multivibrator	AL,CL,CP	16	
MC14539B	Dual 4-Channel Digital Mixer	AL,CL,CP	16	
MC14541B	Oscillator-Timer	AL,CL,CP	14	
MC14543B	BCD-to-7 Segment Latch/Decoder/Driver	AL,CL,CP	16	✓
MC14549B	Successive Approximation Register	AL,CL,CP	16	
MCM14552	64 x 4 Static RAM	AL,CL,CP	24	
MC14553B	3-Digit BCD Counter	AL,CL,CP	16	
MC14554B	2 x 2-Bit Parallel Binary Multiplier	AL,CL,CP	16	
MC14555B	Dual Binary 1-of-4 Decoder	AL,CL,CP	16	✓
MC14556B	Dual Binary 1-of-4 Decoder (Inv)	AL,CL,CP	16	✓
MC14557B	1-to-64-Bit Shift Register	AL,CL,CP	16	
MC14558B	BCD-to-7 Segment Decoder	AL,CL,CP	16	
MC14559B	Successive Approximation Register	AL,CL,CP	16	
MC14560B	NBCD Adder	AL,CL,CP	16	
MC14561B	9's Complementer	AL,CL,CP	14	
MC14562B	128-Bit Static Shift Register	AL,CL,CP	14	
MC14566B	Industrial Time Base Generator	AL,CL,CP	16	
MC14568B*	Phase Comparator/Programmable Counter	AL,CL,CP	16	
MC14569B*	Dual Programmable BCD/Binary Counter	AL,CL,CP	16	
MC14572	Hex Gate	AL,CL,CP	16	
MC14580B	4 x 4 Multiport Register	AL,CL,CP	24	✓
MC14581B	4-Bit Arithmetic Logic Unit	AL,CL,CP	24	✓
MC14582B	Look-Ahead Carry Block	AL,CL,CP	16	✓
MC14583B	Dual Schmitt Trigger	AL,CL,CP	16	
MC14585B	4-Bit Magnitude Comparator	AL,CL,CP	16	✓

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A dozen I/O and peripheral circuits that attach directly to the system bus make it easy to add on peripheral subsystems. Five are programmable LSI devices. These operate under software control in numerous modes and can often replace up to 75—or more—TTL packages each. For example, the Intel 8251 Programmable Communication Interface provides virtually all serial data transmission protocols in use today, including IBM Bi-Sync. Or, for easy interface to printers, keyboards, displays and motor drives, use the 8255 Programmable Peripheral Interface. You can reorganize its 24 I/O lines with software as your needs change.

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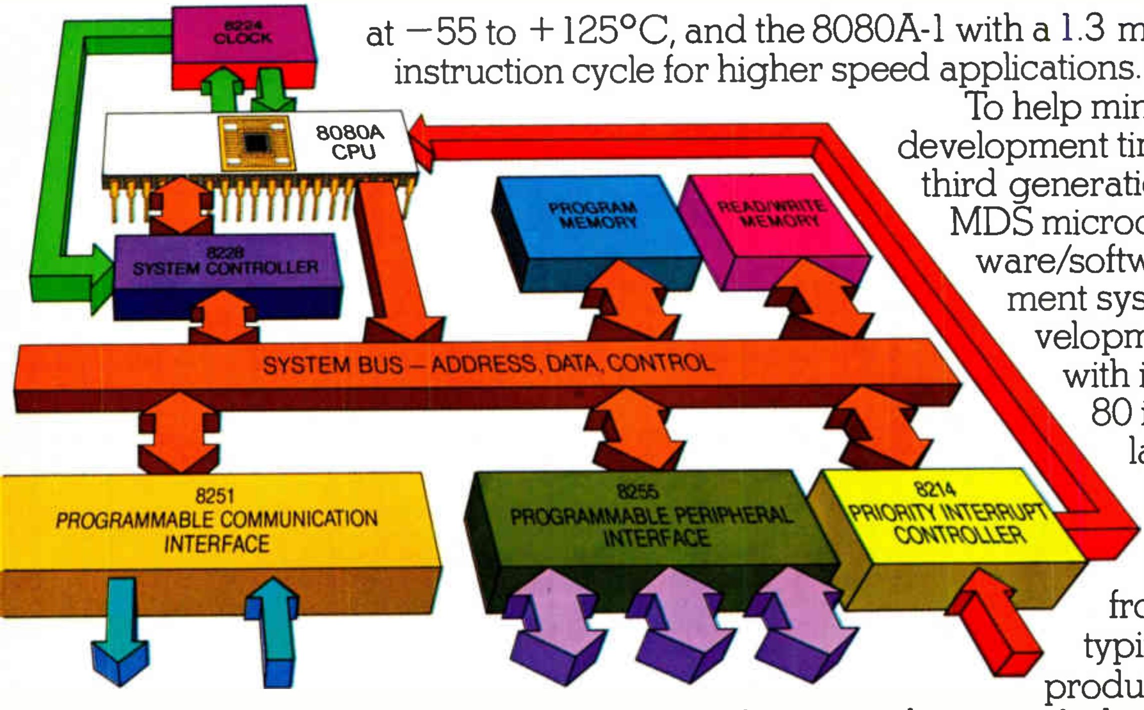
MCS-80™ SYSTEM COMPONENTS

	Part No.	Description
CPU GROUP	8080A 8224 8228	8-bit Central Processor Unit, 2μs cycle Clock Generator System Controller
CPU OPTIONS	8080A-1 8080A-2 M8080A	1.3μs cycle 1.5μs cycle 2 μsec cycle (−55 to +125°C)
I/O	8212 8251 8255	8-bit I/O Port (15 mA drive) Programmable Communication Interface Programmable Peripheral Interface
PERIPHERALS	8205 8210 8214 8216 8226 8222 8253* 8257* 8259*	1 out of 8 Binary Decoder Dynamic RAM Driver (8107B) Priority Interrupt Control Unit Bidirectional Bus Driver, Non-Inverting (50 mA) Bidirectional Bus Driver, Inverting (50 mA) Dynamic RAM Refresh Controller (8107B) Programmable Interval Timer Programmable DMA Controller Programmable Interrupt Controller
PROMs	8604 8702A 8704 8708	512 x 8, 100 ns 256 x 8 Erasable, 1.3 μs 512 x 8 Erasable, 450 ns 1K x 8 Erasable, 450 ns
ROMs	8302 8308 8316A	256 x 8, 1μs 1K x 8, 450 ns 2K x 8, 850 ns
RAMs	5101 8101A-4 8102A-6 8102A-4 8107B 8111A-4	256 x 4 Static CMOS, 650 ns 256 x 4 Static, 450 ns 1K x 1 Static, 650 ns 1K x 1 Static, 450 ns 4K x 1 Dynamic, 420 ns 256 x 4 Static Common I/O, 450 ns

*Available 1st quarter 1976.

se the Intel 8080 system uters combined.



at −55 to +125°C, and the 8080A-1 with a 1.3 microsecond instruction cycle for higher speed applications.

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In addition to the software packages in the development system, three cross product software packages are available on magnetic tape and on several time share networks. The Intel 8080 system is also supported by the industry's largest user's library, training courses and field applications assistance.

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Meetings

Wincon—Aerospace & Electronic Systems Winter Convention, IEEE, Sheraton-Universal Hotel, North Hollywood, Calif., Feb. 18–20.

ISSCC-76, International Solid State Circuits Conference, IEEE, Sheraton Hotel, Philadelphia, Feb. 18–20.

Compcon Spring, IEEE, Jack Tar Hotel, San Francisco, Feb. 24–26.

Nepcon '76 West and International Microelectronics Exhibition, Industrial & Scientific Conference Management Inc. (Chicago, Ill.), Anaheim Convention Center, Anaheim, Calif., Feb. 24–26.

Federal DP Expo '76 (Data Processing in the Federal Government), Instrumentation Fair Inc. (Beltsville, Md.), Sheraton Park Hotel, Washington, D.C., March 2–3.

ACM Conference on Programing Micro/Minicomputers, Association for Computing Machinery (New York, N.Y.), Delta Towers Hotel, New Orleans, March 4–6.

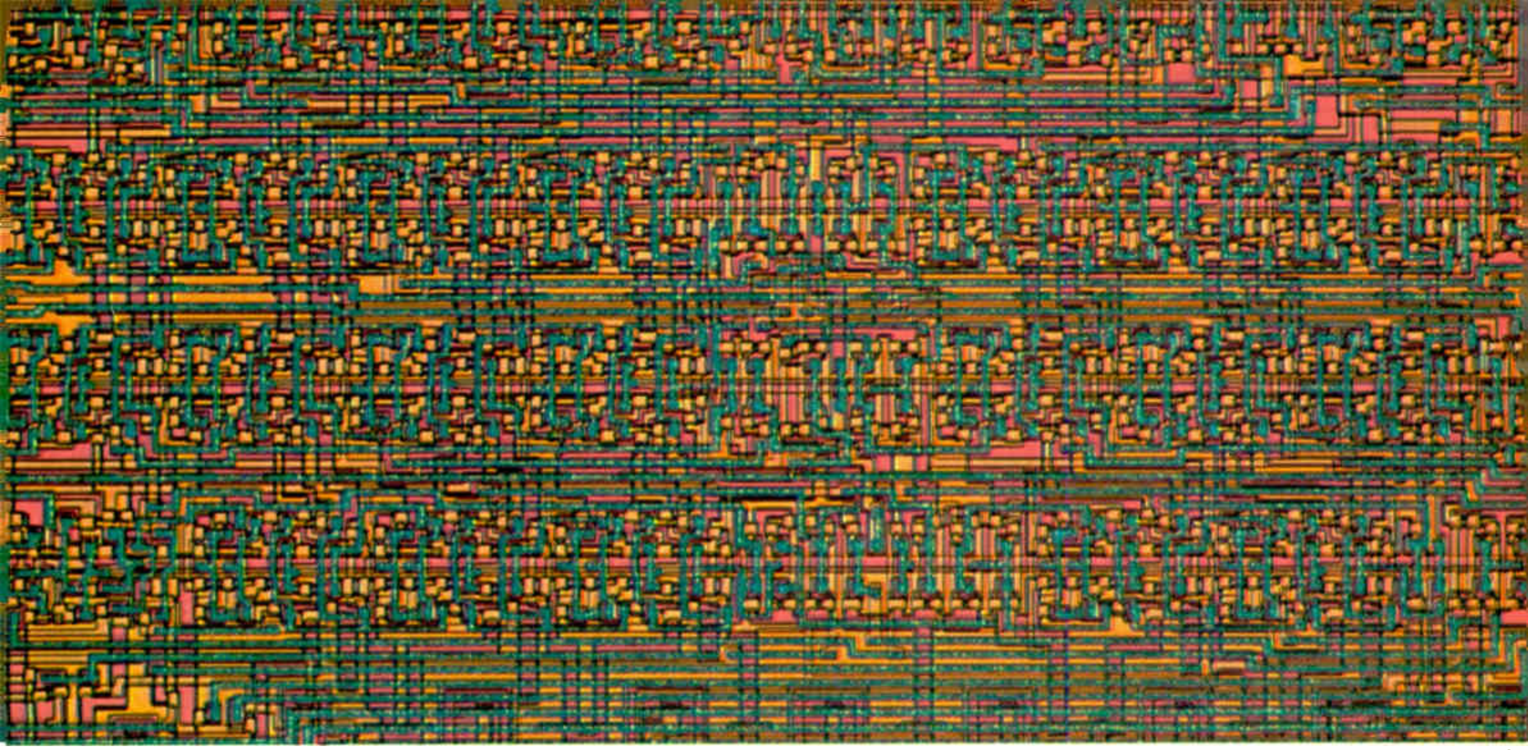
IECI '76—Industrial Applications of Microprocessors, Process Measurement, and Failure Mode Analysis, IEEE, Sheraton Hotel, Philadelphia, March 8–10.

International Zurich Seminar on Digital Communications, IEEE, Swiss Federal Institute of Technology, Zurich, Switzerland, March 9–11.

Control of Power Systems Conference, IEEE, Ramada Central Convention Inn, Oklahoma City, Okla., March 10–12.

Ninth Annual Simulation Symposium, Society for Computer Simulation, Association for Computing Machinery, and IEEE, Sheraton-Tampa Motor Hotel, Tampa, Fla., March 17–19.

Eleventh Annual Meeting of Association for the Advancement of Medical Instrumentation, AAMI (Arlington, Va.), Regency-Hyatt House, Atlanta, Ga., March 21–25.



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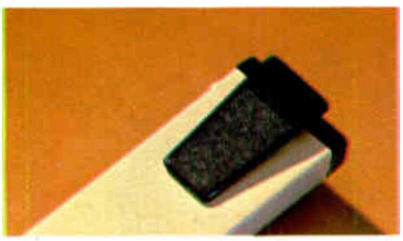

If you're trying to stay competitive with a new product—or by improving an existing product—now is the time to consider a custom development program. We can help you fully understand the very significant benefits of custom LSI.

Performance Bonuses That Cost You Nothing! The real beauty of LSI is the way it gives you product design options. Once you've made the decision to develop a custom circuit, there's usually plenty of silicon real estate to use in new and different ways. You can add performance features to the product at virtually no incremental cost. In short, your product can be much better than a competitor's non-LSI equivalent.

High Yields Mean Lower Costs. Our LSI processes are production-proven. We get high yields. Which means you get lower chip costs. Plus, LSI reduces product assembly costs. Your product should have a competitive edge in price.

Low Power Consumption. LSI circuits conserve power. Their low current requirements often permit portability which would otherwise not be possible. Energy conservation in itself is a product advantage these days.

Small Size is Only Part of the Story. Product miniaturization is the most obvious advantage of LSI. Even if small size seems unnecessary for your application, don't overlook the numerous other benefits that we've been talking about.

Our knowledge of the custom LSI approach can help you to evaluate these potential benefits in your own terms. LSI may be exactly what you need. If it isn't, we'll be the first to tell you.

Contact us today for some of the answers. We'll be happy to send you some fact-filled material that describes actual ways we've helped other companies prosper through the use of custom LSI.

If you'd like to talk specifics, call Dan Hauer or Rich Koury at (408) 247-5350.

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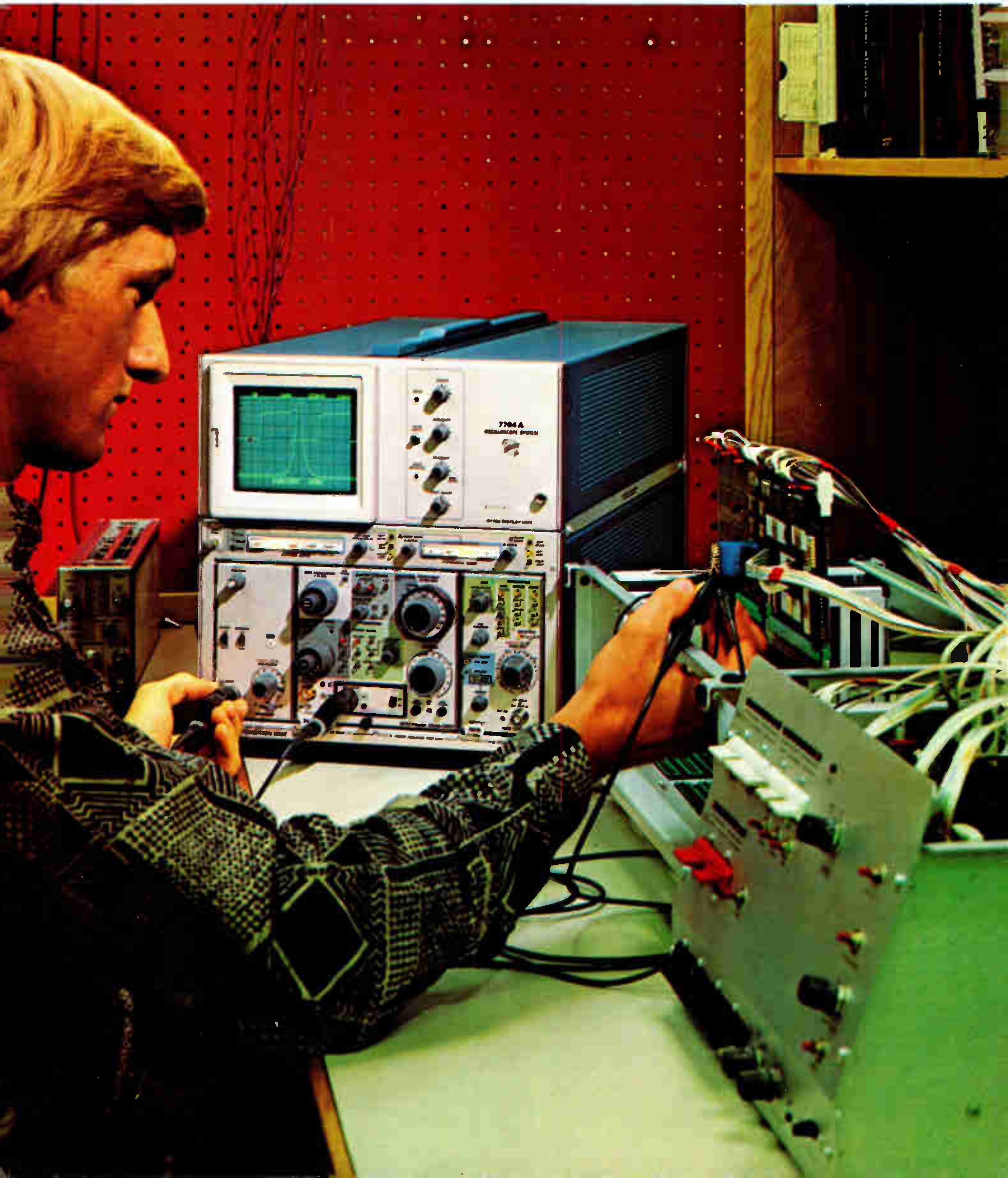
Pick a Plug-in Scope For



Measurement Flexibility

In today's research and development laboratory your work calls for measurements of many different types. For example, in integrated circuit development you most likely need a real time oscilloscope, a sampling oscilloscope, a digital multimeter and digital counters/timers. Or in communications R & D you probably use a spectrum analyzer in addition to all of or most of the instruments mentioned for the IC lab.

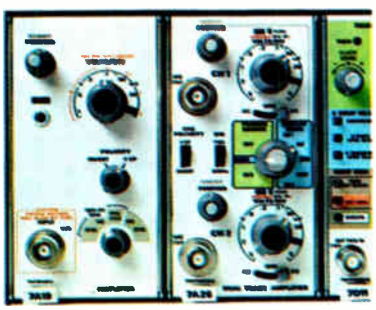
However, your space limitations, budget considerations and operator's convenience all demand that you get the maximum measurement flexibility from each instrument package.

The TEKTRONIX 7000 Series offers just such flexibility in a system of laboratory instruments. Its flexibility allows you to tailor the oscilloscope-based measurement system that most closely fits your needs. You select the measurement parameters—and the measurement techniques—you need, and combine them into interchangeable mainframe and plug-in packages.

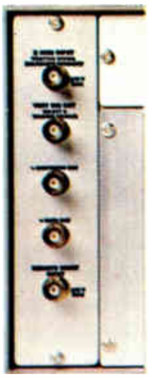
Here are a few examples of 7000-Series flexibility:

BANDWIDTH RANGE—Whether your maximum bandwidth requirement is less than 100 MHz or up to 500 MHz (or even up to 1 GHz in some circumstances), there is a mainframe to match your needs. Eleven amplifier plug-ins and five time-base plug-ins (with sweep speeds to 0.5 ns per division) further help you tailor your system.

INPUT CHANNELS—Whether you need only one trace or up to four inputs, you can select just as many amplifier channels as you need.

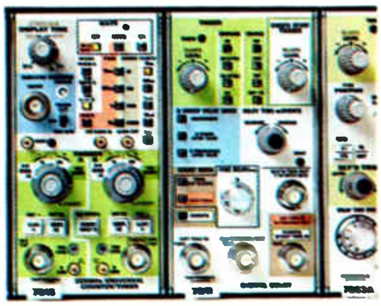


SIGNAL ACCESS—For special signal access or processing such as Z-axis input, sweep gate and sawtooth, remote reset input, or vertical amplifier output, the interconnection scheme of the plug-in scope gives you convenient access points.



DELAYED SWEEPS—For complex measurements requiring delayed sweep, the 7000 Series offers both analog and digital techniques for delaying and expanding sweeps.

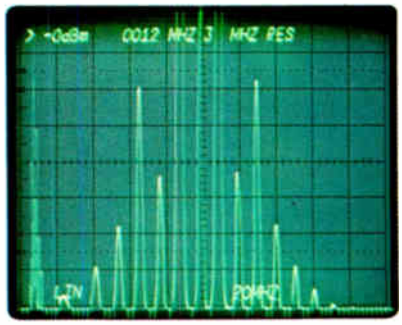
DIGITAL ACCURACY—For digital accuracy to measure selected portions of complex signals, Tektronix's unique capability to interconnect an oscilloscope with digital voltmeters, counters, and timers provides convenient measurement solutions.



DIFFERENTIAL INPUTS—When common mode noise inhibits your measurement of low level signals, differential amplifiers (with up to 100,000:1 cmrr) can be included in your system.

SAMPLING DISPLAYS—When you need to display high-frequency repetitive signals, sampling plug-ins give your system up to 14 GHz of equivalent bandwidth.

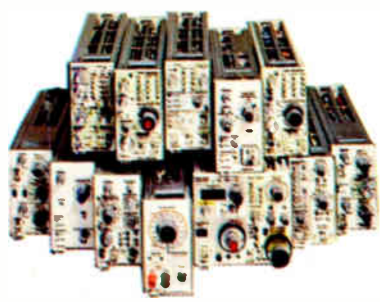
What about your measurement needs that are outside the realm of a conventional oscilloscope, such as spectrum analysis, curve tracing and rapid scan spectrometry? Three spectrum analyzer plug-ins handle up to 1.8 GHz with 30 Hz resolution. A curve tracer plug-in displays dynamic parameters of devices up to one-half watt. And the RSS plug-in scans 400 nm in just 4 ms. (RSS available in U. S. only.)



One more thing about 7000-Series flexibility: with a choice of more than 30 plug-ins and 17 mainframes in a continually evolving family, you can be assured of a long-lived oscilloscope system that will continue to accommodate your needs.

For a catalog describing all the 7000-Series instrument mainframes and their plug-ins, call your local Tektronix Field Engineer, or write Tektronix, Inc., P.O. Box 500, Beaverton, OR. 97077. In Europe, write Tektronix Limited, P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.

**The 7000 Series . . .
more than an oscilloscope**



Microprocessor designer uses time domain plug-ins (7A16A/7B70) and spectrum analyzer plug-in (7L5) to give a combined display on 7704A mainframe. While the oscilloscope displays pulse characteristics, the spectrum analyzer identifies clock jitter down to 10 Hz and measures system noise directly in dB.

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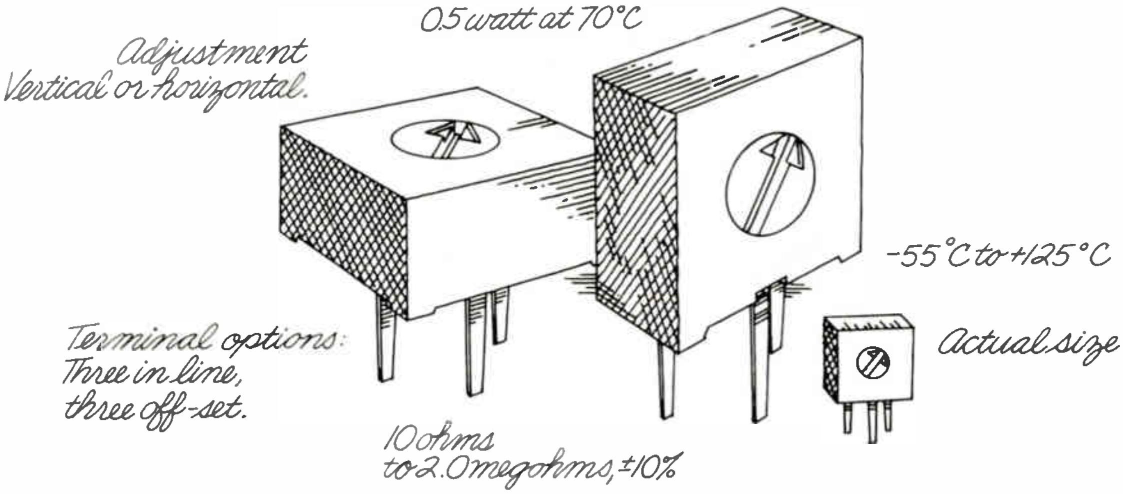

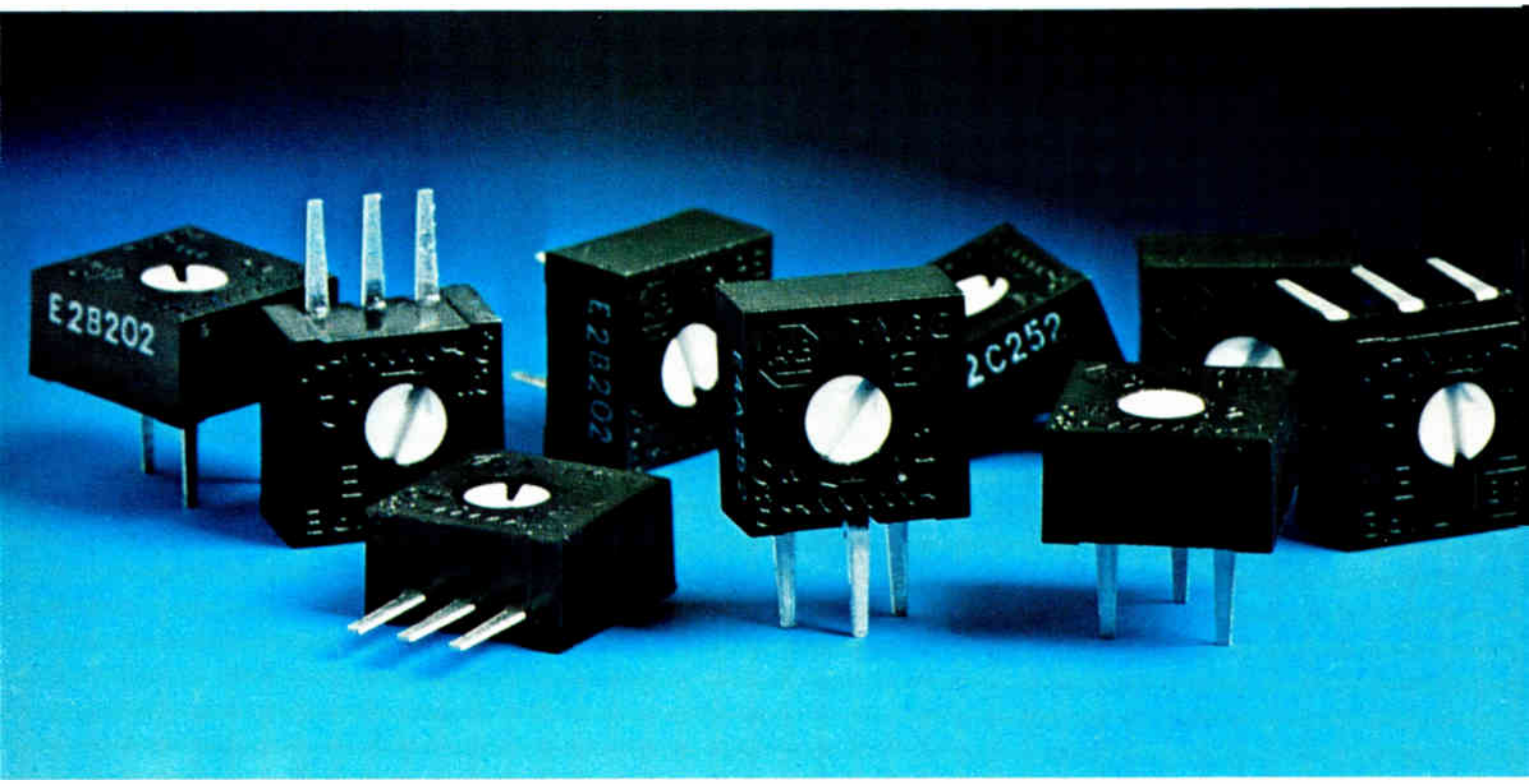

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EC108

Electronics newsletter

Intel, TI face off with 16-k RAMs . . .

The heat is building in the random-access-memory market. The two leaders in 4,096-bit RAM sales, Texas Instruments Inc. and Intel Corp., estimated by industry observers to be shipping 300,000-plus 4-k units per month, are face to face in the 16,384-bit battle. Both will be supplying 16-k sample parts to principal customers during the first quarter—Intel began just before Christmas, TI is now building capacity for customer sampling.

More important, both suppliers are serious about being in production this year. Although the industry didn't expect to see much 16-k activity before 1977 [*Electronics*, Dec. 25, 1975, p. 29], Jack Carsten, Intel's director of marketing says, **"We'll have some real production as early as the second quarter,** with volumes building throughout the second half of the year. We plan a formal announcement in April, plus stock on distributors' shelves, data sheets, and prices."

TI will be there as well. Charles Clough, vice president of marketing, asserts, "We've been characterizing our first 16-k parts since Christmas. The results have been so encouraging that we anticipate some volume production as early as the first half of this year." **On the question of TI pinouts, it's now official. "Expect a variety of pinouts of the 16-k RAM from TI," says Clough.** That can only mean both 22-pin and 16-pin devices.

. . . but users are skeptical about quality

Potential users, however, appear to be skeptical about the promise to deliver 16,384-bit RAMs in volume in 1976. One minicomputer engineer says, **"I'd be happy to get my hands on some good 4-k chips."**

A spokesman for a mainframe manufacturer says, "It took three years before we began to see 4-k parts in volume." However, he adds, "Anyone who overlooks the potential of the 16-k RAM is going to find him or herself in a fall-back position."

Intersil close to pair of second-source deals

Look for Intersil Inc. to usher in the new year with two new second-source arrangements. The Cupertino, Calif.-based firm is negotiating with Signetics Corp. on the latter's **double-diffused MOS (D-MOS) field-effect-transistor family.** Despite the high switching speed and low capacitance advantages of D-MOS FETs, customers have been reluctant to commit to them in large quantities because of the lack of a viable second source.

On a more informal basis, Intersil is set to go into production with its version of National Semiconductor Corp.'s hot new family of bi-FET op amps, the LF155 [*Electronics*, Aug. 7, p. 143], which uses ion implantation to combine JFETs and bipolar transistors on the same chip. Both moves will go far to beef up Intersil's discrete-transistor operation.

Electronics newsletter

Central control business booming for Hughes

Demand for automatic central control systems—like those used in aircraft entertainment units—is picking up rapidly. In fact, one supplier, Hughes Aircraft Co., says it is "being inundated" with requests to bid. The product seems to be one "whose time has come," observes William M. Mueller, who manages Hughes' Microelectronic Products division in Newport Beach, Calif.

The division recently was awarded a contract for more than $1 million by the Smithsonian Institution **to build an automatic central control system for the new National Air and Space Museum.** In designing the system, Hughes will apply the advanced multiplexing techniques used in the passenger entertainment and service systems it builds for the Douglas DC-10 jet.It also will use two-way coaxial-cable communication capabilities, already developed for industrial uses, to handle interactive signal distribution between a control-room processor and 375 remote terminals throughout the museum. Interactive monitor and control data will be transmitted at a million bits per second.

GE to market CB equipment

General Electric, **the first major U.S. consumer-electronics company to compete in the citizens' band marketplace,** plans to have products ready for retail distribution late this June. Initially, GE will offer three mobile transceivers and one base-station model from overseas makers. The equipment will be inspected and quality-controlled by GE's buying office in Japan before being distributed in the U.S.

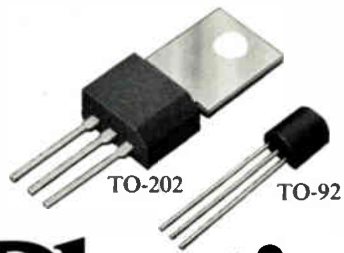
Singer offering Business Machines division for sale

Now that Singer Co. has decided to drop out of the business-machines market, it's actively seeking a buyer for its Business Machines division. It took company president Joseph B. Flavin less than a month to decide that the money-losing division is more of a burden on the company than he is willing to carry. Flavin, the former Xerox Corp. executive vice president, who took over for Donald P. Kircher as chairman and president of Singer on Dec. 1, says **Singer will phase out the business machines and some other money-losing nonelectronic operations** at an estimated write-off of $400 million, $325 million of which is attributable to business machines. The write-off, one of the biggest in recent business history, will be taken during the next 12 months.

"Until today," says a company spokesman, "no serious talks were held with anyone regarding the possible sale of the Business Machines division. But now we're very aggressively looking for a buyer." Although Flavin describes the division's potential as "still significant," he says that its continued operations are "no longer consistent with Singer's over-all and financial resources."

George R. Cogar, who was named president of the Business Machines division only last October, will retain that post, at least until the phase-out is completed. Meanwhile, the division's marketing activities will be streamlined, says a Singer spokesman who adds that the company plans to support its existing customer base for at least five years.

The first packaging breakthrough in power transistors for switching power supplies:



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Introducing the Unitrode Plastic Power Switching Transistors.

The first series of power transistors in plastic designed and characterized for maximum efficiency at 20KHz and above in switching power supplies up to 300W.

This means that now, for the first time, you can get high-priced power switching performance in a low-cost package.

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BV_{CEO}	60-100V	60-100V	100-300V	100-300V	200-500V
I_c	5A	2A	2A	.5A	.1A
$t_f(\mu s)$ typical	.2	.2	.5	.2	1.0
$t_s(\mu s)$ typical	.3	.2	.5	.2	.25

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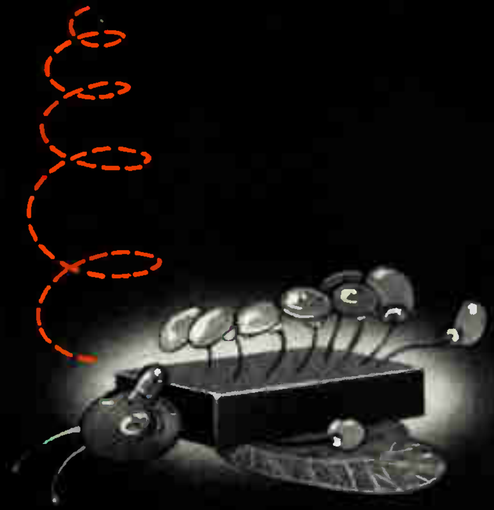

The most common bug in dual in-line program (D.I.P.) switches has been the problem of open circuits.

Contamination resulted from solder, flux, solvents, etc. penetrating the switch during installation. Licon solved the problem with proper sealing. Nine Licon® Standard D.I.P. Switch Models feature ultrasonically welded base and cover junctions, and molded-in terminals. Only .280 inches high, these 2 through 10 pole, low profile Standard Switches are also available with a "pop-top" cover providing complete protection top and bottom during installation. After cleaning, the "pop-top" cover removes easily to program switch functions. Snap-on dust covers are available for after-installation use.

The slide detent mechanism provides positive feel actuation into both open and closed positions, and locks into the desired position preventing accidental actuation. The slide actuators also provide quick visual indication of open and closed positions.

Designed with .100 x .300 inch terminal spacings, the switches insert easily and save space on PC boards.

Licon has expanded the typical D.I.P. switch line to include four unique L.E.D. lighted pushbutton models for press-to-test applications.

Call your local Licon rep or distributor for full details or call or write us for a catalog. Licon, A Division of Illinois Tool Works Inc., 6615 W. Irving Park Road, Chicago, Illinois 60634. Phone: (312) 282-4040. TWX 910-221-0275.

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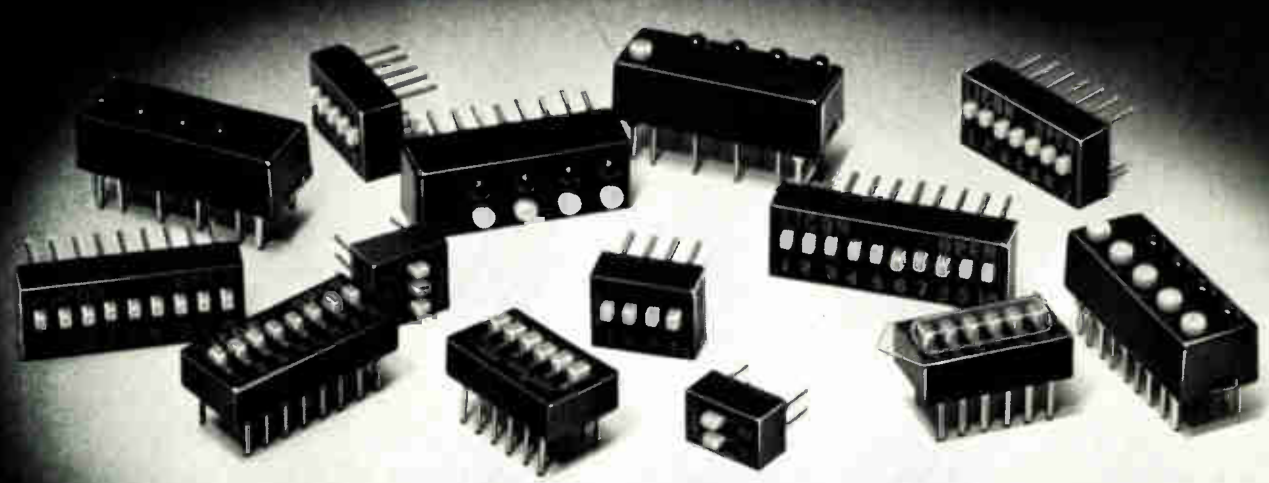


Circle 30 on reader service card

C-MOS synthesizer allows single crystal to tune CB radios

Digital device from Hughes provides up to 1,021 frequency channels with phase-locked-loop detector

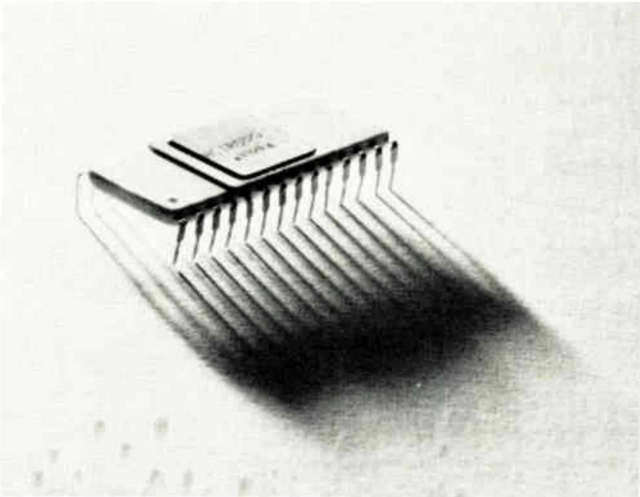
As the market for citizens' band radios starts booming, set manufacturers are getting a look at a complementary-MOS frequency synthesizer on a single chip with an unusual feature—it needs only one crystal oscillator to tune to any CB channel.

The Microelectronics Products division of Hughes Aircraft Co. developed the HCTR0320 frequency synthesizer for the CB market. It is the first commercial frequency synthesizer to be integrated on a C-MOS chip, asserts William S. Eckess, marketing manager for the Hughes division, in Newport Beach, Calif.

The ion-implanted 28-pin C-MOS chip extracts as many as 1,021 frequency channels from the single crystal. In contrast, conventional sets require as many as 14 separate crystals to obtain the 23 citizens' band channels now allocated in the 27-megahertz band by the Federal Communications Commission. Two undisclosed manufacturers are already checking out the chip on breadboards, Eckess says.

In the face of pending FCC changes in CB frequencies, the Hughes chip's flexibility should give it a big edge. Because of the burgeoning popularity of CB radio, the FCC will definitely expand the number of channels from 23 to 50 or 54—it's still pondering which. However, regardless of the decision, the new chip won't need to be changed because it covers 1,021 channels.

Price to fall. Although Eckess pegs the cost advantage of eliminating 13 crystals at "moderate," the advantage of using the LSI chip should increase markedly in the future as volume production drives costs down. The frequency synthesizer is now priced at $8.50 in quantities of 1,000. In contrast, present CB-radio crystals are about 70 cents each.



Eckess emphasizes that the Hughes synthesizer cannot be meaningfully compared with other commercial frequency synthesizers. Built for communications systems by companies such as Hewlett-Packard and Fluke to operate over broad frequency ranges, these synthesizers sell for a minimum of $2,300 each, switch at millisecond speed, and attain accuracy to 0.01 hertz.

In CB radio, where switching speed is relatively unimportant, the synthesizer will be only as accurate as the crystal reference. The programable divider in the synthesizer is similar to one on a C-MOS chip that Hughes builds for its digital-watch modules. Hughes, probably the leading supplier of such modules, shipped more than a million units in 1975.

Functions. The C-MOS chip contains four separate functions: the programable divider, an adder/decoder, a Schmitt-trigger input-signal conditioner, and phase/frequency detector. A phase-locked loop maintains a voltage-controlled oscillator's frequency at a selectable multiple from a reference frequency set by a 5-megahertz crystal.

The phase-locked-loop detector selects the desired channel by combining the divider-output frequency with the reference frequency from the crystal and adjusts the signal input for nearly zero phase error. The detector operates from 50 hertz to 500 kilohertz. The synthesizer operates from a 5-volt power supply, dissipates 5 milliwatts, and is compatible with transistor-transistor logic.

Design of the chip was begun several years ago by another Hughes division, Ground Systems, in Fullerton, Calif., for a Marine Corps program for the man-portable AN/PRC-104 manpack radios scheduled for field tests in the spring. The radio, which weighs less than 15 pounds, uses three of the frequency-synthesizer chips logarithmically to tune to the set's 280,000 channels. □

Solid state

Symbols cut cost of design by computer

Long experience in the computer-aided design of custom integrated circuits gave American Microsystems Inc. the idea for a technique that could reduce cost and design time on standard LSI products by 30% to 50%. At the same time, Andrew Prophet, director of computer-aided design for the Santa Clara, Calif., MOS manufacturer, claims that it will not add much to the final die size, the former major drawback to using CAD in standard circuits.

What AMI designers have developed, says Prophet, is a technique called symbolic layout of integrated circuits, or SLIC, a method of laying out circuits using symbols with meaningful topological characteristics. For example, an "X" stands for a transistor, "–" for a diffusion mask, "O" for a contact mask, "1" for a metal mask, and "+" for a metal/diffusion crossover. And as the number of masks and hence the complexity of the process increase, so does the number of symbols.

In the traditional approach to CAD, developed within the past eight years, a computer designs a circuit by shuffling a library of 200 or so standard structures. But though development time and costs shrink drastically, the IC chips that result are usually twice as large as those done by hand.

Masking. "Assume we are working with a simple four-mask process—for the diffusion, gate oxide, contact cutout, and metal," says Prophet. "With just the few symbols defined so far, SLIC makes it quite simple to lay out simple circuits."

The circuit layout is drawn on gridded paper or Mylar in accordance with two simple rules. First, if symbols are on adjacent grids, then the topologies they represent are assumed to be connected. Second, if symbols are not on adjacent grids, they are not connected, and their separation meets or exceeds minimum mask layout rules. The symbols can be drawn freehand—a much faster process than drawing the topologies in detail (see figure).

Simplicity. Consequently, sophisticated computer-aided-design programs do not have to deal directly with the topological complexities until the actual masks are needed, Prophet points out. "We can use a printer for the layouts instead of a costly plotter," he says. "Rather than supporting a $180,000 CAD graphics system, the same job can be done with a printer and a few peripherals for a tenth the cost."

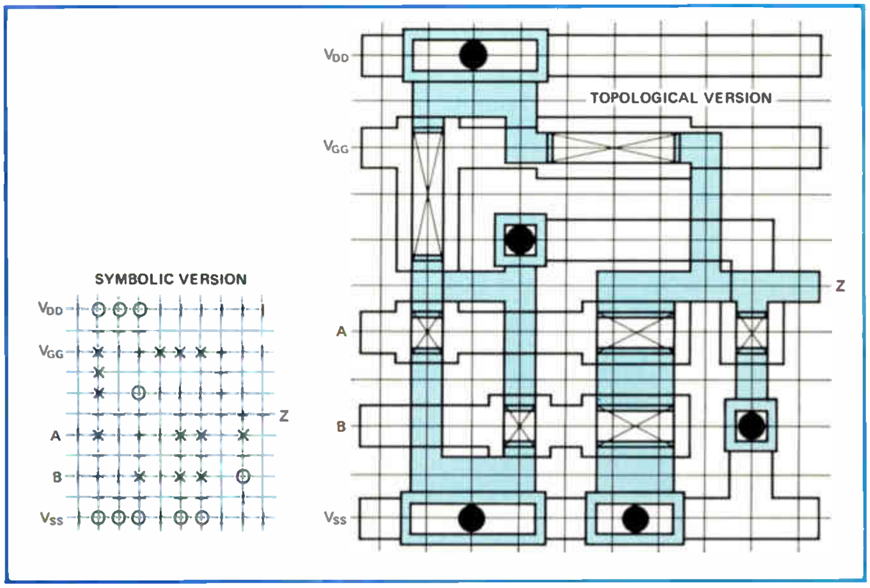
Design-rule checking is reduced to checking symbol-to-symbol location. Continuity and logic verification, plus resistance and capacitance checking, are reduced to tracing predefined gates, capacitors and interconnects. Error correction, circuit modification, and area relocation take only minutes at a remote terminal connected to a central computer, says Prophet. This contrasts with days for either the traditional CAD or hand-drawn approaches.

"Applying SLIC to our custom programs, we've found that the time from drawing to mask generation can be cut 50% with half the manpower effort and half the cost," says Gibson. "Also, the circuits have very few design or logic errors."

In its p-channel MOS circuits, says Prophet, chips made by SLIC are only 3% to 5% larger than the hand-drawn approach. "And this differential resulted only because the SLIC technique had to be retrofitted, as it were, to the p-MOS process," he says. "In our n-channel MOS, complementary-MOS and advanced MOS programs that involve V-groove fabricating techniques, the SLIC parameters are being built into the process. The result should be virtually no size differential, and possibly even an improvement." □

Bell Earoms are nonvolatile

Semiconductor memories have two drawbacks that have prevented more widespread use in certain kinds of equipment: they're volatile, losing their data when power goes off, and they can't be erased and reprogramed electrically. These limitations restrict their use in such



Slick. AMI's designers have reduced device development time 30-50% using symbols instead of actual topological circuit features. Several equivalents are shown above.

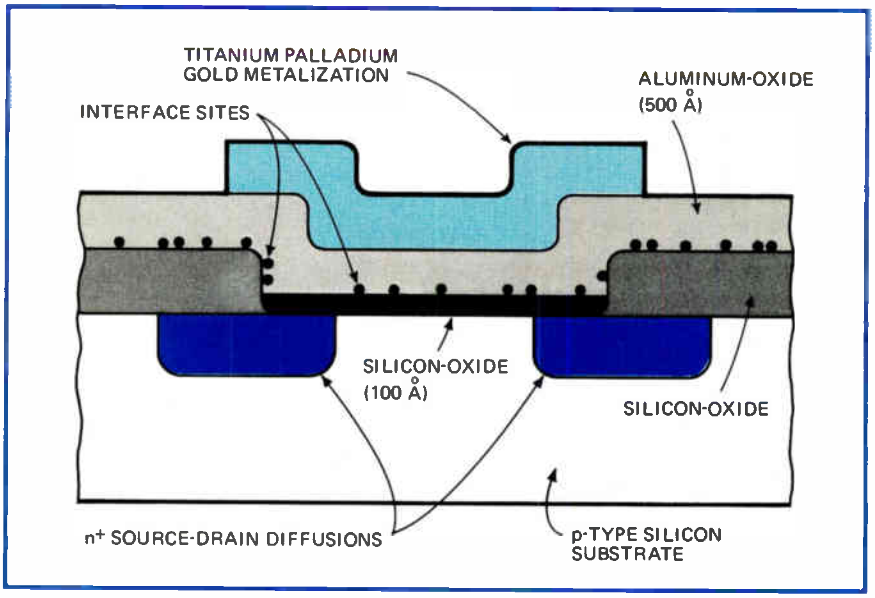
hardware as point-of-sale terminals, telecommunications equipment and remote data-acquisition and sensing systems, where program control is stored in read-only memories. Now, though, thanks to a thick-oxide technique developed at Bell Laboratories, highly reliable electrically alterable read-only memories (Earoms) can be built that perform as well as conventional programable ROMs and can be manufactured at no increase in cost.

The thick-oxide technique was developed at the Murray Hill, N.J. facility under George Smith, semiconductor device supervisor. Researchers have built Earom structures which, based on simulations, can store a charge without power for 200 years at 100°C.

Designers of computer main memories don't have to be overly concerned with volatility or alterability because backup power is plentiful and data is stored in random access memories anyway. But designers of terminal and terminal-like equipment demand ROMs that can be repeatedly erased and reprogramed electrically, and which don't require expensive battery backup systems.

The problem has been that permanent semiconductor storage mechanisms, usually using a nitride layer or MNOS structure, were generally unreliable because thin oxides (20 angstroms) were required at the nitride interface so that carriers move in and out of the storage medium at reasonable voltages (20-40 V). But thin oxides also allowed unwanted migration out of the storage medium, causing unreliable, short-lived operation.

That's why Bell researchers switched to the thick oxide. Their early devices can be operated (written or erased) in less than 0.1 microsecond at 40 volts, or less than 1 millisecond at 25V, and can be cycled (written and erased and written again) more than 1 million times. What's more, the memory cells are extremely compact for programable ROM designs: they measure 40 by 20 microns, or a little over 1 mil². This means that 1-K, 2-K, and 4-K Earoms are feasible.



Tungsten trick. In Bell Labs Earom, interface sites created by doping the silicon dioxide gate oxide with tungsten permit use of thick oxides that reduce gate voltage, speed operation and enhance nonvolatility. Cells have been written and erased in less than 0.1 microsecond.

Tungsten. The key to the Bell structure is doping with tungsten in the silicon dioxide beneath the storage medium (see figure). Here, Bell designers used aluminum oxide (Al_2O_3) for the storage medium instead of the more conventional silicon nitride, but nitride could just as easily have been used. In any case, because tungsten acts as a strong carrier acceptor in the oxide, it was possible to go to an oxide layer 4 to 5 times thicker (up to 100 angstroms) than conventional 20 angstrom-thick oxide layers. The advantage is reliable devices, long storage time, fast operation, and low-cost manufacturing.

The thick oxide prevents unwanted charge migration from the storage medium back through the oxide, a mechanism that degrades storage lifetimes in conventional designs. At the same time, the tungsten-doped structure overcomes the need for high read/write voltages that would be required with undoped thick oxides. Thus, working with test structures having 500-angstrom-thick layers for storage and 100-angstrom-thick SiO_2 layers, Bell engineers have been able to write and erase cells in less than 0.1 microsecond at 40V. □

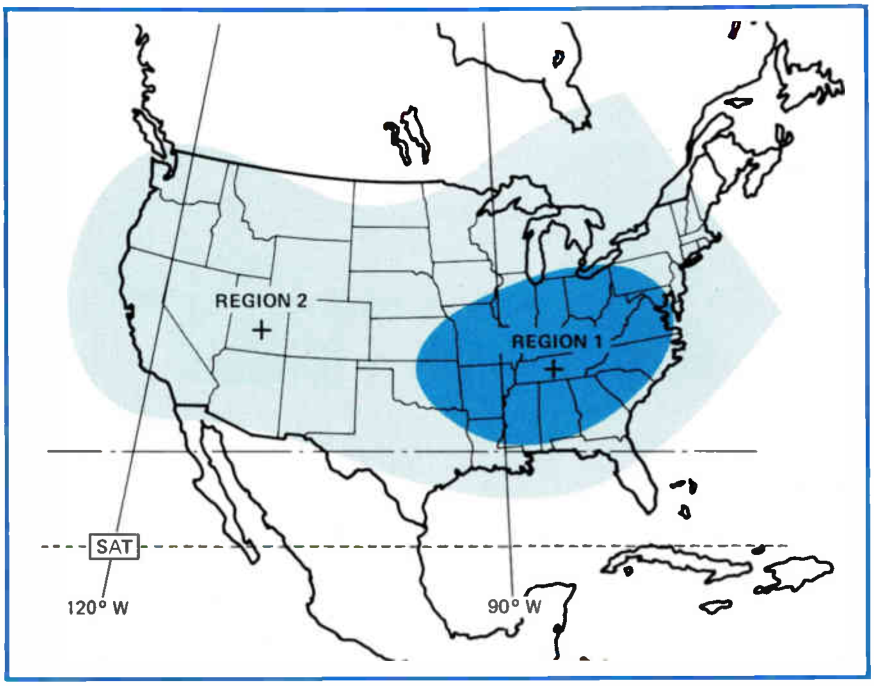
Communications

SBS domsat will use 12–14 GHz

The first major challenge to American Telephone & Telegraph's dominance of domestic communications emerged in detail at year's end, when Satellite Business Systems revealed plans for a new end-to-end domestic communications satellite system to become operational in August 1979.

SBS, the new name for the restructured CML Satellite Corp., detailed its proposal for a two-satellite system in a massive, five-volume filing with the Federal Communications Commission. Equal partners in the venture are newly formed subsidiaries of International Business Machines Corp., Comsat General Corp., and Aetna Life & Casualty Co. (see p. 52).

The long-anticipated filing by SBS, with headquarters in Washington, D.C., proposes that its digitized voice, image, and data system be the first to use the 12-to-14-gigahertz band rather than the 4-to-6-GHz of competing satellite systems [*Elec-*



Patterns. Areas to be covered by SBS show region 1, where 5-meter antennas will be used in earth stations; region 2 will mainly use 7-meter antennas.

tronics, Oct. 16, p. 49]. Moreover, SBS proposes to eliminate wherever possible any need to connect its earth stations to local customers over the telephone lines of AT&T affiliates and other carriers. Instead, it will install small, unattended earth stations on customer property.

Costs. To set up an operational system, SBS estimates, will cost $250 million, counting prior outlays of CML. The new company, which wants FCC approval of its plan by mid-year, breaks down its costs as $119 million for the space segment, including $59.5 million for two operational satellites and a spare; $24.7 million for the ground segment, including 37 ground stations to cost an estimated $474,000 each; plus another $106.9 million for systems development and in-house construction. That's $85 million more than the $165 million previously specified by the partners as their investment to develop the system.

In preparation for its operational system, SBS wants to build and test up to seven earth stations. It plans to use them with leased 4-to-6-GHz transponders on Westar, the Western Union domsat now operational. The pre-operational program will provide private-line communications for IBM.

SBS has already filed applications for the first two earth stations at IBM plants in Poughkeepsie, N.Y., and Los Gatos, Calif. The two stations will cost about $410,000 in electronics, to transmit at 6 GHz and receive at 4 GHz. The voice and data traffic will use a 70 megahertz i-f carrier modulated by a quaternary-phase-shift-keyed digital signal of 50 million bits per second.

In early 1978, when SBS will be testing modulation and access equipment at 4 and 6 GHz, prototype 12- and 14-GHz rf terminals are scheduled at Franklin Lakes, N.J., and Agoura, Calif. There SBS plans to locate its two satellite tracking, telemetry and command stations. For the tests, it will use remotely located satellite transponder simulators.

Satellites. As for the satellites themselves, SBS says each will have eight transponders, each with a useful bandwidth of 54 MHz that's capable of being shared via time-division multiple-access. By using a shaped-beam satellite antenna pattern, SBS says, it plans to concentrate satellite power over the eastern area of the country where traffic will be greatest and permit use of small 5-meter-diameter antennas. Elsewhere, to offset signal attenuation by heavy rainfall, larger 7-meter antennas supported by high-power amplifiers ranging from several hundred to 2 kilowatts will be used.

SBS says its system objective is to provide a total information capacity of 328 million bits per second per satellite using 41 million bits per second per transponder. However, the company has yet to determine whether its satellites will be three-axis or spin-stabilized. □

IBM seeks to bar Dataspeed tariff

Does the new hardware for AT&T's Dataspeed 40 terminal make it a computer or just another package of sophisticated communications gear? And by offering it, does AT&T violate the 1956 antitrust consent decree restricting it to furnishing common-carrier communications service? These were the hard questions put to the Federal Communications Commission just before Christmas by International Business Machines Corp. and the Computer and Business Equipment Manufacturers Association (CBEMA).

The FCC has yet to answer, of course, and it seems unlikely that the answers will come quickly. The questions arose out of what normally would be a routine FCC proceeding—AT&T's November filing for tariff changes to cover new Dataspeed 40 hardware. But the objections of IBM and CBEMA, which contend the Dataspeed 40 is a computer terminal and not subject to regulation, seem likely to force the FCC to delineate for the first time where communications services end and data-processing services begin.

Digital terminal. The AT&T tariff request covers a keyboard that can employ both upper and lower case, a cathode-ray-tube terminal, a printer, and controllers for a station cluster, a device cluster, and a mini-

What's new in solid state...

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Curves and data in the paper reveal the effects of environmental extremes on various packaging systems such as plastic, frit seal and the new Gold CHIP. They show accelerated life and thermal cycling tests with high MTTF figures. An important section compares predictable life data of TTL vs. COS/MOS: under the same ambient temperature, COS/MOS would have a better failure rate by a factor exceeding 20.

There's much more in this important document, ST-6418. We want you to have it, free. Contact your local RCA Solid State distributor. Or RCA.

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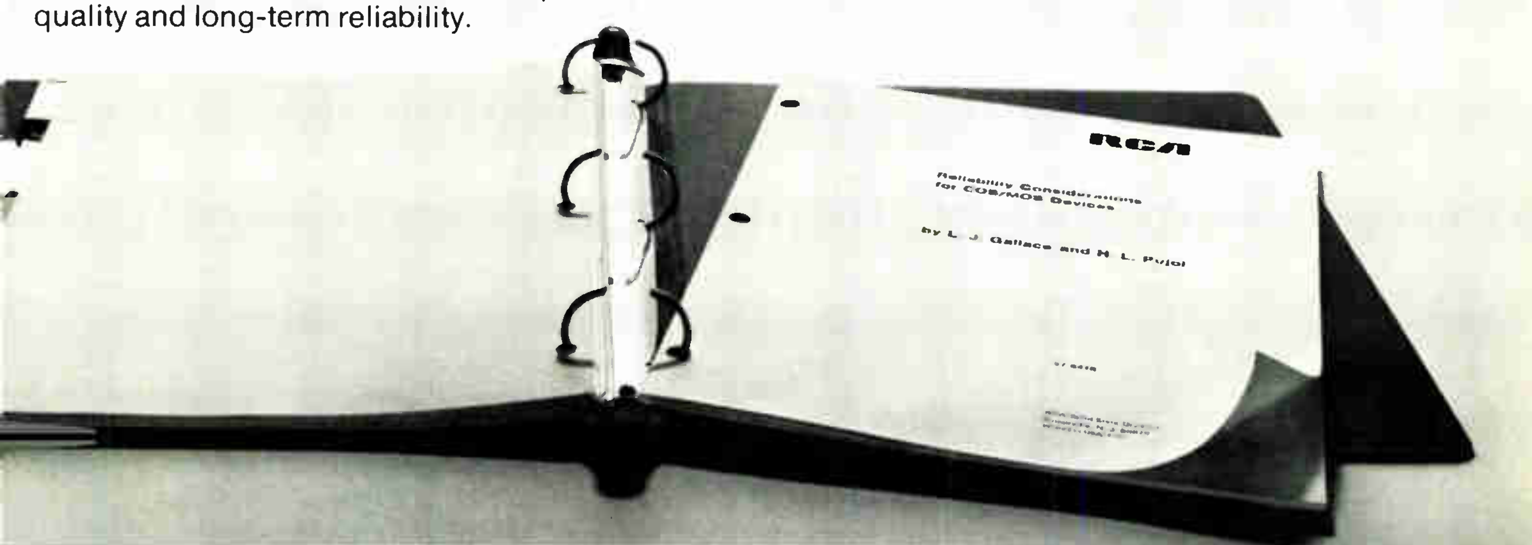
RCA



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Circle 35 on reader service card

cluster—all of which operate over private lines or with Dataphone digital service at 2,400 or 4,800 bits per second. IBM has urged rejection of the tariff changes by the FCC on the ground that "the Dataspeed 40 is data-processing equipment, which should be provided solely on an unregulated basis." CBEMA's petition for relief agrees in essence with IBM's, saying that the AT&T hardware "interacts with a customer's computer and becomes an integral part" of it during operation.

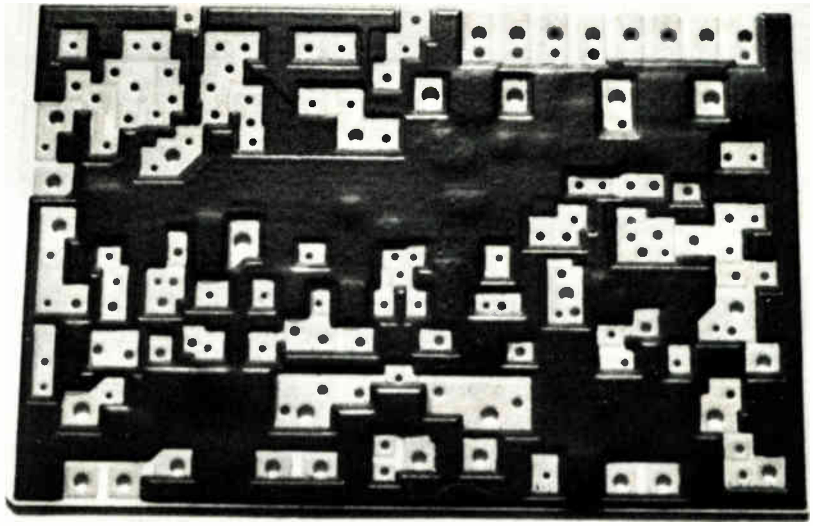
As for AT&T, a spokesman says it is studying the IBM challenge and will respond "later" to the FCC.

Fallback. If FCC fails to find that Dataspeed 40 is a data-processing device, then both IBM and CBEMA have a fallback position. They argue that the equipment is covered by the Commission's definition of a "hybrid service." Thus, FCC, they say, must reject the tariff because AT&T has failed to meet the hybrid-service rule that requires a complete description of the service be delivered to the commission 90 days before a tariff filing.

On the antitrust consent decree issue limiting AT&T to communications services, IBM believes the commission should ask for a Justice Department modification of the order if it finds that Dataspeed 40 is barred from being offered on an unregulated basis. By permitting AT&T to offer its hardware on an unregulated basis, IBM says the FCC "can ensure that potential users are offered the option of selecting the terminal equipment" of AT&T without the associated costs being borne by other users of AT&T's tariffed services, as they would be if Dataspeed 40 were in AT&T's rate base. □

Consumer

Varactor tuner has mass-market appeal



Packed. Besides containing 75 thick-film capacitors and resistors, this substrate will house all discrete components of a VHF varactor TV tuner.

For the last five years, varactor tuners have not been making much headway into U.S. television sets, primarily because of their cost—they add about $50 to the retail price of each set. But the advantages of varactor tuners—greater reliability and easier tuning than the electromechanical standby can deliver—have been well recognized. Now, Zenith Radio Corp., Chicago, the nation's largest color-TV manufacturer, has developed a lower-cost varactor unit that it may eventually apply in a big way.

Production inroads. This year, more than 70% of Zenith's color sets will have varactor tuners, predicts John Ma, section manager of rf systems at Zenith. The lower cost is achieved by combining two manufacturing techniques—thick-film hybrid circuitry for the very-high-frequency section and metal stamping of passive components and interconnections for the ultra-high-frequency portion.

Altogether, the vhf section fits on a 2-by-3-inch ceramic substrate and the uhf on a 1½-by-4-inch piece of metal. Material costs are reduced by 7% and labor costs by 34%, asserts Ma. However, Zenith is unwilling to talk about what the final cost to the consumer will be, although Ma says that costs cannot be matched by conventionally assembled circuitry.

The uhf portion can't be hybridized because no method exists for making satisfactory thick-film conductors or resistors at these frequencies. So Zenith is using stamped-metal construction for four tuned uhf circuits, including all inductance and capacitance trimmers for tuner tracking. Mechanical tolerances are easily controlled.

Instead of using a conventional printed-circuit board, the entire vhf portion is mounted on ceramic. The substrate has a mix of true thick-film capacitors and resistors plus discrete passive and active (transistors, varactors, diodes) components mounted on it.

Fabrication. Construction of the thick-film hybrid begins with firing palladium-silver conductors and base electrodes of the capacitors on an alumina substrate with predrilled holes. Next, a dielectric layer of barium titanate is dried over the electrodes, and this step is followed by a co-fired top layer of the palladium material. The capacitors are then passivated with fired glass, and cermet resistors are fired onto the substrate, laser-trimmed, and, except for external-component lands, coated with a solder resist.

At this point, standard discrete passive and active parts are inserted into the holes in the substrate and wave-soldered in place. This process eliminates the use of expensive chip resistors or capacitors normally used in thick-film hybrids.

Extensive environmental tests helped evaluate the reliability of the vhf tuner, Ma says. For example, What's new in solid state...

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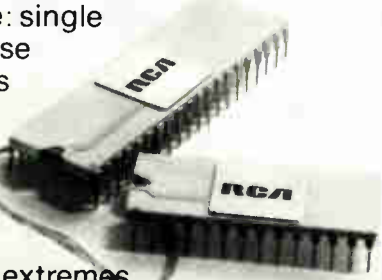

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RCA

RCA 1800. Low-cost approach to microprocessing.

Circle 37 on reader service card

substrates having only thick-film capacitors, resistors, and conductors were subjected to such tests as humidity load at 95% relative humidity and 40°C for 1,000 hours, heat load at 85°C, 60 volts dc for 1,000 hr, and five cycles of thermal shock. Failure rates of substrates and capacitors were extremely low, Ma reports. □

Components

Digital filter set costs under $200

Though digital filters far outrank their analog cousins in performance and flexibility, they do cost more—anywhere from $2,000 to $8,000 for a commercial, variable, multi-order programable unit. This, however, can be expected to change once Advanced Micro Devices Inc. of Sunnyvale, Calif., completes development of a three-chip MSI/LSI digital filter set that employs low-power Schottky bipolar technology.

Using various combinations of the three chips, says John Mick, AMD's manager of digital applications, a typical digital-filter function can be implemented for no more than $150 to $200. That's not much beyond the range of a comparable analog filter.

A digital filter works with digital samples of the input signal. Therefore, whereas analog-filter theory is based on linear differential equations, digital-filter theory is based on linear difference equations. And instead of operational amplifiers, capacitors, resistors, and inductors susceptible to temperature, load, component tolerance and aging, digital filters use less vulnerable digital adders, multipliers and shift-registers. By simply changing the digital filter's coefficients (usually stored in memories), any of the classical filter functions—Chebyshev, Bessel, Butterworth, and elliptic—in various pass modes can be realized using the same filter unit.

But this programability has in the past been offset by power considerations. To achieve the necessary 25–50-megahertz-per-bit sampling rates for most military and commercial applications, digital filters were implemented with standard SSI and MSI transistor-transistor logic with power dissipations on the order of 5 to 6 watts per filter section, says Mick. "Large-scale integration of digital filters has been attempted," he says, "using n-channel MOS technology. The filters that resulted were lower power, about 200 to 400 milliwatts per filter section, but could sample at rates up to only 1 megahertz per bit."

Using its low-power Schottky bipolar technology, AMD has developed an LSI digital filter that achieves a 30-MHz sample rate, but with power dissipations of only 1.6 W per filter section. It consists of three chips with the equivalent of 100 to 200 logic gates each: the AM25LS14, an 8-bit serial/parallel two's complement multiplier on a 97-by-137-mil chip; AM25LS15, a quad serial adder/subtracter on a 95-by-95-mil chip, and AM25LS22, an 8-bit serial/parallel register on a 96-by-112-mil chip. And depending on their configuration, the number of packages—and the amount of power—in a particular filter section is reduced anywhere from four to 10 times, Mick says.

Cell design. But what makes this possible is not so much the low-power Schottky process as the proprietary design of the serial-multiplier cell used in the AM25LS14. "In previous digital-filter multipliers operating on binary numbers," says Mick, "such operations were done in parallel, and the time to propagate a carry unit across the bits of a multiplicand increased as the word length increased."

In AMD's cell design, the multiplicands are taken in parallel, but the multipliers are taken in serial, one bit at a time. "In essence, the carry

News briefs

Leeds & Northrup drops a product line
Shrinking profits caused by increased competition is forcing Leeds & Northrup Co., North Wales, Pa., to drop its power-demand control systems line. Leeds & Northrup, ranked second in the business behind Pacific Technology Inc. of Renton, Wash., has seen the number of vendors quadruple since it entered the market. Honeywell and IBM recently began supplying the hardware, which turns off loads to avoid the surcharge levied by utilities when large users of power exceed the volume called for in their contracts.

AT&T, GTE get nod for joint domsat system
American Telephone & Telegraph Co., which supplies 85% of the nation's telephone service, and General Telephone & Electronics Corp., the largest independent telephone operating company in the U.S., have received Federal Communications Commission approval to develop a domestic communications satellite system. Scheduled for mid-1976 operation, the system will provide additional long-distance voice service throughout the 48 states and Hawaii. GTE Satellite Corp. will own and operate satellite earth stations in Southern California, Florida, and Hawaii. AT&T will own and operate stations near Chicago and in Pennsylvania, Georgia, and Northern California.

Laser plate-maker loses backer
Laser Graphic Systems, Sudbury, Mass., organized 5 years ago to develop and market its letterpress plate-making system, is closing its doors. Its financial backer, publishing-chain Gannett Co., decided to call in the company's loans. A spokesman for Laser Graphic says that, though the potential market for laser plate-making was huge, it failed to develop because companies were hesitant to make a major capital investment—typically $250,000 for a system that could handle a 50,000 circulation newspaper—for which there was only one source of supply.

Perhaps you've already heard about Sound Technology's 1700A Distortion Measuring System. It measures down to .002% total harmonic distortion just by pushing the "Distortion" button. No balancing or frequency juggling required. And it contains its own 10 Hz to 100 kHz push-button-controlled test source at the panel right.

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operation is done within the same cell rather than propagating it," explains Mick. "This is achieved by temporarily storing a carry or borrow bit in a flip-flop until after the partial product is formed and shifted one place towards the least significant bit. The carry or borrow bit is then reinserted in the same bit position into a full adder, which also accepts the next most significant bit from the previous operation and the multiplicand bit." □

Medical

Engineering program aids handicapped

Margaret Pfrommer is a receptionist for Northwestern University in Chicago. She answers phones, takes messages, makes plane reservations, and does some typing. But she's even more valuable as a research assistant for the school's rehabilitation engineering program. She evaluates assistance devices developed for the severely disabled. She's exceptionally qualified because she's a quadriplegic—paralyzed from the neck down by polio since 1956.

Pfrommer owes her vocation—indeed, her freedom—to aids developed by that program: an improved motorized wheelchair and a computer-based interactive system that allows her to answer a multiple-line business telephone, take messages on a tape recorder, dial phone numbers without help from an operator, and create text messages for printout, storage, or transmission by phone to another computer.

Microprocessor base. Though the system is now implemented on a Data General Nova 2/4 and associated peripherals, researchers are working on a system based on low-cost microprocessors. "The advent of the 'amateur' computer is really a boon to us," says Jay M. Kaplan, a research engineer in the Rehabilitation Engineer Program, which is administered by Northwestern's medical school. "We have no speed problem, and memory is getting cheaper, so we think a microprocessor should work." He'll be using a $420 Altair 680 microcomputer built around the Motorola MC6800 by MITS Inc., Albuquerque, N.M.

"The market for rehabilitation systems is generally small, so commercially available devices tend to be high-priced," he says.

For example, a hard-wired comfort and communications system designed by the group several years ago is now sold for $1,200 by Fidelity Electronics Ltd., Chicago. It will control up to eight appliances—such as typewriter, radio, television, electric bed and light—and can be used to answer the phone or dial the operator for placing outgoing calls.

"For less than $2,000, we think we could have a microprocessor-based communications and control system for a small business," Kaplan says. It would control eight machines, like its predecessor, but it could also be used for dialing numbers on a multiline business telephone. And, depending on the amount of memory used, it could have some page-storage capability for, say, creating a directory of frequently called phone numbers, he adds.

The Nova displays a list of initial selections on a cathode-ray tube; the cursor moves in response to "puffs" on a plastic straw, and a category is selected by "sipping" on the same straw, which is connected to a pair of diaphragm-type industrial pressure sensors, rated at 0.5 inch of water pressure.

For example, if "device operation" is selected, Kaplan explains, a new list of choices is presented. Devices can be turned on and off, or the telephone answered, with the same sip-and-puff scheme. The computer simply sends a binary-coded-decimal code to an interface board that determines the type of switch, such as momentary or latching, that activates light-emitting-diode-coupled photoresistors. The optically isolated output directly controls low-current dc peripherals, or the gate current of triacs employed for switching ac loads. Finally,

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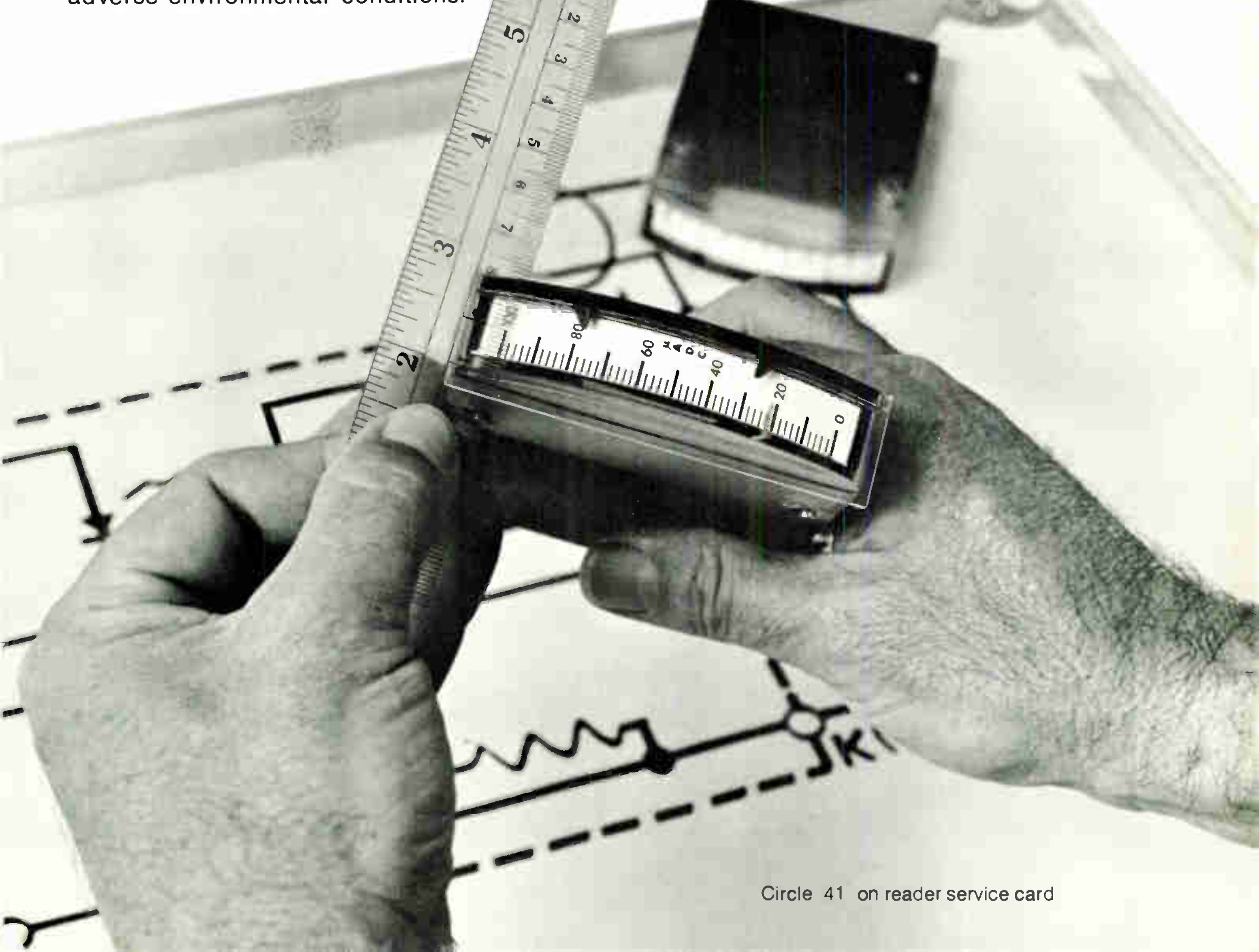

Circle 41 on reader service card

for building messages, the computer displays the alphabet in order of frequency of letter use; puffing starts the cursor scanning, and sipping selects the letter.

Voice control next. "The next big area will be voice-controlled systems," says Dudley S. Childress, the engineer who directs the rehabilitation-engineering program. Later this month, the school will begin evaluating a voice-operated terminal, also built around a Nova, by Scope Electronics, Reston, Va. "We can program it just like our current system, but with voice entry instead of sip and puff," he says. "Margaret now has serial access with some branching; with a voice terminal and parallel access, we'll greatly increase the amount of information she can handle." □

Photovoltaics

Energy agency wants 60-kW station

A central power station that generates 60 kilowatts of electricity from photovoltaic-cell arrays is one goal of the Energy Research and Development Administration's latest procurement in silicon solar cells.

A request for proposals released in December will jump 1976's annual industrial production to 130 kW from the 100 kW of terrestrial cell arrays produced last year for non-ERDA projects. Worth more than $2 million, the new RFP includes the first ERDA performance specifications for the fledgling industry. An earlier 46-kW procurement by NASA's Jet Propulsion Laboratory in Pasadena, Calif., also due early this year, will further boost industry sales [*Electronics*, Nov. 13, p. 40].

ERDA wants panels of weatherproofed cells with a 10-year design life, mounted on 4-by-4-foot structures. Each pane, or subarray, must have a minimum rated output of 60 watts at 60°C. "The subarrays will be subsequently assembled into complete solar arrays to obtain the total power required for demonstration applications. Applications under consideration include: the 60-kW power station for an existing power grid at a remote Defense Department base, 15-kW residential units, and under-1 kW remote sources for such things as battery chargers, an ERDA spokesman says.

40 kW reserved. Four firms at least are expected to win contracts, and JPL has reserved 40 kW of the procurement exclusively for small businesses, to stave off criticism that larger companies will dominate the field [*Electronics*, Oct. 2, p. 41]. To further spread the opportunities for industry participation, JPL may not buy more than 40 kW from a single supplier.

Some industry officials say that the requirement for testing the efficiency of the panels at 60°C will force some manufacturers to improve the performance characteristics of their photovoltaic cells.

"At 60°C, they're approaching the upper limit of photovoltaic efficiency. There is a degrading factor as temperature increases. It will make things rough for some of the vendors," notes a marketer for one of the smaller photovoltaic-cell producers. However, Gene Ralph, vice president of Spectrolab Inc., the Sylmar, Calif., subsidiary of Hughes Aircraft Co., says the new performance specs are "no problem."

JPL and ERDA are anxious to obtain the arrays soon, for standards-setting research at NASA's Lewis Research Center, Cleveland, and demonstration projects with the Defense Department. "Time is of the essence in the performance of this contract," ERDA notes. Detailed subarray designs are due within two months of a contract award, 20 preproduction subarray modules within three and one-half months, and production arrays within eight months of the award.

Industry officials report that the new procurements will not require additional production-line hardware. "If we get a big order, we might have to put on a second shift, at the most," notes a major producer. □

In the re

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The Model 134 measures DC volts, AC volts, DC current, AC current and resistance with a basic accuracy of ±.2% through a total of 22 range scales.

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Model 245 measures ACV (100μV to 500V RMS), DCV (100μV to 1000V), Resistance (100 milliohms to 20 Megohms), AC and DC current (1 microamp to 2 Amps). AC voltage/current response, 30 Hz to 50 kHz.

With over 25,000 in the field the Model 245 is still the only pocket-size portable 4½ digit DMM available.

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Model 1455 — all the virtues of a laboratory bench instrument with the added benefits of complete portability.

A five function multimeter featuring ½" high display, 100% overranging, measures 100 μV to 1000 VDC, 100 μV to 500 VAC; resistance 100 milliohms to 20 Megohms; AC and DC current 1 microamp to 2 amps. AC response, 30 Hz to 50 kHz.

Basic accuracy on DCV is ±0.02% reading ±0.01% f.s., ±1 digit for 6 months. Internal NiCd battery module and recharger.

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The same specifications and features as the Model 1455, except batteries.

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and still only, 4½ digit "pocket size" multimeter and the first 4½ digit portable/bench multimeter; the first 7 digit, 100 MHz, Counter/Timer under $300; and the first 5½ digit multimeter to break the $1000 price barrier.

And Data Precision isn't stopping there. We have just introduced our Model 3400, the first complete 4½ digit systems multimeter under $1000. And the super-fast, super-programmable 5½ digit systems multimeter which will utilize our new circuit innovation, Quadraphasic Conversion, is on the way.

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The world's most accurate 4½ digit DMM, the Model 2440 features a basic accuracy of ±0.007% of rdg. ±1 L.S.D. for six months. 100 μV to 1000 VDC, 100 μVolts to 500 Volts AC, DC/DC ratio, AC/DC ratio, 2-wire and 4-wire resistance, 100 milliohms to 12 megohms. Standard features include autoranging, auto-zero, remote ranging and remote triggering.

Frequency response for AC current and voltage is 30 Hz to 100 kHz. Voltage ratio and isolated BCD output are included at no extra cost. Other Series 2400 models are available from $580.00.

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• DCV 1μV to 1000 volts • ACV 1μV to 700 volts RMS. 30 Hz to 100 kHz • Resistance 1 milliohm to 12 Megohms • 1000 MΩ Input Impedance through 10 VDC • Ratiohmic™ Resistance Method 2 and 4 wire. BCD output and voltage ratio are included at no extra cost.

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SPECIFICATIONS: Sinewaves, Square Waves, Pulses, Pulse Pairs, Complex Waves • Frequency: 5 Hz to 100 MHz; 10 ms/100 ms/1 sec./10 sec. gate times, resolution to 0.1 Hz • Period: ½ microsecond to 0.2 sec. • Period Average: 10, 100 and 1000 periods • Total Events: 0 to 9,999,999 (unlimited with "overflow" indicator) • Elapsed Time: 0 to 99,999.99 sec. (27.8 hrs.)

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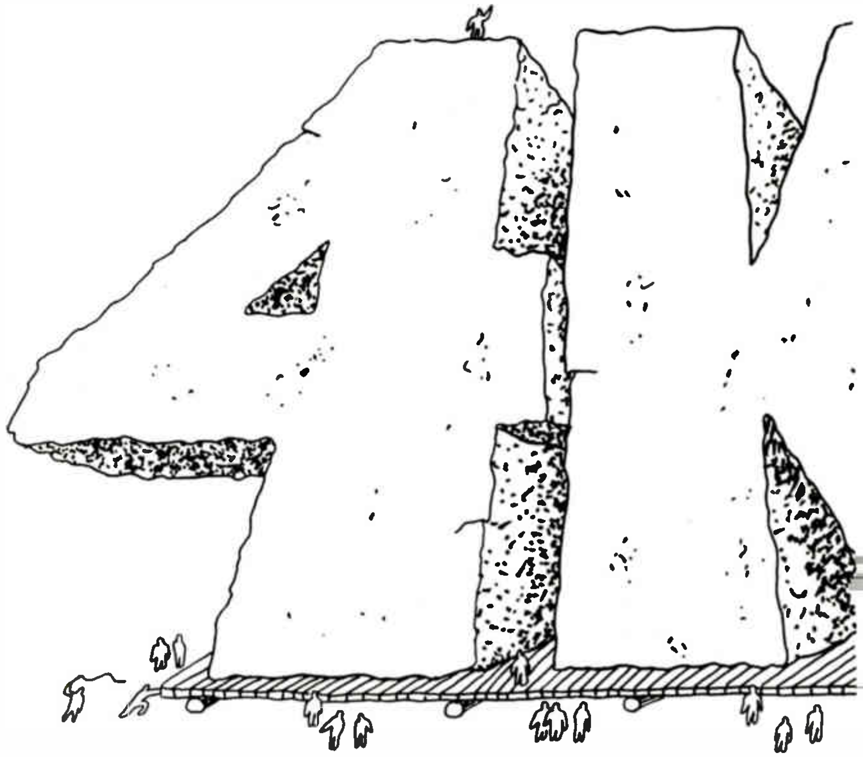

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Being a bit later also let us be a bit better. For instance, our S4021 has a unique sense amplifier that cuts down on power while providing high noise immunity. And we offer three different speeds: 200 ns, 250 ns and 300 ns maximum access times. All three versions have low power dissipation due to typical current of 30 mA (40 mA maximum).

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And its 17,931 square mils give you the best speed-to-power ratio of any single transistor cell 4096-bit dynamic RAM.

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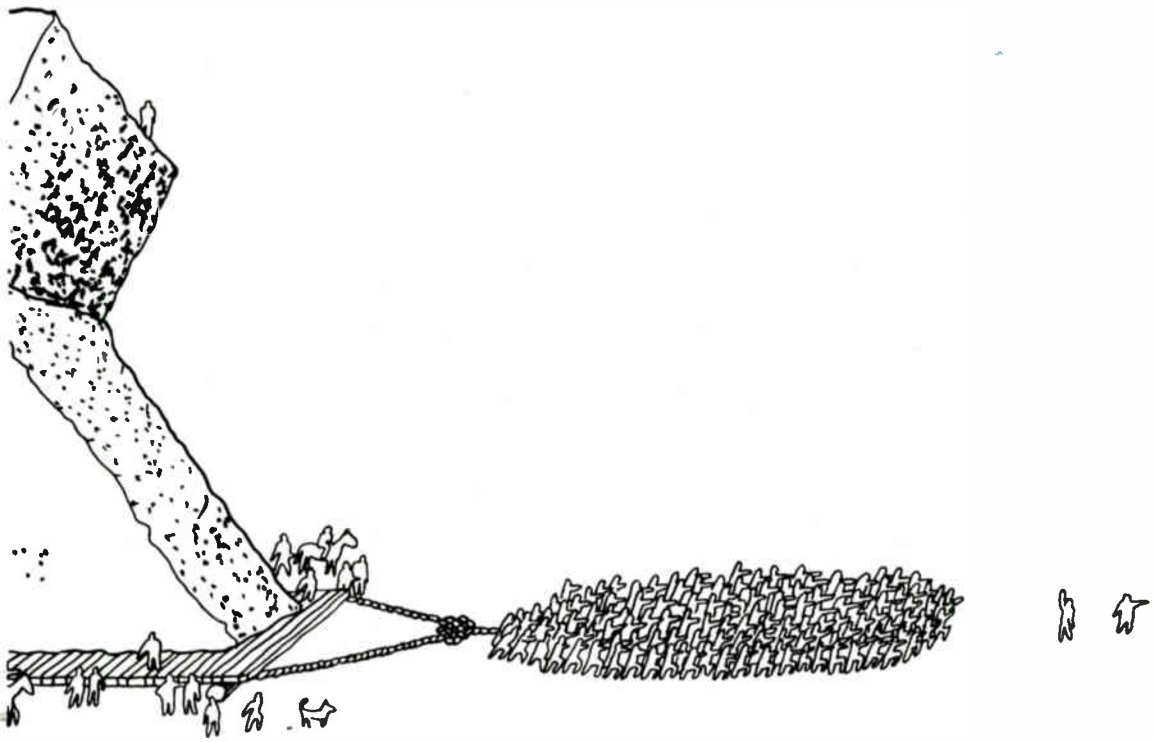

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Specifications	S4021			S4096		
Part Number	−4	−3	−2	−3	−2	−1
Access time (maximum)	200ns	250ns	300ns	250ns	300ns	350ns
Read or write cycle time	400 ns minimum			375 ns minimum		
Read modify write cycle time	510 ns minimum			520 ns minimum		
Power dissipation	30 mA (typical) 40 mA maximum			30 mA typical 40 mA maximum		
Output	Three-state; TTL compatible			Three-state; TTL compatible		
Refresh period	2 ms			2 ms		
Package	22-pin, plastic or Cer-DIP			16-pin, plastic or Cer-DIP		
Pin compatibility	TMS 4060, 2107B			MK 4096		
Technology	N-Channel silicon gate			N-Channel silicon gate		
Cell design	Single transistor			Single transistor		
Size	129 X 139 mils			125 X 148 mils		

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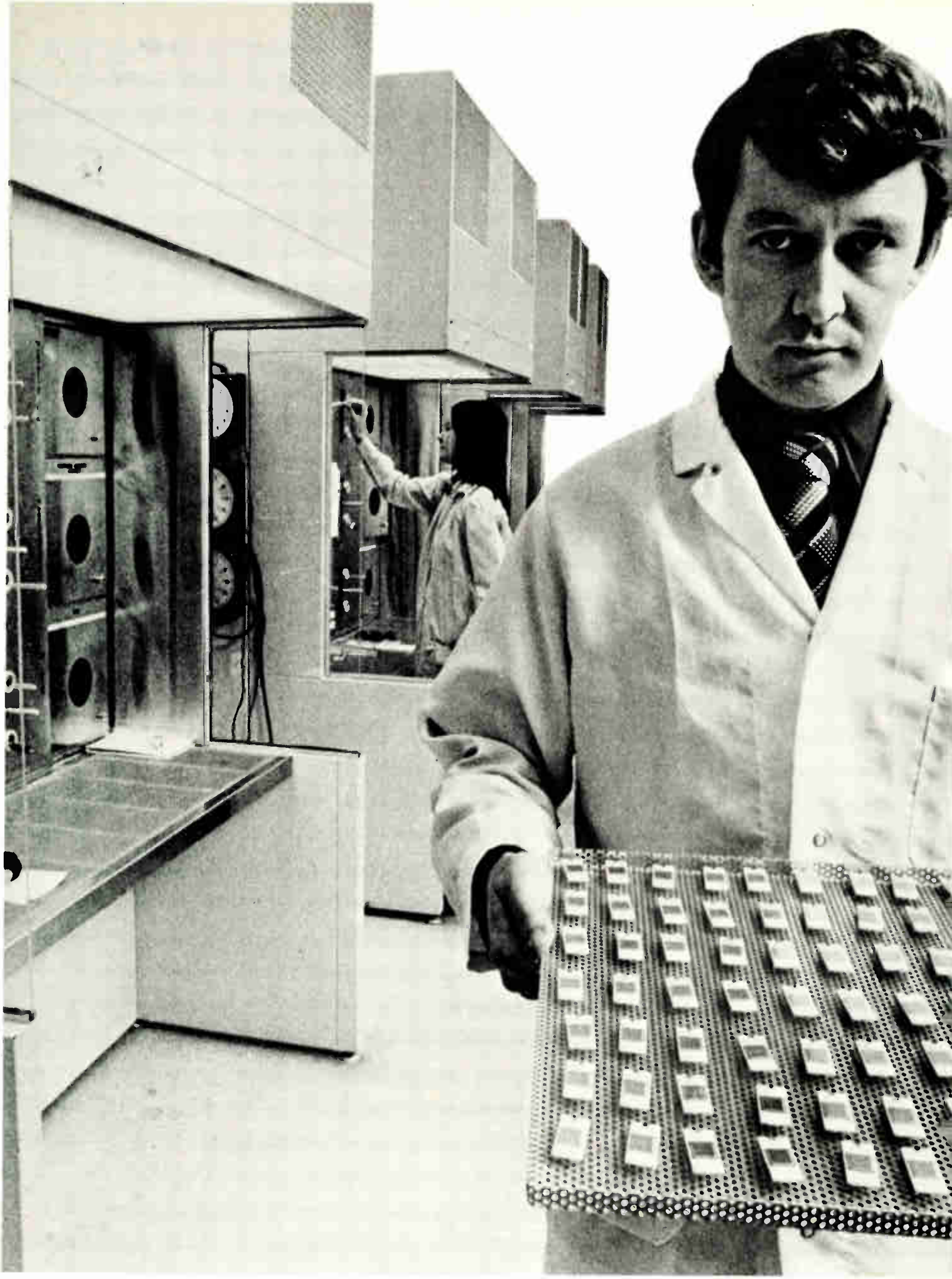

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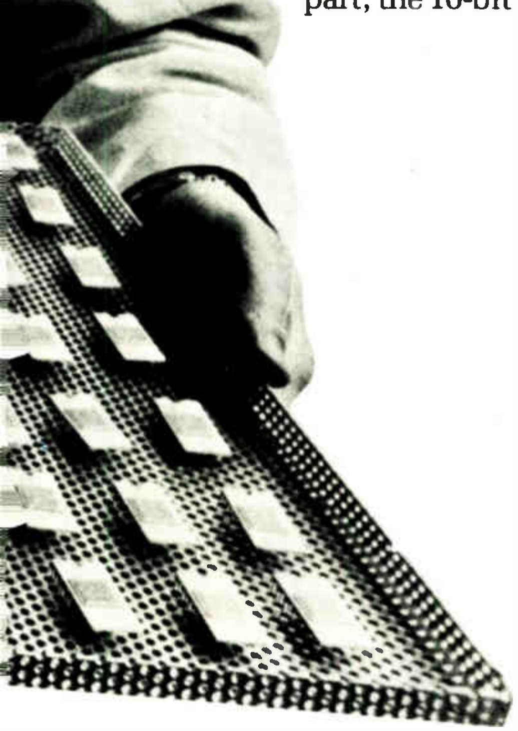

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9 bits (CMOS)	±0.05%	AD7520K
9 bits (CMOS)	±0.1%	AD7522K
10 bits (CMOS)	±0.05%	AD7530L
10 bits (CMOS)	±0.05%	AD7520L
10 bits (CMOS)	±0.05%	AD7522L
12 bits	±0.0125%	AD563
12 bits	±0.0125%	AD562
12 bits (CMOS)	±0.05%	AD7521L

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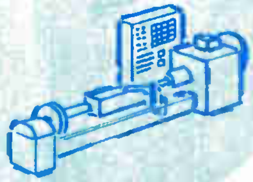

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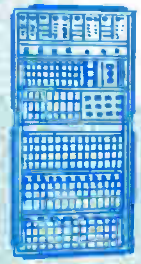

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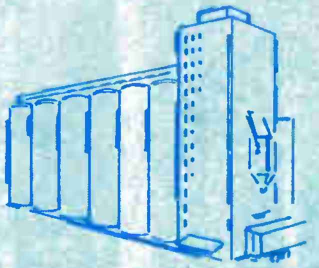

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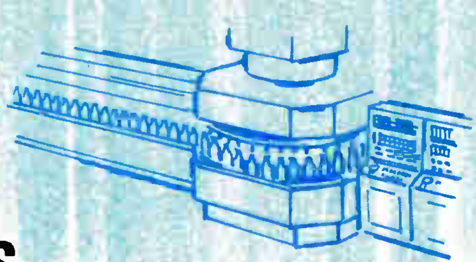
PLATING POWER SUPPLIES



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Washington newsletter

Modular spacecraft survive fund cuts . . .

Despite intense budget-cutting pressure from the White House, NASA will go ahead with its Multimission Modular Spacecraft program. The former Earth Observatory Satellite program has been embroiled in a funding policy battle with the agency since September [*Electronics*, Sept. 18, 1975, p. 49]. NASA wants standardized spacecraft components to reduce the cost of dozens of future missions and stop "reinventing the wheel," officials say.

Slower development of the Space Shuttle, the vehicle for all modular craft, to comply with President Ford's $26 billion budget cutback **will change mission priorities, though**—the Solar Maximum Mission will be the first modular spacecraft, rather than the Gamma Ray Explorer mission anticipated last year [*Electronics*, March 20, 1975, p. 66].

Requests for proposals for up to seven sets of the three standardized subsystems—power, command and control, and positioning—will be released before April 1, NASA officials say. The SMM will measure solar flares and must be launched in 1978 to obtain the closest view of the sun. In an unusual move, NASA's Goddard Space Flight Center released late in December the preliminary specifications for the three modules.

. . . but NASA plans policy changes for industry support

Industry officials view the effort to obtain standard components as a method of reducing the number of aerospace companies, so a shakeout is expected. To counter this appearance and muster contractor support in budget battles with the White House, NASA intends to reduce its in-house contracting. Nevertheless, the end result of NASA's increased dependence on outside design teams and "systems integrators" **will be stronger aerospace giants and fewer small shops.**

Projects which use Multimission Modular Spacecraft components will be managed by a "project integration contractor" that will order subsystems and assemble modular spacecraft under contract to a NASA center. Previously, NASA centers did system integration, buying subsystems and assembling a spacecraft. "This way we get the contractors more involved with our programs," explains a senior NASA official. "Contractors will help us in our efforts to get more funds and new program starts, out of self-interest, when they see more money coming their way." Another trade-off of the new "get industry involved policy" will be fewer aerospace engineers needed at NASA centers.

EFT commission may get hardware expert

After months of political infighting, the National Commission on Electronic Fund Transfer will nominate Jack Benton as its executive director. Benton, currently director of planning, banking, and finance at TRW Electronics in Los Angeles, was a darkhorse candidate. Ahead of him were a bevy of Capitol Hill staffers with political connections but little technological expertise. **The move to name an industry man to the commission staff may placate scores of industry critics,** all clamoring for representation among the bankers, retailers, and politicians on the EFT commission. The Senate must approve the nomination.

The commission has been slow to get under way—it will move into its offices in January, 15 months after President Ford signed legislation creating the commission to propose EFT standards and recommend changes in Government bank policies [*Electronics*, July 24, 1975, p. 79].

Washington commentary

The 1976 telecommunications war: AT&T vs IBM

If there are still some uncertainties in the Bicentennial New Year—the future of Gerald Ford and the shape of the national economy, for example—there is one thing that seems guaranteed: an escalating legal and economic war between AT&T and IBM for control of the U.S. telecommunications market, the world's largest.

After extensive preparations earlier in 1975, International Business Machines Corp. launched its first assault at Christmas time with a 600-page filing with the Federal Communications Commission that laid out its plan for Satellite Business Systems (see p. 33). Though SBS has been restructured from CML Satellite Corp. as a partnership between IBM, Comsat General Corp., and Aetna Life & Casualty Co., the telecommunications community clearly views IBM as the first among equals.

Management by IBM

Almost overlooked in the massive SBS file, for example, was the significant change in command at the new satellite venture. Philip N. Whittaker, IBM's director of commercial development, has moved "on assignment" to become acting president of SBS in the period pending FCC approval. Once that comes—and the partners have agreed to dissolve SBS by mid-1977 if they fail—new officers will be found. SBS says the partners agree that no officer or employee of their companies will be an officer or employee of SBS. Meanwhile, Whittaker, with an IBM press agent at his elbow, is in charge. He succeeds Hilliard W. Paige, a Comsat General alumnus and chief executive of CML since 1973.

Whittaker has his work cut out for him in his new job. Not only does the fear of IBM's entry into the satellite communications business persist, but SBS will not be without competition in a field where Whittaker says SBS will innovate by offering "retail end-to-end services" much like AT&T.

The competitors

Western Union's twin-satellite "Westar" system with 24 transponders began operating as the first U.S. domsat in August 1974. After an estimated investment of $100 million, Westar is operating at about 95% capacity, but much of its business has been in the form of block sales to companies who will later become competitors. American Satellite Corp., for example, presently leases three Westar transponders but says it wants to orbit its own satellites to serve its $25 million earth station network. The satellites are expected to cost ASC another $80 million.

RCA Corp.'s first of two satellites in its Satcom system is already in orbit and will become operational in this month. A second satellite in the $125 million RCA domsat system is scheduled for launch in March.

Where does that leave AT&T? Somewhat behind, but not much. The company will be in the domestic satellite business indirectly in May of this year, when Comsat General launches in May the first of two Comsat satellites for joint use by AT&T and General Telephone and Electronics Corp. Prevented by the FCC from using satellites for data communications for three years, AT&T and GTE will have a capacity of 28,800 voice channels when their second satellite is launched and operational by September.

Comsat General—like IBM and Aetna—has set up a separate subsidiary for its participation in Satellite Business Systems, which it calls Comsat General Business Communications Inc. Nevertheless, the apparent conflict created by CG's attempt to serve AT&T, too, is still an issue in the battle to come.

Collision course

Despite the other competition, however, the main conflict will be between the two industrial superpowers, AT&T and IBM. It is the contention of some cynics that the two Goliaths will not risk mutual destruction in a telecommunications war, but merely stand quietly apart and divide the voice and data markets between them. Yet that is most unlikely. AT&T has too much to lose. Through SBS, IBM plans to use 12–14 GHz in combination with small, rooftop antennas to avoid interconnection with AT&T wherever it can. While AT&T is the larger of the two competitors, most of its capital is committed to long-term hardware investments. IBM, on the other hand, is rich in rather than short of capital, particularly when the financial resources of its Aetna partner are thrown in.

In the past, AT&T—backed by the outstanding technological capability of Bell Labs and its highly efficient production arm, Western Electric—has proven resourceful in combating competition. Yet competitors such as Datran and MCI Communications Co. are in a minor league compared to IBM. No one can yet predict the result of the coming battles, except to point out the obvious: it seems certain to tax the resources of the already overburdened and undermanned Federal Communications Commission.

—Ray Connolly

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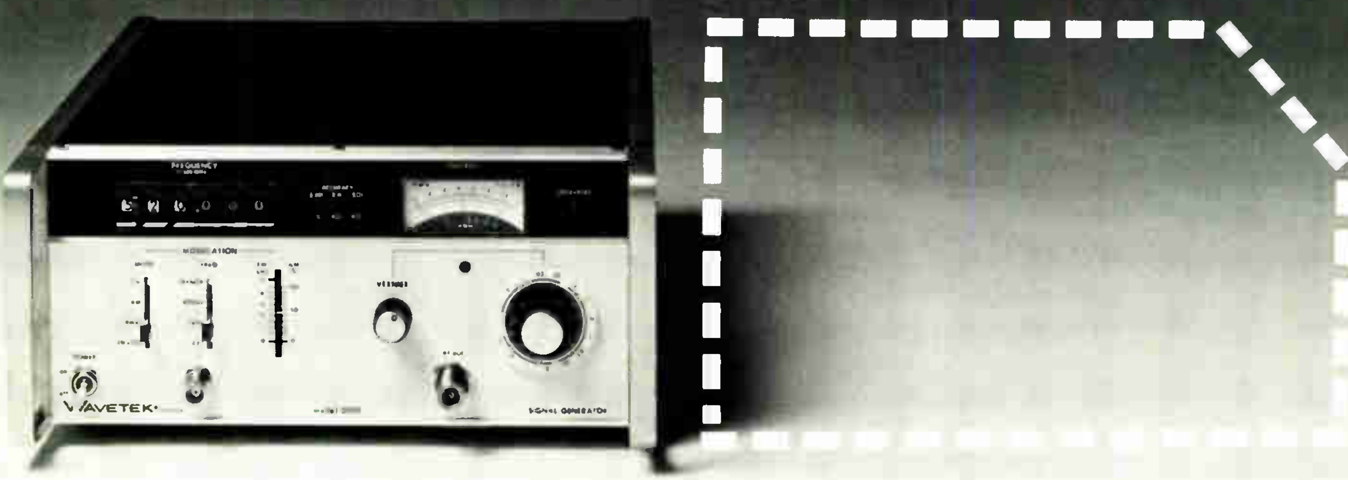

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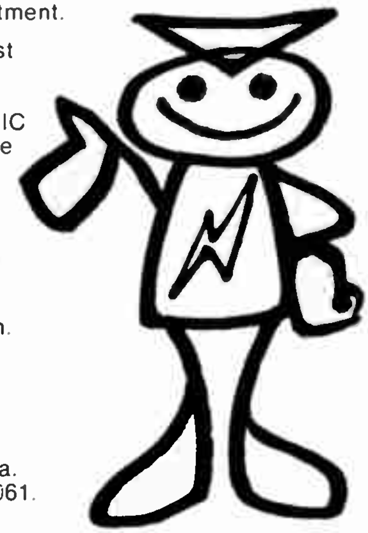

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Terrain simulated by computer in radar-training system

To a fighter pilot flying low at twice the speed of sound, real forests, mountains, and cities look rather different from their image on his flickering radar screen. But training those pilots to fly operational missions over enemy territory is impossible unless realistic radar simulators can be built to do the job at a home base.

In France, the final touches are being added now to a system that can produce accurate radar pictures in real time as radar signals call up digitized map features stored in computer memories. The developer is Le Matériel Téléphonique, a French subsidiary of ITT.

In the LMT system, a photoelectric cell reads features at 50-micrometer intervals from a map spinning on a drum, and that data is stored in a memory. The scan is illuminated by a light beam 50 μm in diameter. The whole scanning unit moves slowly across the face of the spinning standard military map, 80 centimeters wide. When new software is ready early next year, digitizing each map should take about 45 minutes. The contour data is supplemented by manually introduced information on the radar reflectivity of features ranging from electrical-power pylons to railroads and factories.

Conventional computers with memory-access time of about 900 nanoseconds can produce a radar picture of about 70,000 discernible echoes or image points every 30 seconds. But aircraft-simulation standards demand a picture at least every second in real-time operation. LMT's answer to that problem breaks some new ground in mathematics and computer-hardware design and has managed a tenfold compression of memory-stored data.

Compression. The data-compression technique serves only to draw information from the memory fast enough for each echo to be processed in 14 μs. To generate the radar picture, the computer must work 30 times as fast as conventional machines, and to do that LMT has built an array of parallel microprogramed processors, each of which handles a logical function simultaneously with its neighbors. Three separate machines handle standardized processing operations, and a fourth feeds in specialized data on radar characteristics and the flight plan.

The four interconnected computers are controlled by a general-purpose computer that selects the data corresponding to the area chosen by the system operator or by the pilot in a flight simulator. Even without the added expense of a simulated aircraft cockpit, pilots can train to use various types of radar in a variety of flying conditions simply by programing the nonstandardized segment of the picture-generating computer.

The standardized machines decompress the contour data from the memory, calculate slopes and altitudes, decode radar reflectivity data, and calculate the strength of the radar echo by applying standard radar calculations involving radar-beam angles, slant range, and ground reflectivity factors. The system even includes a light-generating device that calculates the precise degree of inaccuracy and picture blur from the radar set. Without that, the simulator would give a clearer picture than any pilot would ever see on his cockpit screen. □

Around the world

Watt-hour meters in Japan to go electronic

Japan will begin early in 1977 to replace the electromechanical watt-hour meters in its 40 million-odd homes with electronic units. These meters, which retain the familiar mechanical display, are smaller, lighter, and more accurate than the familiar induction-type meters. What's more, they require less labor to assemble and consume only 10% as much power.

The reduction in operating power is expected to help alleviate energy scarcity even as building the meters will help manufacturers and utilities. An electronic counter with a nonvolatile semiconductor memory for remote readout has been developed by Toshiba and Tokyo Electric Power Co.

In another development, the same watt-to-current and current-to-frequency converters, which are hybrid integrated circuits, are combined with sampling techniques to measure power in three-phase circuits. Only one of these meters is needed, whereas two induction meters are required on three-wire systems and three units on four-wire systems.

Laser allows 'needleless' acupuncture

Although many doctors are still skeptical about the value of the ancient Chinese art of acupuncture, at least some of them are taking it seriously. Recently, a Hungarian researcher came up with a device that measures skin resistance to help pinpoint the spots to insert the needles. And now, the West Germany aerospace/electronics combine Messerschmitt-Bölkow-Blohm GmbH has introduced a laser-based device that it says works even better than needles.

The MBB equipment, called Akuplas, is priced at about $1,910. It contains a helium-neon gas laser that emits about 1 milliwatt of light power at a wavelength of 0.632 micrometer. Its radiation can either be continuous or pulsed at a rate between 0.2 and 200 hertz. The length of time that a beam is applied to an acupuncture point is precisely controllable.

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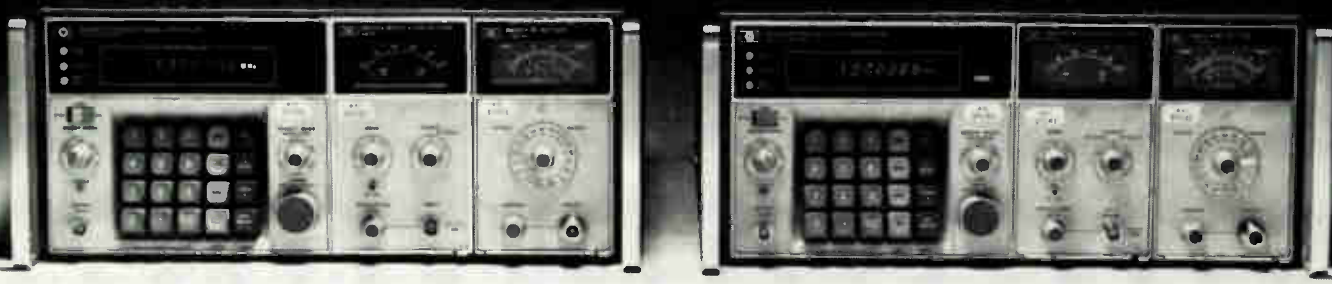

When you buy electronic test equipment for a short-term project, you're stuck with the equipment after the project is completed. Maybe it'll sit around gathering dust and costing you money. Or maybe you could sell it at a loss.

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Circle 56 on reader service card

International newsletter

Siemens introduces standard and dynamic memory systems

Siemens AG has introduced two semiconductor random-access memory systems mounted on Europe-standard plug-in cards. One, a static memory with a capacity of 4,000 words by 4 bits, is made up of 16 1-kilobit static RAMs. The other, a dynamic system with a capacity of 8,000 8-bit words, consists of 16 4-k/b dynamic RAMs.

The static system, priced at 1.14 cents a bit, has a cycle time of 1.1 microseconds and access time of 1.05 μs. **The larger dynamic system, priced at 0.65 cent a bit, has a cycle time of 650 nanoseconds and access time of 450 ns.** The memory systems are designed for point-of-sale terminals, data-display equipment, measurement and control, and microprocessors of all kinds.

Spain to get world's largest undersea cable

The world's largest-capacity undersea telephone cable is slated to go into operation in late 1977 between the Spanish mainland and the Canary Islands. **Britain's Standard Telephone and Cables has won the $51 million contract from Spain's Compania Telefonica Nacional de Espana.** The system, which has a bandwidth of 45 megahertz, will have a capacity of 5,520 circuits. The cable, 270 repeaters, and terminal equipment are being built by STC's Submarine Systems division. The ITT subsidiary logged $172 million in cable orders during 1975.

Germans cut rates to boost remote computing, paging

In an effort to promote the use of remote data-processing techniques, West Germany's Bundespost has lowered the monthly rates for data-transmission systems and is simultaneously expanding the assortment of equipment it offers. **The rate reduction, effective since Jan. 1, is 10% to 30%.** More drastic rate cuts of 45% to 50% have also been decreed on for the Eurosignal service, a paging service offering radio communications from telephones to mobile receivers on a Europe-wide basis.

British company aims radar sets at small boats

Capitalizing on its reported success in the U.S., with the Seascan radar for small boats, Britain's Electronic Laboratories (Marine) is expanding its attack on the marine-radar market. **The upgraded Seaveyor is to be introduced almost simultaneously at boat shows in London, Paris, New York, and Dusseldorf.** Challenging bigger entrenched companies, the small British concern says the $2,700 Seaveyor, a transceiver display console, antenna, and two-pulse-length radar offers a high target resolution at ranges of one half, one and a half, three, six, 12 and 36 miles. The display is an 8½-inch cathode-ray tube with high-persistence phosphor.

Japanese-developed floppy disk offers high performance

A floppy-disk memory developed by Matsushita Electric Industrial Co. in Japan promises the performance of a disk or drum memory plus long life at the price of a digital cassette. **The key to the low cost of the floppy disk, which has a capacity of 32,000 16-bit words, is the use of the same material as magnetic tapes for fm recording.** Virtually unlimited life may be expected because the writing head never contacts the disk. Applications are in inventory-management systems, billing machines, and communications terminals.

The high speed of 1,800 revolutions per minute contributes to the average fast access time of 16.67 milliseconds, and the data-transfer rate is 1.1

megabits per second. The disk, fastened to a vertical shaft, spins in the space between two horizontal steel plates. The top plate, which carries the magnetic heads—one per track—is solid except for the head openings. The lower cover has many openings to provide lower air pressure than the top plate so that, when the disk is spinning, **a controlled air stream about 1 micrometer thick is trapped between each head and the surface of the disk to prevent contact with the recorded track.**

German system checks tires as they rotate

An electronic system that warns a driver of loss of tire pressure while his vehicle is in motion is being tested by West Germany's automotive-equipment maker VDO Adolf Schlindling AG. The Frankfurt-based firm says the warning system may go into production in 1976 "if there's big enough demand for it." On a typical four-wheel passenger car, a control unit under the dash connects to four transmitting/receiving-coil combinations—one at each wheel suspension. Mounted on the inner side of each wheel rim is a coupling coil, which hooks to a pressure-sensing switch screwed onto the tire valve so that it passes 10 millimeters from the coil.

Tire pressure is checked with every revolution of a wheel. **An oscillator in the control unit constantly applies a 7-kilohertz signal to the transmitting coil on the wheel suspension.** If the tire pressure is above the minimum value at the instant the rim-mounted coupling coil moves past the transmitting coil, the signal is inductively coupled to the receiving coil, and the signal goes to the control unit. But if the pressure falls below minimum, the pressure-sensing switch is opened, and the coupling coil circuitry is interrupted. Since no signal is then fed back to the control unit, a warning device is triggered.

Sweden orders computer system for Viggen fighter

The Swedish government is ordering $27 million worth of central computers for the fighter version of the Viggen aircraft from SAAB-Scandia AB. **SAAB will make the computers, to be delivered between 1978 and 1986, under license from Singer's Kearfott division in the U.S.** The number of computers will depend on the final contract from the Defense Materiel Administration. SAAB also made Singer-Kearfott computers for the attack version of the Viggen, which is not now being produced.

High-density Dutch memory based on quartz powder

A new data-storage concept developed by a trio of researchers at the University of Groningen in the Netherlands **could lead to nonvolatile memories that are denser and cheaper than ferrite-core stores.** The memory, devised by Piet Kuindersma, Georges Sawatsky, and Seitze Huinzinga, is based upon phonon echoes that develop when quartz powder is excited by pairs of pulses at high frequencies. Echoes recorded in the quartz powder can be read out a year or more later. **One small powder-filled tube can store about 100,000 bits.** Arrays with the quartz powder between capacitor plates would have vastly higher capacity.

The powder is held inside a small glass tube 1 centimeter in diameter and 1 cm long, which is encircled by a coiled LC circuit. Read-in pulse pairs have ranged as high as 80 megahertz, but frequencies to 10 gigahertz seem feasible. Each 0.2 to 0.3 MHz or so of spectrum corresponds to an address that can be read out later by applying a single pulse at the address frequency.


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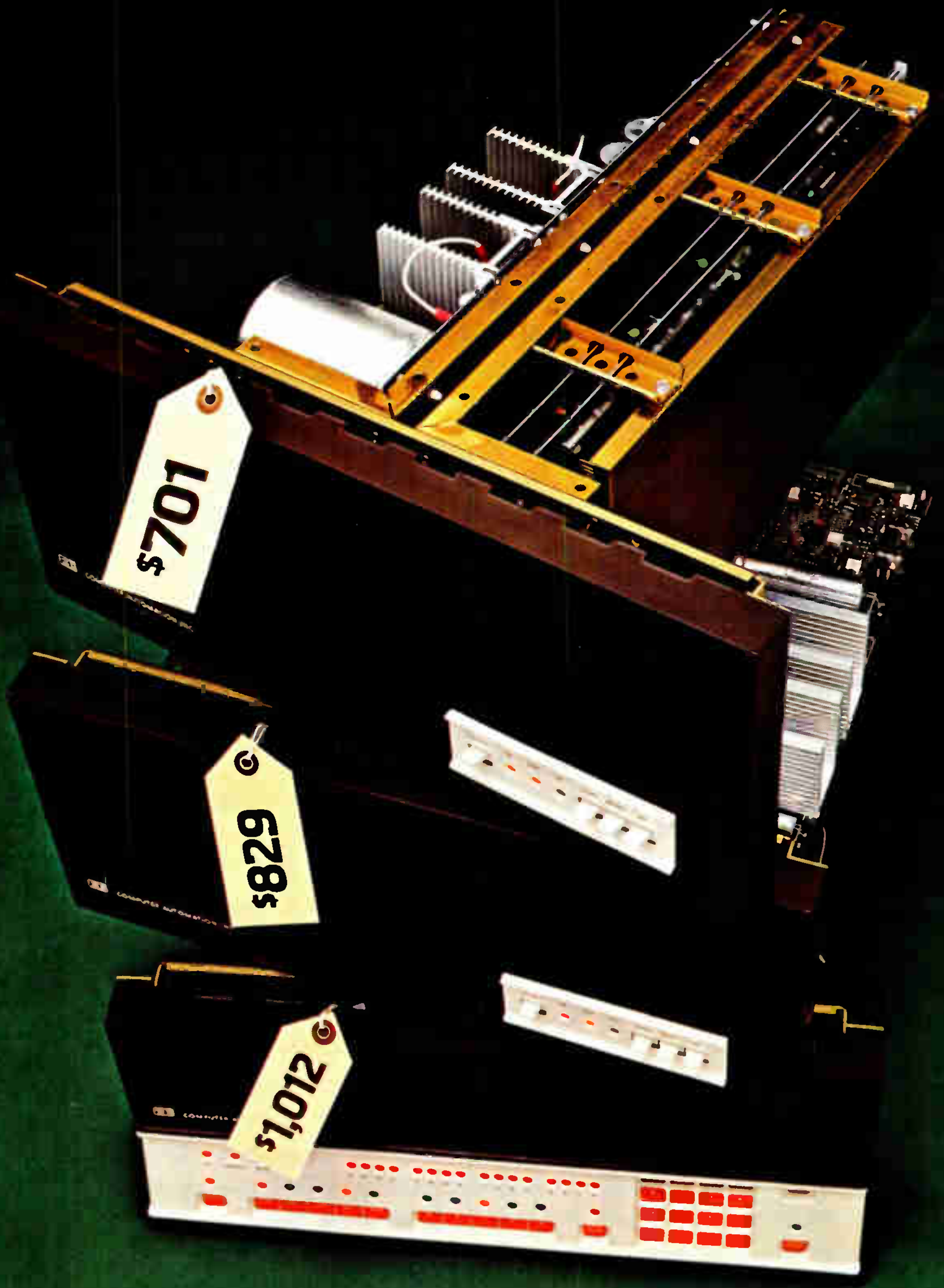

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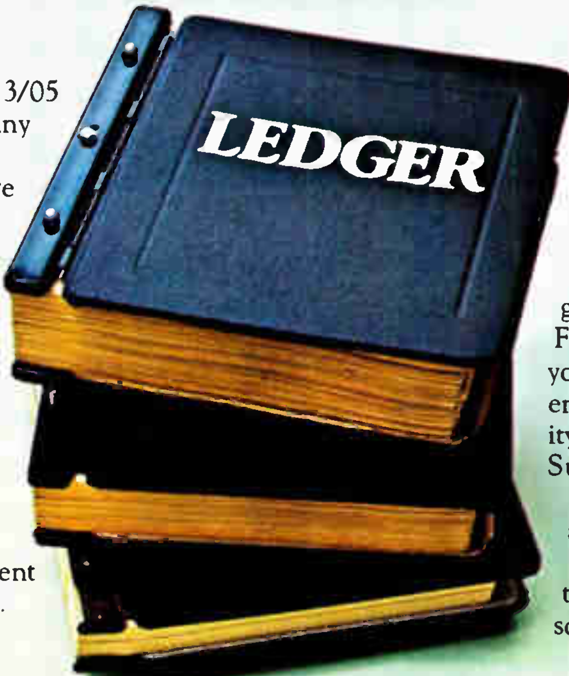

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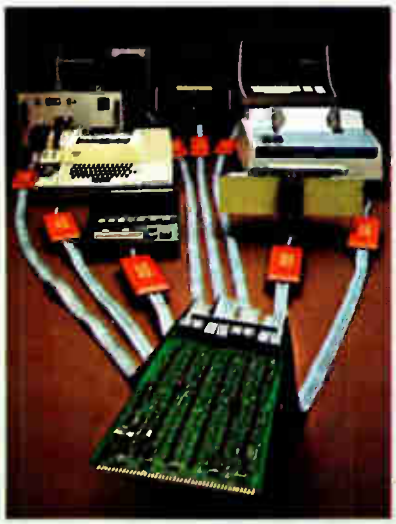

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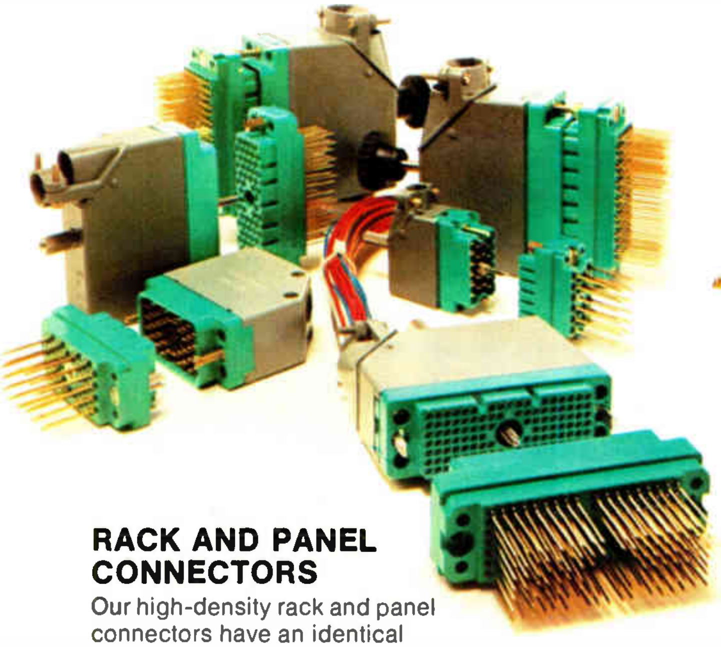

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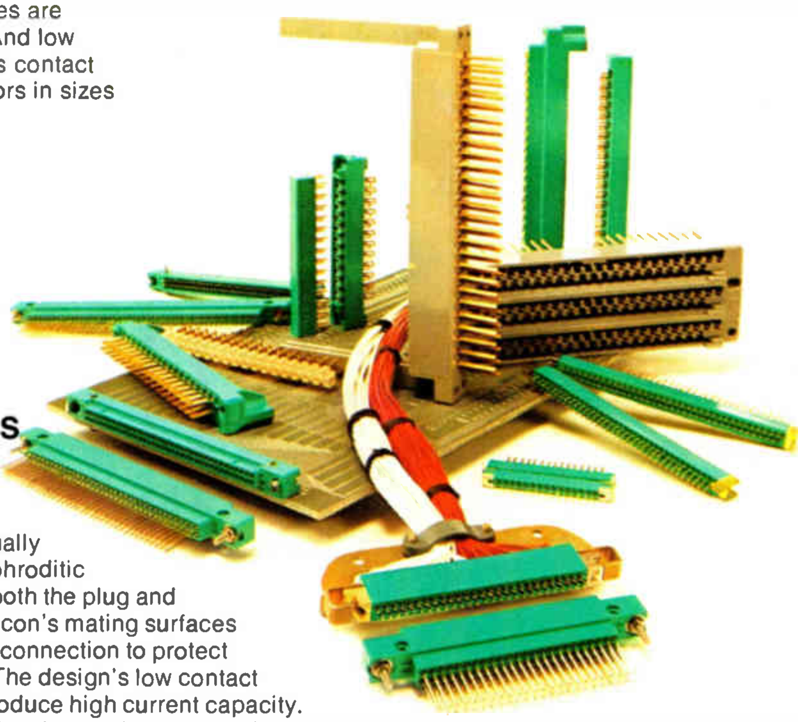

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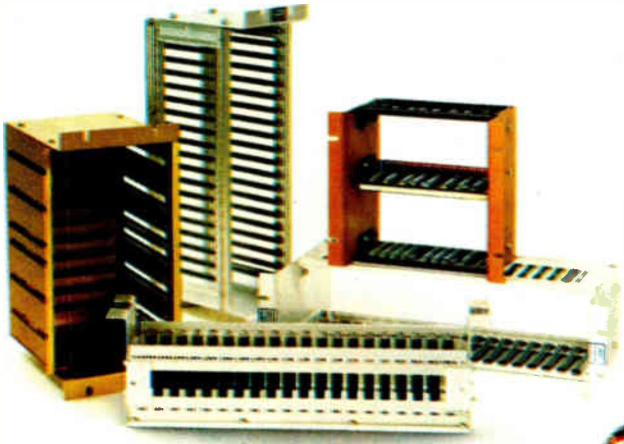

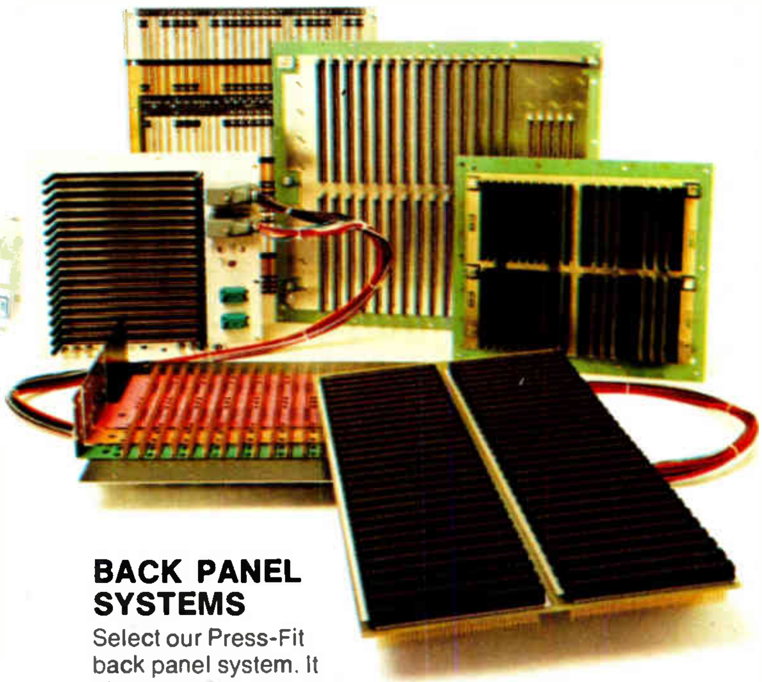

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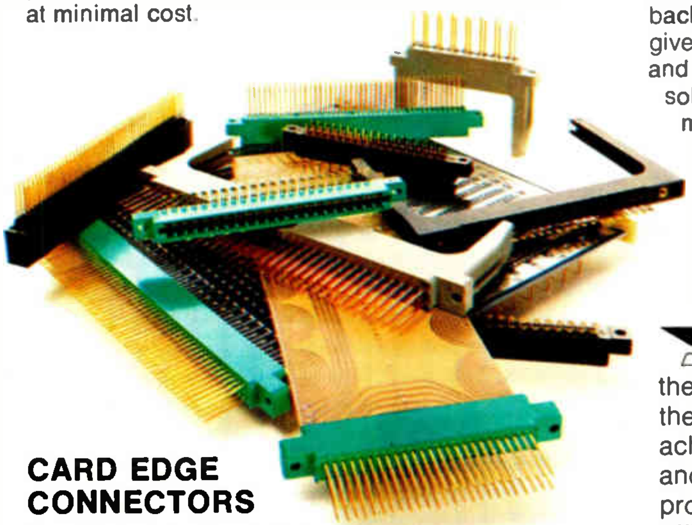

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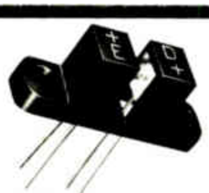

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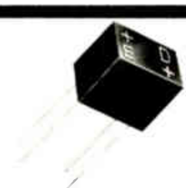

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GENERAL ELECTRIC

High technology flows

by Ron Schneiderman, New York bureau manager

Several months ago, a U.S. trade representative of an East European Communist country traveled to Canada in an attempt to purchase American-made semiconductor test instruments—equipment the U.S. Government specifically forbids being sold to Soviet bloc countries. It was an experiment. The representative just wanted to see if he could actually "get the goods." He succeeded—he was promised three weeks' delivery.

In West Germany, the marketing manager of a U.S. subsidiary received an order from an Eastern country for components with certain specifications. Recognizing that these devices were on the U.S. Commerce Department's list of embargoed materials, he rejected the order. A few weeks later, he received an order for the same devices from a local trading company. Suspecting the same customer to be behind it, he again turned down the order. But on a recent business trip the American executive learned that his would-be customer had obtained the devices after all—through a trading company—from a less suspicious West European competitor.

These stories, disclosed by U.S. and West European sources, demonstrate how easy it is for Eastern countries to buy embargoed U.S. electronics technology—and price is no object. According to the Commerce Department's Office of Export Administration, Eastern bloc countries are paying cash premiums of 180% or more over the net landed cost in Western Europe for certain strategic U.S. products. Significantly, a report on East-West trade activities recently published by the Commerce Department states, "Scarce hard-currency resources would rarely be used for purchases unless a unique or more advanced Western technology embodied in the equipment is to be gained."

Charles B. Clements, director of the Office of Export Administration's Compliance division, readily admits that the sale of embargoed U.S. electronics equipment and components is a "growing problem and one that we're hard put to control." In a letter to some 125 U.S. semiconductor production and test-equipment manufacturers, Clements says that recent investigations by his staff have disclosed that semiconductor production and test equipment is being sought for illegal diversion to Eastern Europe.

"Due to the clandestine nature of this procurement effort," says Clements in his letter, "both domestic and foreign parties may become, or have become, unwittingly involved as intermediaries." Clements asks the companies to notify him immediately if they have received an order for equipment or devices from a foreign or domestic firm that "appears suspicious because of market conditions, financing, ordering party, end-user, routing, destination, or any combination of these."

The Soviet bloc countries "will use any means possible" to get this equipment from the U.S., says Clements. "They just put out a shopping list of their requirements in four or five places, and when they have managed to fill the bill, they withdraw the list."

Despite accumulating evidence that firms in Singapore, Lebanon, Austria, Switzerland, and other countries may have been or are presently involved, he believes the activity is almost impossible to stop.

illegally from U.S. to Soviet bloc

Restricted test instruments, components, other sensitive items leave the country in diplomatic pouches or are simply diverted after being sold to legitimate customers; officials are stymied

The simplest technique, disclosed by East European sources, is to move restricted components and test instruments out of the U. S. by diplomatic pouch. Larry Brady, deputy director of the Office of Export Administration, says he is aware that certain "strategic" items are being diverted in this manner, but admits that such tactics are extremely difficult to trace. "Some things are simply bought over the counter here, and there isn't much we can do about it."

People close to the situation agree. One specialist in East-West trade says, for example, "It's a domestic cash sale, and some reps and distributors don't ask questions."

It is "entirely possible," admits the president of one U. S. distributing firm, that some distributors are shipping embargoed components to Eastern bloc countries without realizing it. "I'm sure we get a certain amount of this business just by advertising through various foreign embassies. A lot of it is ordered right out of Washington through foreign embassies or diplomatic missions. Usually what happens is that they'll place an order here with instructions to ship the merchandise to a freight forwarder in Baltimore, Washington, or New York. We don't know where it goes from there."

A much more active and productive procedure is to divert equipment from a legitimate source in Western Europe. Equipment can be shipped under general license to so-called Free World nations without application to the Commerce Department, and even when end-use guarantees are made on licensed exports, U. S. companies say they have no way to police overseas customers to be sure they are not selling the equipment to a third party—possibly in another country.

Clements says equipment is being shipped from one location to another, re-crated and re-marked at each point, until eventually everyone loses track of it. The U. S., however, recently seized embargoed equipment suspected of heading for an Eastern bloc country, and several items are currently under surveillance.

"If it gets into Switzerland, we just throw up our hands," says Clements, because that country's secrecy laws forbid disclosure of any information involving business transactions, either by the government or those involving the Swiss business community. "Swiss laws are very strict in this regard," he says. "The Swiss have told us they couldn't cooperate with us if they wanted to because of their laws."

Although considered an industrialized Western country by the U. S. Commerce Department, Switzerland is not a member of the Free World Coordinating Committee (CoCom), an organization made up of America's NATO partners (except Iceland) and Japan, which maintains a list of commodities of strategic significance it considers to be deserving of control. Each participating country, however, retains the right to control exports of commodities not on the list if it so desires.

Switzerland is identified by a well-traveled top U. S. semiconductor-manufacturing executive as the site of a recently established engineering group that designs and produces semiconductor-production equipment to sell to the Eastern bloc. According to the executive, who says his information comes from sources "whose knowledge I value in these matters," the group includes several well-paid American engineers experienced in semiconductor-production-equipment technology.

Switzerland is an ideal location for such a facility, not only because of its secrecy laws, but because a Swiss firm can sell its own products to the East without the risk of finding itself being blacklisted by the Commerce Department's Office of Export Administration.

Furthermore, says the executive, embargoed production equipment is being shipped from the U. S. to a dummy semiconductor-manufacturing facility that is located in the Far East, where it is diverted to an Eastern bloc country. Commerce Department officials say they have no knowledge of these operations.

Curiously, tiny Liechtenstein, resting between Switzerland and Austria, has become a particularly painful thorn in the side of the Office of Export Administration's Bureau of East-West Trade, whose responsibility it is to control exports to Eastern bloc countries. Embargoed semiconductor-production equipment is being shipped to a "postal drop" in Vaduz, Liechtenstein, and picked up there by a freight forwarder, never to be seen again. Liechtenstein has the advantage of operating under the protection of Swiss secrecy laws.

According to Dana Robinson, a Boston-based international marketing consultant, who represents the Polish government's Unitra Electronic Industries Union in U. S. trade matters, most of the diversions take place in a second or third foreign country—often Austria or Yugoslavia. "When a company obtains

a license to ship to Austria or Yugoslavia," says Robinson, "it furnishes a piece of paper which says the equipment is going into the country for use in that country and it is going to stay in that country. But is it up to the supplier to say 'This is the seventh one I've shipped there; I don't think they need it'? The weakness of the whole system," he says, "is that no one asks why $10 million worth of production equipment is going to Vienna when they have only two plants."

For now, at least, the Soviets apparently are concentrating on obtaining production equipment, test instruments, and commercial components. There are also indications that embargoed computers and computer peripherals have filtered into the Soviet Union.

Within the past few months, in fact, the Office of Export Administration fined and put on probation the European affiliates of Fairchild Camera & Instrument Corp. and Hewlett-Packard Co. for shipments of strategic electronic test instruments to Communist bloc countries without U. S. Government approval.

Fairchild Automation Systems GmbH, Wiesbaden, Germany, was fined $1,000 and put on six months' probation for shipping, without approval, its model 1264 programable transistor tester to Vienna, where it was diverted to a nation in the East bloc. Fairchild says that the tester was shipped to the East by a former

Americans frustrated as foreign competitors do business with East

The export of U.S. technology to Eastern bloc countries is a hot topic today in both industry and Government circles. The Commerce Department released a major report on the subject in August and sponsored an East-West technological trade symposium in November. The Senate Commerce Committee last month opened the first extensive hearings on East-West trade since 1968. And just a few weeks ago, Sen. Robert Byrd (D., W.Va.) urged that the U.S. put a moratorium on the sale of computer technology to Russia. Byrd says manufacturers in Western nations, including the U.S., have been selling computer hardware and data to the Russians and "they have obtained some very good results in military applications."

Electronics industries in the U.S., meanwhile, are frustrated. They want to sell their products to the USSR and other Eastern bloc countries, but are hindered by Federal export controls that restrict the sale of "strategic" goods and technology, while their traditional Japanese and West European competitors do a thriving business with the Soviet bloc.

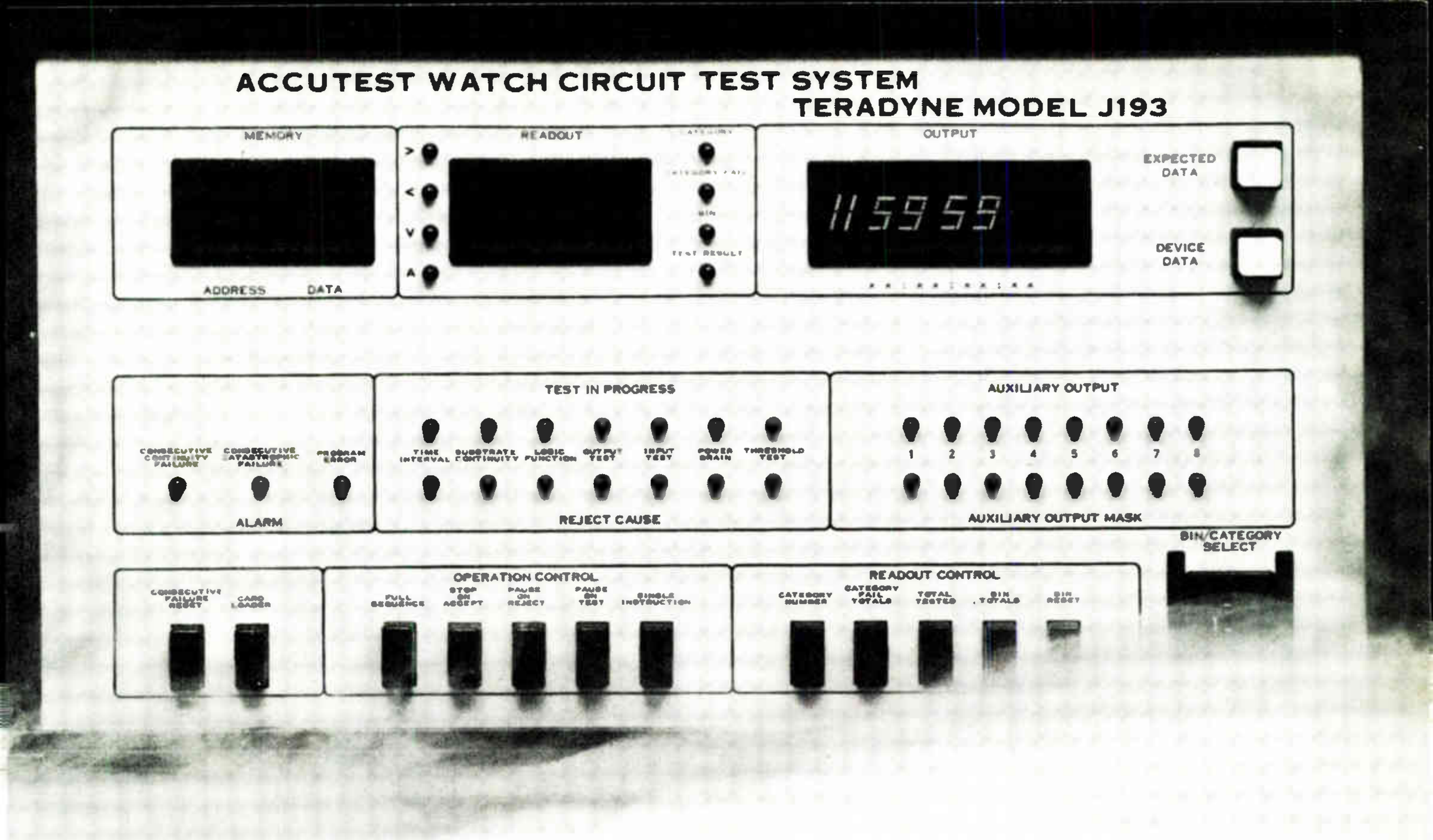
"Knowledge can be our most important export, and it is an endless resource," insists C. Lester Hogan, vice chairman of Fairchild Camera & Instrument Corp. and a major proponent of more open trade with Eastern bloc countries. "We can sit inside a wall," says Hogan, "but if we do, we'll be on the outside more than the inside."

J. Fred Bucy, executive vice president and chief operating officer of Texas Instruments, believes the U.S. should continue to encourage the sale of "nonstrategic" finished products throughout the Eastern bloc. "But we should prevent the flow of high-technology, key manufacturing equipment and knowhow to the Communists."

Frederick Van Veen, director of corporate relations at Teradyne Inc., Boston, recently completed a two-year term as a member of a Commerce Department technical advisory committee charged with reviewing export regulations for semiconductor-production and test equipment. He says that export controls to East European countries appear to have tightened, not loosened, in the past year or so and observes: "There's a high political content in this. East-West trade is totally a political issue. It waxes and wanes with détente."

"The one thing we have provided the Soviet Union by our denial," observes Raymond Vernon, professor of international business management at Harvard University and a consultant on East-West trade, "is an early-warning system of its own shortcomings."

Although the Commerce Department administers the country's export and licensing process, the Defense Department is the final arbiter on what may or may not go to the Eastern bloc. Industry sources who have dealt with the Pentagon in these matters say that if there is any element of doubt about an application for export, Defense officials turn it down. According to one, "It's next to impossible for anyone not really privy to these matters to argue with the Defense Department. They usually have the final decision, and they have all the information to decide what is strategic and what isn't."



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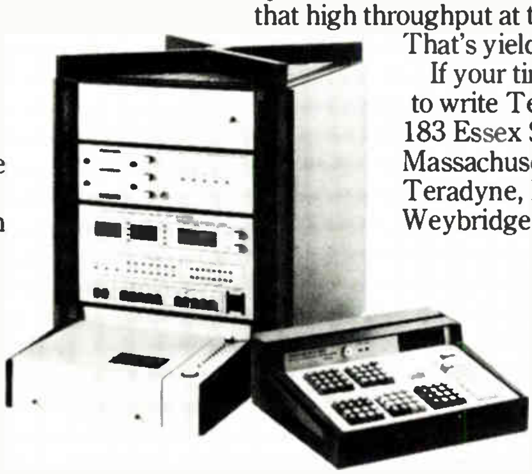

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Circle 71 on reader service card

employee acting on his own and that it was never paid for the equipment. The employee has since been dismissed.

Hewlett-Packard GmbH in Vienna was slapped with a $6,000 penalty and placed on six months' probation for shipping computer-test equipment to Czechoslovakia without approval of the government. Hewlett-Packard officials say they have taken steps to prevent any further unauthorized shipments.

Major manufacturers in Western Europe say the premiums paid by Eastern bloc countries for U.S. hardware aren't worth the risk of being blacklisted by the U.S. Commerce Department. Most of them believe it is the small and relatively unknown traders and jobbers who are channeling embargoed equipment and components to the East. Indeed, the blacklist is studded with the names of trading companies and individuals who have either been denied export privileges or been put on probation by the Office of Export Administration.

It is impossible to gauge the value of high-technology products being diverted from the U.S. to Eastern bloc countries. But one marketing official at a U.S. subsidiary in West Germany estimates that until about two years ago, when the CoCom

commodities list was reduced, 5 million to 10 million components annually went East illegally.

A U.S. test-instruments marketer says: "You could argue all day about the magnitude of it. Nobody really knows for sure. People aren't going to advertise the fact that Eastern Europe has the equipment." An analyst at one of the largest international financial institutions in New York, who closely follows the semiconductor industry worldwide, says rumors are "currently hot and heavy that hundreds of thousands of dollars worth of U. S. components are pouring through Zurich and Stockholm" into more than receptive Eastern bloc countries.

"The one thing that is difficult to do," admits one trade source, "is to get source-inspected, government-certified, radiation-hardened devices—MIL-type items. So, you take the next best thing—high-reliability commercial parts." The USSR, he says, isn't interested in production quantities for its military requirements. "What Soviet military factory would design around imported components?"

Frank Hickey, chairman and president of General Instrument Corp. of New York, who last summer signed a multimillion-dollar calculator-component and equipment contract with the Soviet Union, says that his talks with Federal officials in Washington indicate their serious concern that restricted devices and equipment are going to the USSR with little difficulty.

Lewis Solomon, GI's vice president for marketing, who made four trips to Moscow to negotiate his company's calculator-production agreement with the Soviet, would be among the last to allay their fears. Solomon says he has seen in the USSR American-made semiconductor-production equipment that is at "the top of the restricted list. But who knows how they got it?"

Larry Brady of the Office of Export Administration tells of the American electronics executive visiting a Soviet production facility and spotting one of his own company's machines operating in the plant. "He was dying to get the se-

rial number off the machine to try and trace it later," says Brady, "but he just couldn't do it unobtrusively."

Several West European marketers are convinced that much of the re-exporting activity is done unwittingly. Trading companies and distributors, for instance, don't always have the technical expertise that might be expected of a manufacturer who sells directly. In fact, one source at a U. S. subsidiary in West Germany reveals that even some of the officials in the government-operated export agencies whose job it is to approve shipments to foreign customers have trouble interpreting complicated technical specifications on license applications. "Sometimes we're asked to help in evaluating the status of an item," he says.

Another problem is that European distributors often sell to each other. Although one distributor may caution another about the embargoed status of certain components, the devices may change hands several times with less and less attention paid to export regulations each step of the way. Finally, they get to a trading company that, unwittingly or not, makes the connection with the East. According to another source, most of the embargoed products end up in the Soviet Union, which has other East European countries buying for it. "They don't want to be accused of enticing Western companies into breaking the embargo."

To complicate matters, distributors in Western Europe usually don't reveal the names of their customers in apparent fear that the producer will bypass them in any future sale. Of course, each time the shipment changes hands, the price goes up; the final price is often several times the original value of the shipment. "But if the components are badly needed," says a West German company official, "Eastern customers don't mind paying excessively high prices." To them, he adds, "Fulfilling the plan is their prime consideration. Price is secondary."

The Eastern customer's purchase may be influenced by the Council for Mutual Economic Assistance (Comecon), an organization established by the USSR and the East European nations in 1949 to promote economic integration of the entire area. If under the Comecon work-sharing policy one of the Eastern bloc countries is committed to build certain electronics equipment with a specific range of specifications, it must build that equipment regardless of component cost.

Although Clements says he is now getting good leads from several U. S. semiconductor manufacturers, as well as cooperation from his counterparts in West European countries, investigating the smuggling of high-technology electronics equipment and devices is no easy task. One method of investigation has been at least partially successful: Clements has been tracking the purchases of U. S.-based foreign embassies. "We look at what they buy and try to determine if it can be used in the normal operation of an embassy," and this includes equipment and replacement parts for the embassies' elaborate communications facilities.

In one recent case, Clements questioned the purchase of an unusually large number of antennas from a Washington area firm by the embassy of a Communist bloc country. "They said they liked the antennas very much and planned to use them at their embassies in other locations. Naturally, we checked this. Their story was true."

Edward H. Stroh, deputy director of the Bureau of East-West Trade, says that like the West European export agencies, his office does not have enough technically qualified people to handle the backlog. It currently totals some 500 applications for export licenses from U. S. companies hoping to do business in Eastern Europe. But he expects to get the compliance job done.

"That doesn't mean spotting people at every port," says Stroh. "There are other ways of handling this problem, and we're looking at these ways now." For openers, the bureau is seeking additional funds to expand its technical staff and data-processing activities. Observes Brady dryly, "There's a realization here that the resources are inadequate to deal with the problems." □

★ NATIONAL ANTHEM ★

A Review of New Products and Literature from National Semiconductor • No. 1, January, 1976

National Rewrites the Book: LF 156 a New Standard of Comparison for Op Amps

National is very pleased to tell you about a new IC process that we've been working on. In fact—brushing modesty aside—we've come up with the industry's first major new linear process in a decade.

Put rather simply, we married the best that JFET technology offers to the best that bipolar technology offers. We call the union Bi-FET™ technology, and its first offspring are our LF155/156/157 op amps . . . so spectacular that they set completely-new standards for op amp performance.

The secret of Bi-FET performance is in the combination, on a single monolithic chip, of JFETS—well-matched via ion-implant techniques—with standard bipolar transistors. When reduced to practice—as in an op amp with JFET

(continued on page 77)

Tri-share RAM puts 4096 bits in 18-Pin Package

We've entered the 4K RAM marketplace in a big way with our MM5270—a read/write memory that represents a major breakthrough in the design of MOS memories.

The MM5270 makes use of a unique design concept, which we've dubbed Tri-Share™. The Tri-Share concept lets a single port serve three functions —read/write, logical chip select, and VCC—saving three leads needed by all other RAMs.

And since our new RAM also features a Tri-State®, common input/output lead, we've managed to reduce the package lead count for 4096 bits of memory from 22 leads, which most of you have had to deal with 'til now, to only 18 leads on our MM5270. This allows a PCB memory density nearly *twice* as great as that possible with 22-lead, 4K RAMs, which translates directly into dollars saved. Thus, you can assemble 4K memory systems at a cost lower than previously possible.

And while you're saving money you're acquiring high-speed performance: the access time of the MM5270 is 200 ns min.; its cycle time is 400 ns max. So if you're looking for an unbeatable combination of system economy and performance, look into our MM5270; it's got it all.

NSC does SO Make FETS

Junction FETs . . . by the carload. We make virtually every type of JFET on the market today, including some with characteristics superior to anything else available.

Look at our brand-new PF5101-3 (molded TO-92) and NF5101-3 (metal TO-72), for example. Specially selected for ultra-low-noise audio and video applications, these JFETs feature a common-source spot noise figure at 10 Hz of only 1.5 dB maximum; and a typical e_n of only 5-7 $nV/\sqrt{Hz}$ at 10 Hz, 2-3 $nV/\sqrt{Hz}$ at 1 kHz . . . superb in preamps for hydrophones, vidicons, particle detectors, and high-quality audio/video equipment in general.

Remember too that we pride ourselves on being the most flexible and cost-effective JFET supplier you'll find anywhere. So when you think FETs, think National.

We're Big on Small-Signal Transistors

Singles, duals, quads . . . Metal can, molded, and ceramic packages . . . All popular commercial, industrial, and military types, and in volume . . . The best prices in town . . . And customer service unequaled in the industry.

We've just upped our capacity for both existing and new JAN/JTX/JTXV types, for example. Check out our 2N3498/99, 2N3500/3501, and 2N3700. Or our 2N2920, a dual for which we're one of the few active suppliers of its JAN/JTX/JTXV versions.

We support memory and peripheral houses too: witness our DH3467/3725/6376 quads in both epoxy and ceramic.

We second-source Motorola, Fairchild, TI, GE, and Sprague, which gives us a package/pinout versatility second to none. And this lineup now even includes the popular "Silect" types—our new Series TIS9X, 2N581X, etc.

We're the only supplier of all-copper-lead-frame, Epoxy B TO-92 types; a combination that gives you the most advanced product you can buy.

Small-signal transistors are a very big business with us. Just tell us your needs; we'll meet them.

In Support of RAMs

Imagine a diagram that shows a large block of random-access memory surrounded by an array of smaller blocks; each of the smaller blocks is an interface circuit necessary to the operation of the memory itself. If you imagine further that National part numbers fill all the interface blocks, then you can see the significance of our DS3640-49 and DS36147/149 families of RAM support circuits.

Regardless of function, these circuits share a number of features: they can drive highly-capacitive loads; they have DTL/TTL-compatible inputs; there is a damping resistor in series with each output. (Companion series DS3670-79 and DS36177/179 feature,

(continued on page 78)

NATIONAL INTROS ACTIVE FILTER LINE

Whether you're after a Bessel, Butterworth, Cauer, or Tschebycheff function, our new AF100 active filter will do the job. You need only four external resistors to program it for any specific, second-order function; so if you wish to form, say, a sixth-order function, simply cascade three AF100s, embedding each in an appropriate resistive-programming network.

Lowpass, highpass, and bandpass functions are available simultaneously at separate outputs; notch and allpass functions are available by combining outputs in the unit's uncommitted summing amplifier.

Available to meet either commercial or military specs, and housed in both TO-8 metal-can and dual-inline packages, the AF100 operates from ±5 to ±18 V, and features independent frequency, gain, and Q adjustments, a Q range to 500, and operation to 10 kHz.

MD²™ Cuts System Display Costs

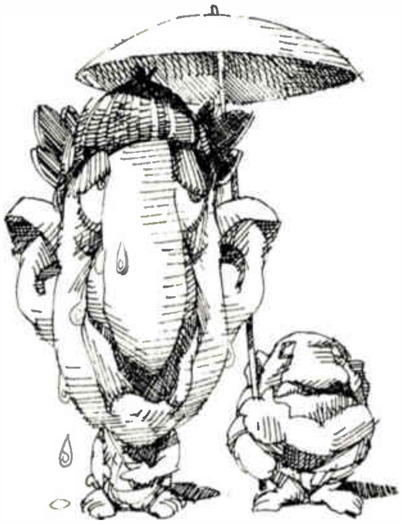
We've got a nifty item for any of you who have to display multiple digits. It's our MultiDigit Display family—MD²™ for short. Any member of this display family can significantly cut your display costs and, at the same time, improve the appearance of your LED readout because of MD²'s uniform segments, uniform digit-to-digit brightness, and good contrast.

Clocks, clock radios, appliance timers, instrumentation—you name it and MD² can handle it. Not only are dozens of display combinations possible, but MD² interfaces directly to MOS clock chips, MOS segment and digit drivers, DPM chips, even microprocessors and transducers.

MD² units are common-cathode displays (so far), with heights of either 0.3 inch or 0.5 inch. Both heights are end-stackable in multiples of five, for the 0.5-inch displays, or eight, for the 0.3-inch displays. And they're available in both multiplexed and direct-drive versions.

To find out more about the unique MD² concept, we suggest you call your local National sales office. Between our standard list and our custom options, we're pretty sure you'll find just what you're looking for.

Durawatt 92-Plus™... *A Surefire Way to Beat the Heat*



We bet you're one of many designers who've been playing the do-it-and-keep-your-fingers-crossed game. You know what we mean—trying to keep parts costs down by specifying TO-92 types and overstressing them "just a bit," because the next-higher-dissipation package costs maybe three-times more.

Sure, you win on short-term parts costs but . . . ZAP! You lose on long-term equipment reliability and service costs. Just when you thought you had it knocked.

That's been the story—either pay up or take a chance. Until now.

For our Durawatt 92-Plus™ types change the whole picture. A new line of general-purpose, complementary-symmetry power transistors, Durawatt 92-Plus devices take over where TO-92s fall short. They finally fill that long-empty slot—in dissipation *and* price—between TO-92s and the much-more-expensive, much-higher-dissipation packages.

With a 1200-mW dissipation capability, a built-in heat-dissipator tab, and 80-V/2-A maximum ratings, the Durawatt 92-Plus family is just what you've needed all this time.

No more "add on" dissipative components; no more compromises. Durawatt 92-Plus power types give you a solid dissipation capability at an affordable price, in an operating region where neither existed before. Remember the name—Durawatt 92-Plus. You can uncross your fingers now.

A Lamp for all Reasons

We call our new NSL4944 a *universal* lamp, for you can drive it with as little as 2 V or as much as 18 V, ac or dc. In response, our new lamp gives you uniform brightness (0.8 mcd, typ.) across that operating voltage range. Add a PIV of -18 V, and you've got a lamp unmatched in versatility by anything else in the marketplace.

The key to the NSL4944's wide-range operation is an IC current-regulator built into the two-lead T-1¾ package. As a result, the NSL4944 is the only lamp available that you can place directly across a TTL output and have it come on at TTL's guaranteed "1" state of 2.4 V. (The only other current-regulated lamp on the market comes on at 4.5 V, is usable to only 11, 12.5 or 16 V depending on the version, and its PIV is limited to 3 V.)

So no matter how you look at it—forwards or backwards—our NSL4944 universal lamp is unbeatable. Get a data sheet; or better yet—call your National salesman, ask for a sample, and see for yourself.

4-Digit Counters

We've recently introduced a family of 4-digit counters with some rather nice features that make them eminently suitable for clocks, DVMs, DPMs, and so on.

Each counter, for example, has an internal multiplexing circuit (which doesn't need an external clock) with four multiplexing outputs, NPN output sourcing-drivers for 7-segment displays, and an internal output latch. All of the counters operate from 3 V to 6 V, and source 80-mA (typ.) segment currents.

Let's start with the MM74C925—a basic 4-decade counter with Latch Enable, Clock, and Reset inputs. Next is the MM74C926: like the 925 except it adds a Display Select input, and a Carry-Out for cascade connection. (The Carry-Out goes high at 6000, low at 0000.)

The MM74C927 is like the 926, except that the second MSB divides by six, rather than by ten. This means that for a 10-Hz clock frequency the display reads tenths of seconds, seconds, and minutes.

Finally—the MM74C928: like the 926, except the MSB divides by two and the Carry-Out is an overflow indicator that is high at 2000, and goes back low only when the counter is reset. Thus, the MM74C928 is a 3½-digit counter.

A Review of New Products and Literature from National Semiconductor

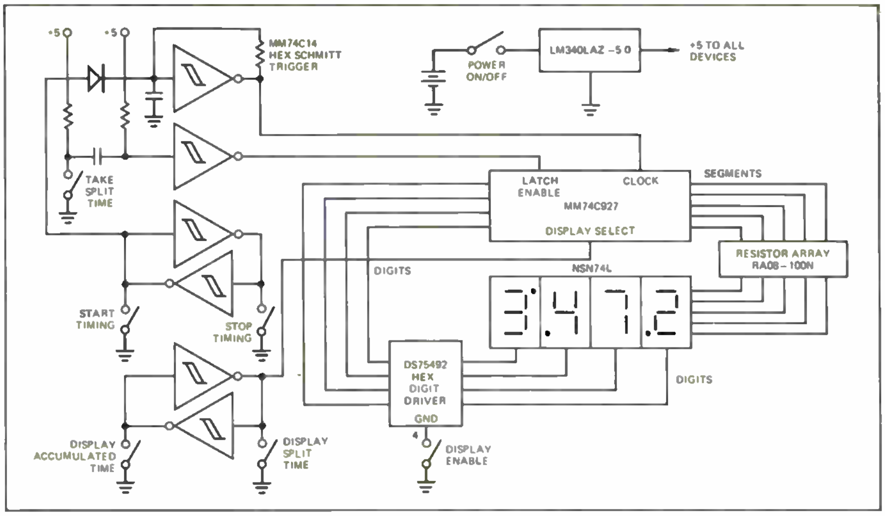
APPLICATIONS CORNER

Taking Time Apart... The Easy Way

Our MM74C925-928 family of 4-digit, multiplexed-output counters is well suited to a variety of instrumentation uses in which events must be counted and then displayed in a numeric format.

Consider the MM74C927, for example. In this part the second-MSB divides by six, which means that for a 10-Hz clock input the output display format is tenths of seconds, seconds, and minutes. This capability is exploited in the stopwatch design shown here, a very inexpensive circuit suitable for the timing of laboratory events, horses, swimmers, cars, soap-box racers, or whatever. The accompanying diagram shows the complete circuit.

A 10-Hz, RC, Schmitt-trigger oscillator provides the MM74C927's clock, which is started or stopped by a debouncer/latch formed by cross-coupled Schmitt triggers.



The Display Select debouncer/latch enables the contents of either the counter or the internal latch to the on-chip display drivers, which lets you read either accumulated time or split time (pulsing the Latch Enable line allows the taking of split time).

Grounding the emitter rail of the digit drivers enables the display; this technique yields a brighter display and longer battery life than would be otherwise obtainable. Uniform display brightness over the lifetime of the battery is assured by regulating the battery voltage to +5 V.

The voltage regulator, which also assures the stability of the RC clock oscillator, is our LM340LAZ-5.0, an inexpensive device housed in a TO-92 package. The switches, too, are inexpensive; with the exception of the main power-ON/OFF switch, all switches are Form-A contact, momentary-on types.

LF 156-Op Amps

(cont'd)

input, bipolar intermediate, and bipolar/JFET output stages—Bi-FET technology yields unbeatable performance. Witness these LF156A/LF356A specs, for example:

V_{OS}	2 mV max.
V_{OS} Drift	5 μV/°C max.
I_{OS}	10 pA max.
GBW	4 MHz min.
Slew Rate	10 V/μs min.
0.01% Settling	1.4 μs typ.
e_n	12 nV/√Hz, 1 KHz; 15 nV/√Hz, 100 Hz (typical)
i_n	0.01 pA/√Hz typ., 1 kHz and 100 Hz
CMRR	80 dB min.
Power BW	200 kHz

These specs are for our prime version; but if you look over the 14-page data sheet, which presents the specs of all prime and standard types (including wideband and low-current-drain versions of the basic LF156), you'll find that *all* our Bi-FET op amps offer you performance superior to anything you've seen before, whether for military, industrial, or commercial usage.

Our UAR/T, Your FIFO Make Beautiful Music Together

Our MM5303 Universal Asynchronous Receiver/Transmitter, while often found snuggled cozily next to a FIFO, quite contentedly makes its home wherever data processing equipment interfaces to data transmission lines—as in modems, quite obviously. But remember, too, that even in more esoteric situations—data rate changers, for example—an LSI UAR/T such as our MM5303 still buys you more for your dollar than does any other approach.

So much for philosophy. Getting right down to it, our MM5303 replaces the TR1602A and COM2017 in many applications, as well as the TR1402A, COM2502, and TMS6011 in many other sockets.

The MM5303 is fully programmable for 5-, 6-, 7-, and 8-bit word lengths, and operates at full or half duplex, simultaneously receiving and transmitting at different baud rates (30K max.). Parity generation/checking may be even, odd, or inhibited. Stop bits, either one or two; and, in addition, our MM5303 is internally connected to generate one-and-a-half stop bits when programmed for a 5-bit code.

For Sale by Owner: Voltage Regulator Handbook

At last . . . A definitive, how-to book of contemporary power-supply design, which tells you everything you'll have to know to design local power sources using three-terminal and dual-tracking monolithic voltage regulators.

In its more than one hundred pages, our Voltage Regulator Handbook takes you from the raw basics of power-supply design, through heat flow and thermal resistance theory, and on to applications. Along the way, you're shown the inner workings of these regulators, and learn how to expand their capabilities beyond the expected.

Finally, our Handbook not only describes and specifies most of National's extensive line of three-terminal and dual-tracking regulators, but also provides you a cross-reference listing that puts major, competing types in perspective.

The Voltage Regulator Handbook is yours for four dollars; at three cents a page, it's a bargain.

A Review of New Products and Literature from National Semiconductor

Relevant Education:
Microprocessor Training Schools

National offers complete, microprocessor training courses . . . in-depth sessions divided about equally between lectures and hands-on lab work. The lecturers are professionals in the microprocessor field, and you work with the same National devices, prototyping systems, and so on, that you'll use when you leave school and return home.

The courses offered are Microprocessor Fundamentals, Programmable Systems Design, Advanced Programming, and Microprogramming; the course prerequisites guarantee that you work with others at your level. Each course lasts four days (with an optional fifth day available for additional lab work or consultation), they cost $395, and are taught at permanent NSC facilities in Miami, Dallas and Santa Clara.

VIP CARD

Complete card and mail to
NATIONAL SEMICONDUCTOR
2900 Semiconductor Drive, Santa Clara, CA 95051
Attn: Marketing Services

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- ☐ **MD² Displays, Page 2, Col. 1**
- ☐ **Durawatt 92-Plus, Page 2, Col. 2**
- ☐ **NF/PF5101-3 FETs, Page 1, Col. 2**
- ☐ **MM5303 UAR/T, Page 3, Col. 2**
- ☐ **LM199 Zener, Page 4, Col. 3**
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- ☐ **MM74C925-928 Counters, Page 2, Col. 3**
- ☐ **Small-Signal Transistors, Page 1, Col. 3**
- ☐ **RAM Support Circuits, Page 1, Col. 3**
- ☐ **Microprocessor Schools, Page 4, Col. 1**

THINGS TO READ:
A Compendium of Recently-Issued Literature (e.g., stuff to file)

- ☐ **AN-125** LM377, LM378, and LM379 Dual 2-, 4-, and 6-W Power Amplifiers
- **AN-132** A new Interfacing Concept: the Monolithic Temperature Trans-
- ☐ **AN-139** MOS Encoder plus PROM Yield Quick-Turnaround Keyboard Systems
- ☐ **AN-142** Using a Microprocessor Beyond Apparent Speed
- ☐ **AN-144** Designing Memory Systems Using the MM5262
- ☐ **AN-147** Low-Cost IC Stereo Receiver
- ☐ **AN-151** Low-Noise JFET—the Problem Solver
- ☐ **LB-29** Low-Cost AM-Radio System Using the LM1820 and LM386
- ☐ **LB-30** Low-Cost LED Thermometer
- ☐ **μSpec 7** POWR I/O
- ☐ **μSpec 9** IMP-16 Assembler Programs
- ☐ **μSpec 13** Arithmetic CROM

WANTED:

QUESTIONS TO ANSWER

We would like to have a Question-and-Answer column as a regular feature of the National Anthem. We know that many of you, from time to time, have questions about our products . . . questions pertaining to their use, specs, or whatever. We will use the new column to answer as many of these as we can fit into a given issue.

The questions that we use in the Anthem will be those we feel to be of general interest to our readers. Nonetheless, all questions submitted will be answered, either in the Anthem or by direct correspondence.

Obviously, we need your help to make this idea work. We need your questions; and the sooner we receive them, the sooner we can answer them. To speed things along, we've allowed space on the VIP card for a question. Make use of it, and by helping us you'll help yourself.

Question: ______________________________

______________________________ E 1/6

Your End Product or Application: ______________________________

Please print clearly. This will be used as a mailing list. Have Salesman Call ☐ **YES** ☐ **NO**

NAME ____________________ TITLE ____________________

COMPANY ______________________________

ADDRESS ______________________________

CITY ____________ STATE ____________ ZIP ____________

In Support of RAMs
(cont'd)

instead of a damping resistor, direct, low-impedance outputs.) In addition, all of our RAM interface circuits make use of Schottky technology for good ac performance, and PNP input transistors to minimize loading.

The individual circuits that comprise our DS3640-49 and DS147/149 series of RAM support elements include Tri-Share™ port drivers, latch drivers (ours minimize propagation time and address skew because we use fall-through latches), refresh counters, address drivers, I/O registers, an enable demultiplexer, and clock drivers of all kinds (including the only available N-channel, single-supply device—our DS3642/72).

So if you're using a RAM (and who isn't?), remember who supports it. We've got the circuits that make it work.

6.95 V 'til Hell Freezes Over (and then some)

We've come up with the most stable Zener you've ever had the pleasure to work with . . . a Zener with an ultra-low TC (1 ppm maximum), in which both the Zener voltage (6.95 V ±2%) and the TC are insensitive to current over a 20:1 range (0.5 to 10 mA) . . . a Zener with an incredibly-low and stable dynamic impedance (typically, less than an ohm), very-low broadband noise (20 μVrms max.), and fantastic long-term stability (20 ppm typ.)!

We're talking about our LM199: a Zener combined with a temperature-stabilizer circuit on a single monolithic chip. From −55° to +85°C, the LM199 shows a 1-ppm max. TC (0.3 ppm typ.), which increases to only 15 ppm max. (5 ppm typ.) at +125°C. And it shows these TCs at currents from 500 μA to 10 mA. (Try this with any other so-called low-TC Zener and see what happens.) And if you need still better, we've got a prime version (suffix-A); this one even comes with 883 processing and/or certification of long-term stability.

Of course, if you don't need quite such a virtuoso performance, consider our LM299—0.3 ppm (typ.) to 1.0 ppm (max.) from −25° to +85°C; or our LM399—0.3 ppm (typ.) to 20 ppm (max.) from 0° to +70°C. Other than these differences in TCs, the LM199/299/399 are pretty much identical. So no matter what area you work in—military, industrial, or commercial—our super-low-TC Zeners stand ready to do a super job.

A Review of New Products and Literature from National Semiconductor

Companies

Executives' worries are global

Worldwide survey shows recovery, unemployment, inflation, financing are concerning the men who run electronics companies

As 1976 peers over the horizon, electronics executives around the world are worried about the slow recovery, especially in Europe. Particular concerns are unemployment and inflation. In fact, mindful of overly enthusiastic predictions of a full recovery by the end of 1975, most of those executives are unwilling to be anything more than hopeful about the coming year.

"After you've just come through a recession," says Charles E. Sporck, president of National Semiconductor Corp. of Santa Clara, Calif., "you don't end up being very bullish." While Sporck expects sales to rise, he is concerned about the continued slow business overseas. "The European market clearly has not shown the improvement that the U.S. has," he says, but "Europe will start contributing to growth [in the semiconductor market] in the spring."

Equally concerned about overseas business is Sporck's opposite number at Fairchild Camera & Instrument Corp. in Mountain View, Calif., Wilfred J. Corrigan. Foreign sales account for 30% of his company's activity. He notes that when business is bad overseas, those countries tend to buy their semiconductors at home.

"There's more of a chauvinistic attitude, and the hangover lasts a lot longer," he notes.

"International sales don't drop with quite the kerplunk of the U.S. because of one or two markets that remain strong," but the lag in foreign sales is still a nagging worry for Tektronix Inc.'s William D. Walker, group vice president and general manager for test and measurement operations. The lag "will dampen domestic sales" for the Beaverton, Ore., instrument maker, adds Walker. Conditions overseas also concern Control Data Corp.'s John W. Lacey, senior vice president for corporate plans and controls in the company's Minneapolis headquarters. "Generally, our feeling is that overseas economics won't recover as fast as the U.S. will—the picture is a pretty flat one," he says.

At TRW Inc., J.S. Webb, executive vice president responsible for worldwide operations of TRW Electronics, expects 1976 to be a better year than 1975 for his Los Angeles-based division. But Webb still is concerned about the need to fine-tune the growing rate of sales and production. The trick here, he says, is "not to write too much low-margin business, in order to have the capacity for better business" as conditions improve. Still, says Webb, a pickup should start in the third quarter of 1976.

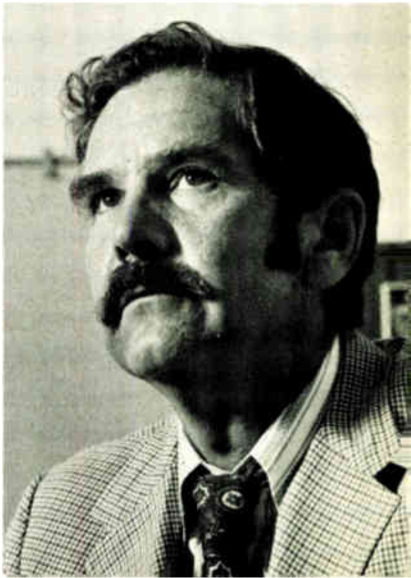
In the process-control industry, Robert W. Moe, vice president and general manager of Honeywell Inc.'s Process Control division, says he's somewhat concerned over the absence of strong signs of recovery in the industry. Moe adds that he's slightly optimistic about the prospects for his Fort Washington, Pa., operation, but is keeping a weather eye on Europe and Japan. If things

Bernhard Plettner
Siemens

Koji Kobayashi
NEC

J.S. Webb
TRW

Charles Sporck
National



Gerard Seelig
ITT

R.H. Jones
GE

Edouard Guigonis
Thomson-CSF

don't pick up there, he notes, the U.S. economy could be adversely affected.

Another concern for Moe is materials. He reasons that if the economy moves up too quickly, and inventory-stripped customers demand quick deliveries, there could be problems with suppliers. Moe also is pessimistic about the chances of a decrease in the rate of inflation. "I think the forces that are at work are going to heat that up again," he says.

Also watching the foreign picture with a worried eye is Roy H. Pollack, vice president and general manager of RCA Corp.'s Consumer Electronics division in Indianapolis, Ind. But Pollack's concern isn't with overseas economic recovery as such. Rather, he's worried about competition.

"Obviously very high on our list of concerns is Japanese imports," he says. "We've all seen the merchandise that has been hitting very, very low price levels for the last six to nine months, and the impact is felt at both distributor and retail levels. I wouldn't want to use the word 'dumping'—its meaning is always subject to debate—but there's very good reason to suggest that some of the pricing has not been on the basis of sustaining a healthy business," Pollack adds. But overall, Pollack sums up his list of concerns for 1976 under one very big word: "profitability."

The threat posed by Japanese business aggressiveness is also felt at Motorola Inc.'s Communications group in Schaumburg, Ill. Joseph F. Miller Jr., vice president and group executive, sees it as a real problem. "Not one stick of equipment manufactured in the U.S., Germany, England, or the rest of the world is type-approved in Japan, and we don't limit their activity here. We believe in free trade," he says, "but we think it should be fair trade, too."

But Miller's worries aren't limited to the Japanese. He's also concerned about cuts in Government spending, if the land-mobile industry will rebound after a flat 1975, and the possibility that cellular 900-megahertz systems "will not proceed as they were agreed upon. I'm concerned that the FCC will not rule against the telephone company on cellular private dispatch, which is not efficient reuse of the spectrum."

With many U.S. companies bothering about events overseas, what are some of the executives in Europe and Japan worried about? In Western Europe, the list varies from country to country, but includes recovery, inflation, inventories, price pressures, orders, and unemployment levels.

In Eindhoven, the Netherlands, headquarters of Philips Gloeilampenfabrieken, the largest electronics company outside the U.S., there is some queasiness about prospects for the coming year. While looking for improvement in such areas as consumer products, the Philips board of management, with president A.C. van Riemsdijk, put together a statement citing uncertainties ahead and saying: "We remain very concerned about the rate of inflation and the level of unemployment."

At ITT Europe in Brussels, president Maurice R. Valente pinpoints the consumer's attitude as a prime concern. "Our hopes and beliefs are predicated on a change in the consumer in 1976 from his present level of savings and mood of caution. This, in turn, is predicated on unemployment staying at its present level or even receding," he says. But at West Germany's largest electronics firm, Siemens AG in Munich, inflation is near the bottom of the worry list. There, the company forecasters, headed by president and chief executive officer Bernhard Plettner, warn, "The worldwide economic recovery might come much later than expected."

Farther west, the concerns take on a different slant at Thomson-CSF in Paris, France's top electronics firm. With its main products relatively recession-proof—radar, fire control, and air-traffic-control equipment—and a heavy order backlog, Thomson-CSF's major worry is R&D. Says senior vice president Edouard Guigonis: "Our main preoccupation is financing research and development, which is necessary to maintain our position in export markets. What we have done in the last year is get the results of our earlier R&D." Guigonis fears that the company won't be able to keep up with its American competitors, who have the advantage of big Government programs, especially for the military.

Ray Stata
Analog Devices

A.C. van Riemsdijk
Philips

William Ballhaus
Beckman

Thomson-CSF also does much of its business in components. Guigonis' big worry in that sector is prices. "Semiconductor prices are going down and down and down," he says, "and we find it difficult to hold our position against the conjunction of U.S. technology advances plus the investment [U.S. semiconductor houses] have made in the Far East in countries with low wages. They are making the maximum of their dominant positions. This is a problem we have not solved yet."

For Japanese electronics firms, the problem is the government. At least that's the view of Koji Kobayashi, president of Nippon Electric Co. Kobayashi's biggest concern as he heads into 1976 is that the government has not yet come to grips with the new economic conditions and hasn't formulated long-term plans. He thinks the government is overly afraid of inflation and says that excessive worrying about inflation can lead to planning mistakes by officials.

In addition to concern with economic conditions in other countries and competition from companies there, American executives mention a variety of other of worries occupying their attention. For Gerard L. Seelig of International Telephone & Telegraph Corp., 1976 will be a year of watching carefully where he puts his money. Seelig, a corporate vice president who heads ITT's semiconductor operations from headquarters in New York, says, "We were too optimistic. We were reaching too much into the fourth quarter. In 1976, our customers will have to demonstrate that their demand is real before we commit ourselves to capital investments or anything else in the asset-management area. We paid too dearly depleting our inventories [in 1975] and waiting for our customers to deplete theirs."

Reginald H. Jones, chairman of the General Electric Co., New York, says much the same thing. "The keys to GE's 1976 strategy," he states, "will be unrelenting cost control, effective cash management, realistic price improvement, and growth-oriented resource allocation."

Getting to the root of the executive's garden of worries—money—is Ray Stata, president of Analog Devices Inc. in Norwood, Mass. Stata's major concern is that equity financing is drying up for all but large companies. This means, Stata reasons, that his company, which makes components and modular instruments for measurement and control, won't be able to grow as fast as it could with sufficient equity gained through stock offerings.

"Venture capital simply isn't functioning," says Stata, "and small companies get hurt when the equity market dries up." He maintains that that larger companies have other sources to tap for expansion capital, such as the bond markets, "but the demise of equity markets is clear, and this discriminates against small companies." He points out that in 1974 there were just nine stock offerings by new companies worth an aggregate of $16 million. But in 1969 there were 698 that raised $1.4 billion.

Stata is equally worried about legislative efforts aimed at altering capital gains taxes and closing so-called tax loopholes. If successful, he believes, they could further chill investment in small companies. "There's great fervor legislatively," he says, "to pounce on tax loopholes without enough concern for side effects. Where are the Analog Devices, DECs, and Data Generals of tomorrow going to come from if this keeps up?" he asks.

As for how the situation affects Analog Devices itself, Stata finds it frustrating. "There are very good opportunities in the electronics industries going wanting for lack of capital investment, and Analog Devices could be doing more than it is to take advantage of them" if it had a deeper equity base. But Stata remains optimistic about 1976.

William Ballhaus, president of Beckman Instruments Inc. in Fullerton, Calif., is even more blunt than Stata. He says, "It's the adverse investment climate that is a major cause of our nation's economic difficulties." Ballhaus charges that the 1969 change in tax laws precipitated the downward econmic spiral. Those changes essentially increased capital gains taxes considerably while cutting deductible losses in half. □

Reporting for this survey was provided by Arthur Erikson, Margaret A. Maas, Ron Schneiderman, Larry Curran, Larry Armstrong, Gail Farrell, Judith Curtis, Larry Waller, Charles L. Cohen, John Gosch, and James Smith.

World electronics markets

MOUNTING A PUSH TOWARD A SLOW MODEST RECOVERY

Following a year of stagnation, even the relatively moderate growth anticipated for 1976 will be welcome to the world's electronics equipment and components makers

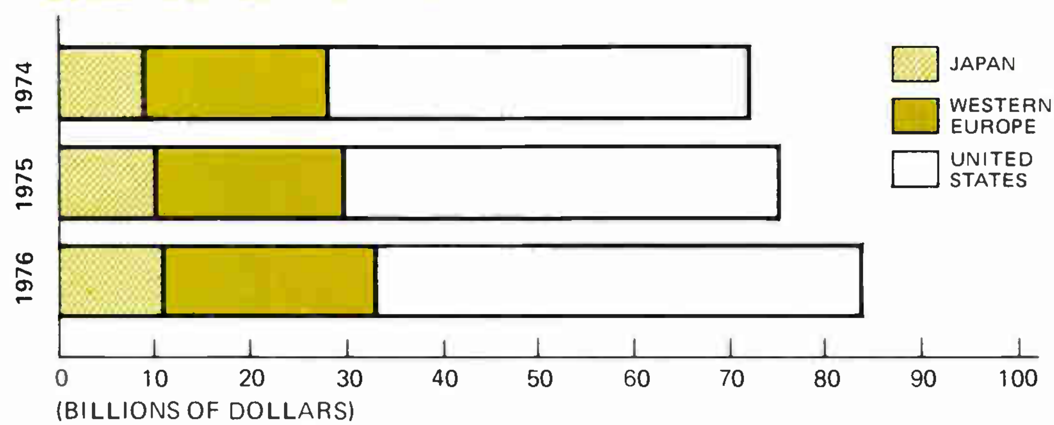
☐ For most of the electronics companies around the world, 1975 was a good year—a good year to forget, or to wish had never happened. But its disheartеningly low sales and profits can only make 1976 look better, since this year it looks as though the major world markets will at last get back on track, if only at moderate speed.

Electronics manufacturers foresee recovery, slow at first, then gradually picking up steam in the second half. Although confidence is running much higher this year than last, there are still doubts about the rate of the recovery.

The chief electronics markets, the United States, Western Europe, and Japan, all reacted alike last year. Major market sectors—computer and consumer in the U.S., consumer in Europe and Japan—did not perform with enough vigor to bring up the total sales curves. In addition, continued inventory reductions of semiconductors and passive components further depressed parts manufacturers' sales.

As noted a year ago, because the recession has been worldwide, electronics producers hit the decline almost simultaneously. By the same token, recovery is proceeding this year at about the same rate in the three major markets. However, it appears that the economy in general, and electronics business in particular, will recover at a faster pace in the U.S. than in either Western Europe or Japan. The recovery will not be uniform, either. In Europe, for example, West Germany and France will regain momentum faster than Great Britain. Also, different electronics industries will lead or lag the industry average; for instance,

DOMESTIC CONSUMPTION OF ELECTRONIC EQUIPMENT IN THE MAJOR MARKETS



consumer electronics, led by color TV, will spark the U.S. and European recoveries, while computers will give Japan its lifting power.

The predictions that *Electronics* has collected from companies in these major markets the world over indicate that this year is going to be worth remembering. Total equipment consumption for the U.S. is projected to be $50.04 billion, a 10.1% gain over 1975. For West Europe, the 1976 total should be $21.29 billion, 10.4% better than the previous year. Estimated total equipment consumption in Japan this year is $11.44 billion, 11.5% above the 1975 total. The grand total comes to $82.77 billion.

While the similarities among the three markets are many, due in part to the international character of technology, there are special indicators to watch in each. In the United States, for example, inventory rebuilding of components will shape the year to come. Users had slashed parts inventories to the bone so that the pickup in orders now experienced by semiconductor and passive-components firms may mean an end to pipeline filling and a sign of renewed expansion. Another indicator is spending for new plant and equipment by American business. McGraw-Hill's Economics Department pegs total investment plans for all companies at $123.45 billion for 1976, a 9% increase above the depressed 1975 level. More specifically, manufacturers plan to increase capital expenditures by 8%. According to McGraw-Hill, the gross national product should rise 11.7%, with real growth up 5.5%. A third indicator, consumer spending, is expected to loosen up as well, although no buying spree is expected.

In Western Europe, a prime factor will be how quickly West Germany snaps back. Another question will be how badly Great Britain's economy will lag. A relatively new factor, the growth of exports of weapons systems and aircraft to the Middle East, should continue to swell electronics sales to the defense contractors.

An important indicator in Japan will be how and when the government puts its latest plan to revitalize the economy into effect. Since almost everything in Japan is done by consensus, it's going to be a long process, perhaps too slow to suit the nation's impatient industrial giants. In the past the Japanese have been inclined to export their way out of recessions. So while the government struggles to develop a domestic program, another indicator to watch will be Japan's export level.

On the whole, the world electronics market should show gradual improvement through the year. Perhaps growth will not be up to the percentages enjoyed in the past, but after 1975, who can complain?

U.S. MARKETS

☐U.S. electronics manufacturers enter 1976 with cautious optimism, anticipating gradual sales improvements that will turn into a good second half. Unspectacular as this prediction is, after 1975 it's a solid vote of confidence.

Business was expected to turn around in 1975, yet producers found their hoped-for recovery to be elusive. Instead, there was stagnation or actual decline in the U.S. electronics markets. According to a consensus of manufacturers surveyed by *Electronics*, the total equipment consumption of $45.4 billion for 1975 was only 4% above 1974. Hardest hit was consumer electronics, off 5.3% at $6.54 billion.

Components fared even worse than equipment. Passive devices declined in 1975 by 7% to $4.66 billion. Semiconductors also suffered a whopping decline: down 23% to $1.8 billion. As so often before, inventory reductions contributed to the slack in components orders and compounded the problems of parts makers.

In short, 1975 was a bummer, almost a slow-motion replay of the last recession to hit the electronics industries. The key word here is slow-motion, for there was no quick recovery as expected, but instead a frustratingly gradual climb out of the slump. However, it appears that the boom-to-bust cycle time is getting shorter. The last bust was 1970–71, and the next decline could very well come along in 1978–79, rather than 1980.

The worst of the present downturn appears over, however, and this year promises a return to meaningful growth. Contributing strongly to the 10.1% gain in the U.S. electronics equipment market forecast for 1976 will be consumer electronics, with a growth of better than 14%. Communications will turn in 1976's best growth percentage, 15.6%. Computers, industrial controls, and test equipment are all expected to register gains.

Component parts should also enjoy a happier new year with passives estimated to grow by 8% and semiconductors expected to increase by over 23%. End users have already loosened their close-to-the-vest inventory policies so that orders are picking up rapidly in anticipation of general sales improvements.

Edging out of the doldrums

More with a sigh of relief than a smile, the data-processing industry is edging out of the doldrums that lasted from late 1974 through mid-1975. This coming year, the total market should rise by about 10%, hitting close to $19 billion in purchases of computers and data-processing peripherals and office equipment.

For computers in general, 1975 was not a good year. Over-all shipments were off by some 11.5%. As the worldwide economic picture brightens, data-processing systems will find more buyers, but even so 1976's estimated figure of about $6.4 billion will just barely show growth over 1975's $6.25 billion.

That old bugaboo of the computer market—waiting to see what IBM will do—will account for some of the sluggishness, as will a residual conservatism in customers' budgets for capital investment. Will 1976 be the year in which IBM announces its successor to the System/370? It would not be a bad bet, but the odds would be better if 1976 had 18 months.

The move to decentralize

Meanwhile, the trend everyone has been following for the last year is distributed processing—putting the processing power closer to the actual users in the operational centers of a business. In conformity with the trend, large centralized systems will be extended by the addition of communications facilities and terminals. As a result, data terminals will achieve an increase of 9.4% to $1.13 billion, with the intelligent-terminal category showing a very healthy increase, growing by more than 26% to $290 million.

At the other end of the computer line, minicomputer manufacturers are continuing to make headway as they peck away at the market in small business systems with the new distributed-processing concepts. Consequently, *Electronics* projects that computer systems in the medium-range class, being the most vulnerable to distributed-processing systems, will suffer a 20% decline. The small computer systems, by contrast, will grow by 10% to $1.1 billion.

Purchases of minicomputers aimed at original-equipment manufacturers should show an upturn as the OEMs exhaust their inventories. Of course, the biggest unknown in 1976 will be the impact on OEM minicomputers of the solid-state newcomers, semiconductor microprocessors and microcomputers.

Undoubtedly, the bulk of the semiconductor microprocessor sales will go into low-level applications that have never been open to minicomputers. However, full microcomputer assemblies from semiconductor manufacturers will cut into low-end OEM minicomputer sales because they will use the latest in LSI technology and cost less.

Minicomputer manufacturers, of course, are moving to counter this threat in two ways. A major readymade defense is their present large investment in software for compatible lines of processors. In a more aggressive move, they have introduced their own custom-designed microcomputers. Digital Equipment Corp., for example, introduced the LSI-11 early in 1975 and says that the coming year will be a "building and delivering" year for the 16-bit microcomputer. It won't be going just to a few big customers but, DEC says, to hundreds of different customers, 70% of whom are new on its customer list. This indicates that new market areas are indeed being opened by these type computers.

What attracts first-time users

First-time users probably make up the healthiest part of a data-processing market. The IBM System/32, introduced in January 1975, has been selling "substantially beyond forecasts," according to the company, which says it increased production levels in July. Close to 5,000 System/32s were shipped in 1975, and shipments could easily double in 1976. In fact, some analysts say they could quintuple to 25,000 for 1976.

The key to wooing and winning the first-time user is easy-to-use software. IBM, when it announced its System/32, for example, offered prepackaged software in five "industry application packages" and subsequently added eight more. In 1976 users may even be able to obtain additional programs through the System/32 user's society, which is headquartered in Las Vegas and will act as a clearing house.

Manufacturers of input/output peripheral equipment have, by and large, passed through the recession period with only a pause in their growth curves. Overall, this area will see somewhat less than 7% growth in 1976 climbing to $1.6 billion. However, data-storage peripherals should do better, hitting $3.27 billion, a 20% growth for 1976.

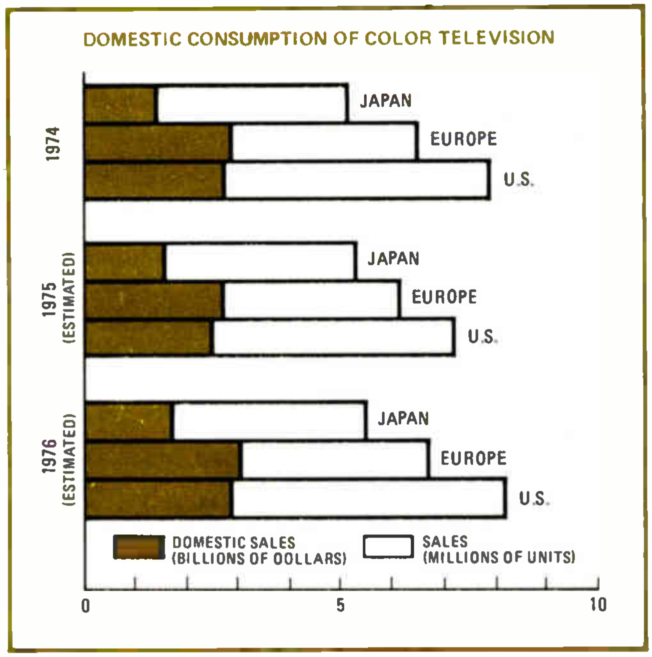
IBM's model 3850 mass-storage system, introduced in late 1974, was shipped in September of last year. The first system went to NASA Goddard Space Flight Center in Greenbelt, Md. Although the 3850 was initially billed as a virtual-memory unit for direct on-line access to data, first uses will probably be only as automated tape libraries to reduce costs of manual handling. The 3850 carries a high price tag—it costs $496,050 to buy a minimum, 35-billion-byte model—and thus is only for the really big users. Control Data Corp.'s entry in the mass-storage system market, the 38500, will be delivered in the second quarter of 1976, with volume shipments scheduled for early 1977.

Then there's IBM's model 5100 portable computer. This machine is probably a probe by IBM into an essentially unexplored market, albeit one with vast potential. Though not a major weapon in the company's over-all product arsenal, the 5100 could cause a real sales explosion this year and will be watched closely.

They're buying again

Instead of taking off swiftly in midyear, as expected, the consumer-electronics market has been laboring along more or less at the level to which it fell a year ago. Some products did improve in the second half, however, and by now the pent-up demand among consumers is beginning to erupt.

So 1976 should be a solid year for color television, audio, calculators, digital watches, and newly arrived electronic games. The *Electronics* survey puts total 1975 consumer consumption at $6.5 billion, down slightly from 1974's $6.9 billion, but predicts a comeback and a return to nearly its pre-recession dollar level—a 14.5% increase over 1975.



What the people want

A look at the key product categories shows where the strengths and weaknesses are:

- Television. Disappointing is the word for 1975 color-TV sales. Unit sales to dealers, initially predicted to be around 8 million sets, did not reach even 7 million. This year, however, manufacturers predict that 7.8–8.7 million sets worth better than $2.9 billion could be sold, thanks to new, deluxe features such as electronic tuning, plus television coverage of special events like the Olympic Games, the presidential conventions and election, and the various Bicentennial observances. During the second half of last year, Japanese imports picked up rapidly amid torrid price competition.

Black-and-white TV, incidentally, is beginning to resemble radio sales in its unspectacular but steady performance. Over 5.5 million sets should be bought this year and, though monochrome dollar value dropped under $500 million last year, it is expected to increase to $531 million this year.

- Audio. If American companies have been hurting in sales and profits, the Japanese imports have not. The total audio consumption in the U.S. should gain slightly, reaching $2.5 billion in 1976, according to *Electronics* figures. Last year, hi-fi equipment stayed level at $542.5 million, but is expected to jump 11% this year. As always during hard times, the stereophile equipment at the upper end carried the whole market, while the low-end products slumped. Audio tape equipment, dominated by imports, hung in there, reaching $731 million last year and projected to hit $743 million this year.
- Microwave ovens. Americans are beginning to like them as much as the Japanese and indeed are willing to pay for the higher-priced models. According to the *Electronics* survey, the dollar value sold this year should surpass Japan sales by some $52 million, $426.3 million compared to $374.2 million. Part of the reason for this reversal is that the high-priced U.S.-made and Japanese models are popular in America.
- Calculators. Sales of handheld calculators have just about leveled in the U.S., totaling $268 million in 1975. The balance of production for all types of calculators has again shifted to Japan. Thus, while U.S. consumption is estimated to be over 21 million units this year, less than half will be American-made.
- Solid-state watches. Having quickly established a strong demand for themselves, these products should earn twice as many dollars in the coming year—$225 million. The market is also consolidating—about half the present 45 or so manufacturers and 70 or 80 name brands should drop out by the end of the year.
- Automotive electronics. Demand for cars is already becoming less inhibited, and, if Detroit is right in predicting 1976 sales of 9 million plus cars, electronics will be one beneficiary. Engine controls for fuel management and pollution abatement will benefit most. This year the trucking industry should make substantial progress in developing standard electronic testing procedures for electrical and engine performance and, if so, it will add a completely new and lucrative diagnostics equipment segment to the automotive market.

The two new products due to make a start this year are video games and video disks. Much closer to taking off are the games, which cost between $65 and $700. Besides the tennis or ping-pong games, it will soon be possible to play more elaborate racing, flying, and other action sports on the TV screen, some even in color.

Even the most bullish believers in video disks do not expect this market to take shape this year. The competing optical, capacitance, and mechanical-stylus systems will need heavy promotion to interest consumers, and large libraries of software will also have to become available.

CB, mobile radio on beam

Though sales are humming along in some segments of the communications-equipment market, which showed a 10.9% rise to $3.02 billion in 1975, a good deal of last year's uncertainty still persists. The slow economic recovery is still discouraging many buyers and hence curtailing telephone companies' expansion plans.

But citizens' band radio and the land-mobile markets are flourishing, and recent rulings by the Federal Communications Commission are stimulating competition with AT&T. Businessmen eager to cut costs are considering new private-branch-exchange equipment, and the breakthrough in earth-station costs promises to strengthen the market in satellite communications.

Capitalizing on citizens' band

Ever since March 1974, the FCC has been receiving some 200,000 citizens' band license applications per month. This figure topped 300,000 last October and could easily keep growing throughout 1976. In addition, retailers have been eagerly latching on to the fact that seemingly almost everyone has a use for a CB radio—from the truckdriver warning other truckers about radar speed traps to the housewife calling neighbors to gossip.

Consequently, the market for CB radio equipment last year jumped 80% to $360 million, according to the *Electronics* survey, and looks to be heading for $500 million by the end of 1976 and possibly $790 million by the end of 1979. About $100 million of that 1979 figure could come from the more sophisticated class E CB gear that will soon start being available.

In land-mobile radio, much of the action right now is in the uhf bands below 512 megahertz, at any rate in the cities, where the vhf channels have been crowded for some time. And once the new 900-megahertz mobile radiotelephone systems start up, land-mobile sales should grow still faster. Bell's field trial of the first such cellular system in Chicago isn't scheduled until 1978. But the market could grow substantially before 1980, thanks to the FCC's decision last year to open it not just to Bell but to all financially "qualified" common carriers who can show a public need for a cellular system. What's more, Motorola Communications divisions, Schaumburg, Ill., has announced [*Electronics*, Dec. 11, 1975, p. 95] the availability of a complete turnkey mobile-radio system that is fully compatible with Bell's.

On the interconnect market, independent manufacturers of private-branch exchanges are confronting Bell's new Dimension PBX with its two-tier pricing. (For a lease period of several years, a Dimension user pays equipment and maintenance charges, then after that pays only a maintenance charge.) Till now, the independents have enjoyed a head start over Bell for computerized telephone-management services. Now in great demand by business users, these services typically record information about outgoing calls automatically and route users' calls the cheapest way.

On the regulatory side, the FCC is planning to do away with its rule that there must be a Bell-approved interface module on all equipment directly connected to the local telephone lines. As of April, the rule will no longer apply to modems and data terminals anyway. But if other equipment also is made exempt in April as planned, manufacturers will obtain a new freedom to innovate that could open the gates to all kinds of interconnect devices. Meantime, the ancillary-device market (answering devices, automatic dialers, decorator phones, etc.) will grow rapidly. *Electronics* places this market at $12.4 million this year, up 44%.

Unlike suppliers of PBX and key telephone sets, however, most modem makers don't view the FCC decision as a boon to sales. Though their prices will drop slightly, the change won't be enough to encourage new users.

A real erosion in modem prices, though, will start in the late 1970s as low-cost LSI devices take over many modem functions. This erosion will get further impetus as competition increases and as Bell extends its Dataphone Digital Service, which eliminates the need for modems on those phone lines.

As communications satellite channels become increasingly available, more earth stations will be needed both in the U.S. and abroad to cope with the demand for more telephone, telex, television, data, and facsimile transmission. The fastest-growing segment of this market is the low-cost small earth station, which uses small antennas (less than 30 feet across) and efficient time-division-multiple-access techniques. *Electronics* pegs this market segment at about $55 million in 1976.

Mobile takeover. Police communications equipment in the nation's capital will be completely portable with the newer units serving as mobile radios when plugged into the charger in the car.

Electronic controls gain

After a lethargic 1975, the industrial electronics market is entering 1976 in a more ebullient but still cautious mood. By the year's end, the total U.S. consumption should reach $1.6 billion, versus $1.4 billion in 1975. And if the Government extends the investment tax credit or lowers the corporate income tax rate, spending could spurt higher. But growth will occur erratically.

In the process industries, for example, chemical firms plan a 23% increase in capital expenditures, while steel producers will cut spending by 2% over 1975. Petrochemical companies will stay about level with last year, when, however, they spent double what they had in 1974. The petroleum industry, viewed as a large potential purchaser of electronics, has soft-pedaled expansion plans in the light of uncertain oil consumption and a muddled picture of energy conservation coming from Washington lawmakers. Machine tools, on the other hand, will climb back close to 1974 levels, and machine-tool controls will follow suit.

Overall, industrial electronics will gain, mainly because the electronics content of capital equipment continues to grow and not because of any surge in capital expenditure. In fact, the McGraw-Hill Economics department in its latest survey predicts a flat year—manufacturers plan to spend about 8% more this year than last on capital goods, which in real terms represents a 2.2% gain.

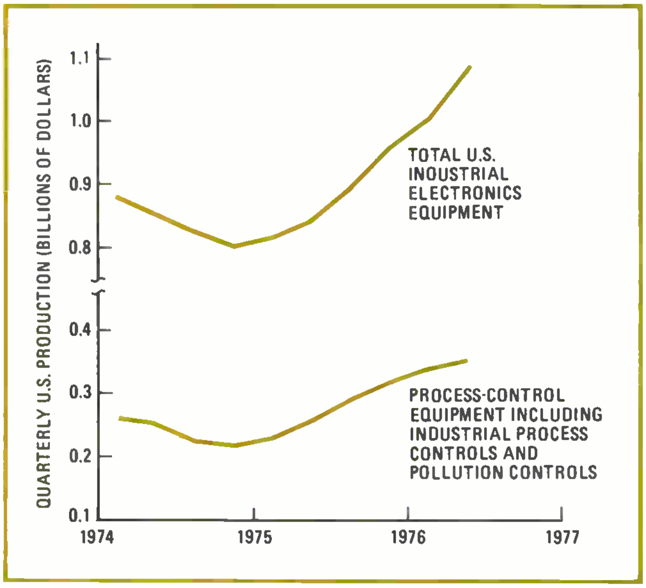
The process-control segment of the market should have a gradual upturn during the beginning of 1976 with a much stronger surge in purchases during the second quarter. Growth in real dollars will average about 5.5%, which is less vigorous than in the early 1970s, but still a healthy figure.

The war on waste heats up

Most notably, manufacturers will be purchasing more analytical instrumentation, to the extent that the market should grow about 9% to $422 million in 1976, according to the *Electronics* survey.

What's promoting this growth is a demand for tighter process control to prevent waste, increase productivity, and lower fuel bills. Moreover, the microprocessor is making it possible to implement these controls more easily and more economically. As a result, more advanced controls are being used at a lower level in the system than before. Distributed control, involving at least one microprocessor-based unit as part of the overall hierarchical system, will evolve as a major trend in 1976, with chemical and petrochemical producers moving toward it the fastest.

An active extension of the process-control market this year will be in equipment for monitoring pollution and logging pollution data. Particularly lively will be smokestack monitoring—instrumentation for measuring what is going up the stack and in what quantities. Esso Research Corp., under the sponsorship of the Environmental Protection Agency, has estimated that the stack-monitoring market, which was less than $5 million in 1973, will grow to $80 million by 1980.



Recovery in 1976. According to market research firm Gnostic Concepts Inc., the industrial electronics market will begin to climb sharply in the third quarter of 1976. Gnostic's equipment total includes categories not listed by *Electronics* such as industrial production and test equipment, materials handling and sensors. Production dollars are quarterly estimates and are not adjusted for inflation.

Automated production machinery and machine tools, dependent on industry's capital spending for new plants and equipment, should revive this year. As capital spending programs were revised downward in 1975, orders for machine-tool controls declined rapidly, down 50%. But the decline has bottomed out, and orders are now coming in at the best rate in over a year. That doesn't mean all is well, however, because orders were not all that good a year ago.

Thus, machine-tool builders expect the recovery to be gradual, gaining strength later this year. By the end of 1975, orders will probably be double the 1975 level, putting backlogs slightly below the 1974 total.

Growth for the electronics segment of this market will be greater than for the machine-tool market as a whole, because numerically controlled machines are in demand to compensate for a growing shortage of skilled machinists. Similarly, plastics processors are having trouble finding employees who are willing to operate extruders and molding machines. So these companies are forced to hire people with less than adequate skills and to compensate for this fact by purchasing more automated equipment. This trend will also force growth in machine controls for plastics-processing machinery.

Automatic testers spur gain

Last year, test and measuring instruments hardly moved from zero center in terms of real growth. But this year should see a much larger swing of the needle to the plus side. The U.S. market has already begun to recover, and if the economy revives and R&D budgets expand during 1976, as expected, the outlook is quite hopeful.

Cutbacks in research and development spending following the economic downturn of 1974 caused such a softening in 1975 demand that only the increase in exports kept U.S. instrument makers from just keeping pace with inflation. Thus the nearly 7.6% dollar gain in consumption—to $1.05 billion—registered during 1975 exceeded the inflation rate by only a few percentage points. However, inflation is expected to be less of a factor this year, so the 12% increase projected for 1976 looks much more substantial in real terms.

Testers replace skilled labor

To summarize the prospects for this year, automatic testers and medical diagnostic and surgical support equipment will be among the best performers. In addition, test equipment designed for use by firms that produce and maintain such communications products as citizens' band radios can anticipate a good year. Digital panel meters, too, are expected to increase their penetration into the OEM market, in many cases at the expense of analog panel meters, which are facing a drop in dollar volume. But prospects for other products, such as signal sources, will depend on the rate of their technology change.

Medical equipment use is being spurred by improved performance, along with faster and lower-cost operation. A 19% spurt to $1.41 billion is expected in 1976, and high growth rates will continue.

The advent of Medicare, by increasing the number of patients requiring multiple tests, has created a booming market in both multi-channel, multi-test and simpler, dedicated analysis equipment. Most in demand are ultrasonic scanners, which are a safer way of viewing internal organs than either X rays or surgery, and instruments for automated blood analyses (count, glucose, electrolyte, and blood-urea-nitrogen), which can save on a technician's time and wages. One new medical X-ray technique enables doctors to view cross sections of a patient's body. Called computerized axial tomography, it is creating a possibly billion-dollar worldwide market [*Electronics*, Sept. 4, 1975, p. 65].

WORLDWIDE SALES OF DIGITAL VOLTMETERS AND MULTIMETERS, 1975 – 80

Type	Annual sales (millions of dollars)					
	1975	1976	1977	1978	1979	1980
Low-cost	22.0	26.0	31.0	37.0	41.5	47.0
Bench	37.0	38.0	39.0	40.0	40.0	40.0
System	16.5	18.0	21.0	23.5	25.0	29.0
Total	75.5	82.0	91.0	100.5	106.5	116.0

The desire to cut operating expenses despite rising labor costs is also popularizing automatic test equipment. Use of automatic integrated-circuit testers, which rose a disappointing 12% in 1975, should post a 22% gain in the coming year as IC manufacturers themselves make better profits. An even higher growth rate of 27% should be enjoyed in 1976 by manufacturers of automatic test equipment for loaded printed-circuit boards. Consumption of digital board testers should jump better than 29% in 1976 and analog testers nearly 24% as their cost continues to decline and more IC users find it economical to invest capital in lowering operating expenses over the long term.

The same considerations will boost automated microwave-measuring equipment. Over the next few years this figure is expected to go from $8.5 million in 1976 to $16 million in 1979.

Of more immediate interest is the projected increase in purchases of communications test equipment. Part of the gain will result from sales of citizens' band radios and from the opening of the 900-megahertz communications channel. For instance, demand for under-1-gigahertz counters should be 12.6% higher in 1976 than in 1975, and a larger percentage of general-purpose test gear such as digital multimeters will be bought for communications applications.

Technological change for the better

The over-all view for digital multimeters shows higher growth rates for the less costly 3½-digit-and-below units than for higher-resolution DMMs. In 1976, the lower-cost units should have a sales increase of about 13%, while the higher-priced units should grow about 5%. Prices of digital multimeters will go on dropping as more instrument makers introduce less precise DMMs, with accuracies to within 1% or 2% instead of 0.1%, and as DMMs using single-chip converters become more common. Single-chip converters may also lure more semiconductor firms into the DMM and digital-panel-meter business, integrating vertically as they have in watches and calculators.

Technological change, or lack of change, strongly influences growth in other areas, too. In signal sources of below-microwave frequencies, for example, sales for the most mature product line, oscillators, will be static, and demand for signal generators—also a mature line—will be soft. But generators, which are still improving in performance, will closely track the industry average, and the more sophisticated frequency synthesizers will outpace the trend for test and measuring instruments.

The chips are flying

It was a lean and hungry year for semiconductor manufacturers. Down by more than 23% from 1974 levels, U.S. consumption in 1975 failed to reach the $2 billion mark and shrank to the pre-1973 level of $1.8 billion. All segments of the industry suffered—discretes falling to $664 million, down 25% from 1974, and integrated circuits falling to $938 million, down 24%.

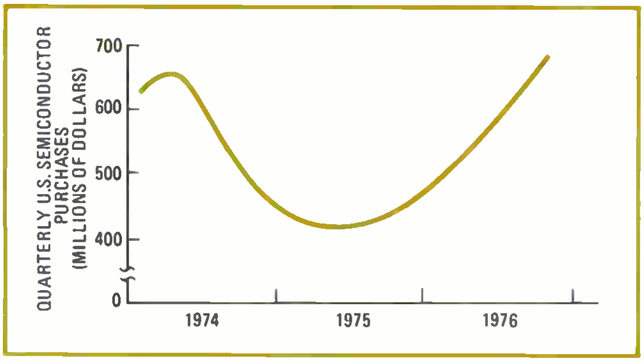
This year, however, promises a return to abundance by the second half, when an improved economy, stimulated by the approaching presidential election, should once again quicken the demand for electronic equipment and hence semiconductors. The total market is expected to grow more than 23% over 1975, reaching $2.2 billion at year end. Consumption of ICs should swell, while discrete purchases should rise by 12%.

The recovery in semiconductor consumption has already begun, but its painfully slow start occurred late—toward the end of 1975 and not around midyear, as had been hoped. Instead, equipment manufacturers, notably in the consumer and computer areas, responded to a sharply reduced demand for their products by holding components inventories at typically five-week levels. This policy kept production schedules at semiconductor suppliers at near-starvation levels. And the pincer of low inventory and slackened end-product demand will last at least through midyear.

The old order changeth . . .

Hardest hit in semiconductors are the high-volume commodity items—small-signal discretes, TTL and C-MOS standard logic, as well as low-end linears, such as operational amplifiers and comparators.

TTL dropped 47% from 1974 levels, reaching a mere $165.2 million, as fewer computers and less industrial control equipment were produced. Moreover, the interest in microprocessors for new system designs is squelching hope for further growth. The only upbeat TTL product was low-power Schottky, which tacked up a tidy 15% gain in dollar purchases, partly because more suppliers started up production and partly because of rising demand from builders of high-speed, low-power military systems and industrial process controls. For next year, purchases of Schottky LSI are expected to boom at the expense of standard Schottky (except possibly for low-power types) and reach $70 million.



Complementary-MOS was another poor performer in 1975. Dropping more than 20% from 1974 levels, the collapse surprised most observers, who thought the low-power easy-to-use features of the C-MOS would assure continued strength, especially in industrial control and timing. But oversupply, plus a shrinking industrial base from mid-1974 on, led to price cutting throughout 1975. And although the number of units shipped actually remained flat (whereas TTL units slumped), the depressed price levels brought C-MOS domestic consumption to the $60 million level, and the weaker suppliers began dropping out. Nevertheless, prospects for C-MOS remain good, and the market in standard and custom devices should total $75 million to $80 million by year end.

The most flourishing of all semiconductor devices in 1975 were undoubtedly memories and microprocessors. Nourished by new MOS and bipolar technology, these LSI devices will continue to thrive for years to come.

Last year, the RAM market outperformed the semiconductor market as a whole—though it still declined by 12% to $152 million—and this year it is expected to surge upward by more than 30%. The n-MOS RAMs—static devices for peripheral designs and dynamic devices for main memory—will lead the way, followed by bipolar and C-MOS RAMs.

. . . yielding place to new

In 1976, too, the industry will feel the effect of the commercial production of microprocessors. Last year, there was a great deal of prototyping and sample purchasing but not much high-volume buying. This year, however, the number of suppliers will grow, prices will decline, and equipment manufacturers will become used to microprocessor-system design, so the big buys should begin—first as logic replacement techniques in consumer applications, computer peripherals, and industrial controls, and then, as performance grows, in on-line control and computer controllers.

The market potential of microprocessor systems is indicated by last year's performance when microcomputers (microprocessors plus memory and input/output devices) reached U.S. sales of nearly $70 million, an increase of almost 50% from 1974. What's more, domestic consumption should double this year, reaching the $135 million mark, and could well approach $500 million by 1980.

By far the largest market share belongs to the general-purpose 8-bit system—it probably accounts for over three quarters of U.S. sales this year. But looming in the wings are the new 16-bit single-chip microprocessors, which could make significant inroads into new minicomputer and process-control applications.

Components

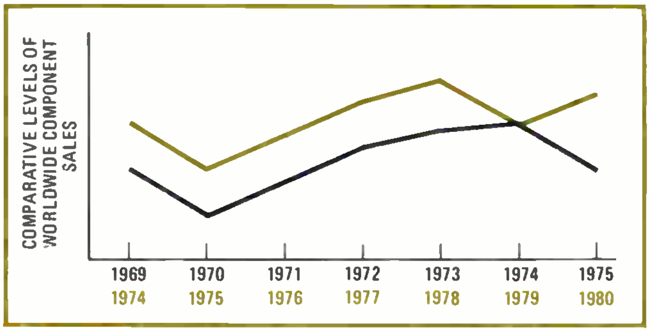
Moving to firmer ground

Still reeling from a very unsettling 1975, component makers are hoping for a firmer 1976. Most agree that the worst is over, but a solid turnaround has yet to establish itself. And unless there is a sweeping improvement in the general economy, the upturn in component consumption will continue to be gradual through the better part of 1976.

But even with this slow recovery, most components should finish out the year at dollar levels very close to what they were during the boom years of 1973 and 1974. Furthermore, the brisk business pace of the final quarter should carry over into 1977, which could be an exceptional year, as real growth resumes and shortages become likely. But the business cycle for components is getting shorter, as noted in the figure on the right, and consumption will probably be plunging downward again within three years from now.

For the most part, business continued to be sluggish through much of 1975, although it began picking up slightly around midyear. As a result, many components had finished out the year at depressed levels. But according to the *Electronics* survey, 1976 consumption should be much better than 1975's—rising 15% to $619.3 million for capacitors, 9.5% to $431.3 million for resistors, 9% to $292.4 million for switches, and 6% to $341.8 million for relays.

Actually, even now, conditions are ripe for a full recovery. In recent months, even though high-volume long-term orders have been few and far between and competition for new orders has been fierce, confidence in the turnaround has been growing. The rate of new orders is picking up steadily, and these newer orders are for bigger contracts, involving more parts and sometimes even protracted delivery over several months or so. Moreover, components purchases should pick up in the consumer market, which was the first to take a nose dive but has already begun a slow recovery.



The inevitable cycle. Worldwide components sales should begin to recover in 1976, as real growth returns and a new but shorter business cycle begins, with only four years or so between recessions.

Federal

Ford's priorities rule

The Office of Management and Budget's mandate from the White House is to trim Federal spending by 28% in fiscal 1977. Yet even if there is a significant fourth-quarter downturn in Federal outlays—and planners surveyed by *Electronics* expect no worse than 10–12%—Government electronics spending will hover near a record-setting $14.7 billion. The $799 million increase, though, should barely offset inflation.

More than 91% of that increase—some $731 million—will be absorbed by the Defense Department, reflecting President Ford's priorities. Nearly half of the $13 billion for defense electronics will go for procurement, with avionics and related ground equipment showing relative strength as major buys of fighter planes proceed. The nearly $3.9 billion for research, development, test and engineering outlays, on the other hand, will reflect smaller growth overall, although weapons development funding will rise at the expense of new research efforts.

The slowdown in Government spending for nonmilitary research, development, and hardware is especially bad news for the National Aeronautics and Space Administration. Its $810 million electronics expenditure in 1976 represents less than a 2% increase that doesn't come close to keeping pace with inflation. That means smaller sales of electronics to the aerospace giants.

One small bright spot in the nonmilitary spending area can be found at the Energy Research and Development Administration in its schemes for developing new solar and laser-fusion power sources. ERDA's $60 million spending program for these areas in 1976 is not large as Federal programs go, yet it is more than double last year's $25 million. Laser-fusion research, pegged for $40 million, is seen as spawning a new market for nanosecond-sensitive, pulse-measuring instrumentation to monitor new power plants.

Apart from advanced air-traffic-control and communications concepts now being translated into hardware, the Department of Transportation promises little new for electronics vendors in 1976. Costly R&D for next-generation rail and mass-transit systems has been reduced to in-house paper studies in the face of skyrocketing construction cost projections.

U.S. MARKETS FORECAST 1976

Market estimates represent industry-wide consumption (at the factory level) of goods shipped by U.S. and foreign manufacturers for the U. S. market. Some product categories have been added, deleted, or redefined. Therefore these totals are not directly comparable to those of previous years.

(millions of dollars)	1974	1975	1976	1979
COMPONENTS, TOTAL	**5,019.4**	**4,662.5**	**5,055.9**	**6,040**
Capacitors, total	**695.9**	**539.8**	**619.3**	**862**
Paper	85.2	69.3	76.0	77
Film	87.8	73.0	84.3	106
Electrolytic	286.0	212.7	222.5	326
Aluminum	138.7	98.0	107.5	148
Tantalum	147.3	114.7	115.0	178
Mica	37.0	23.5	25.9	33
Glass and vitreous enamel	6.9	6.6	6.0	4
Ceramic, except chips	149.2	120.4	157.0	242
Variable	12.6	13.1	18.3	24
Chip	21.0	13.2	20.9	39
Other	10.2	8.0	8.4	11
Connectors, total	**562.6**	**577.1**	**638.4**	**744**
Coaxial, standard size	39.3	40.6	46.0	54
Coaxial, miniature	20.0	21.5	26.5	32
Cylindrical, total	132.0	146.5	155.5	184
Standard	30.5	29.0	31.0	36
Miniature	55.0	60.0	64.0	79
Subminiature	46.5	57.5	60.5	69
Rack and panel	131.0	117.0	132.7	154
Fused	12.5	14.5	16.5	21
Printed-circuit	124.5	131.0	145.5	164
Card-insertion	55.5	57.5	63.5	70
Two-piece, metal-to-metal	31.5	35.0	39.5	46
Plate-module	37.5	38.5	42.5	48
Special-purpose	73.3	72.7	78.7	93
Device sockets and socket panels	30.0	33.3	37.0	42
Electron tubes, total	**1,113.2**	**1,066.8**	**1,142.6**	**1,199**
Receiving	176.0	155.0	135.0	80
Power and special-purpose, total	325.5	346.5	355.6	368
High-vacuum	62.3	60.0	60.0	56
Gas and vapor	15.4	14.6	15.0	12
Klystrons	41.5	38.0	35.0	32
Magnetrons	42.5	41.0	41.5	38
TWTs, including backward-wave	60.0	84.3	89.2	100
Light-sensing	11.0	12.5	13.3	15
Image-sensing, including TV camera and image-intensifier	36.4	38.3	40.6	48
Storage	15.6	15.5	16.5	16
Cathode-ray, except TV	31.3	33.3	36.0	44
Other	9.5	9.0	8.5	7
TV picture, black-and-white	37.0	36.0	32.0	20
TV picture, color	574.7	529.3	620.0	731

CONSUMER ELECTRONICS

(millions of dollars)	1974	1975	1976	1979
CONSUMER ELECTRONICS, TOTAL*	**6,908.2**	**6,537.6**	**7,484.6**	**10,059**
Television receivers, total	**3,378.6**	**2,972.8**	**3,448.4**	**4,276**
Black-and-white	563.8	489.4	531.2	562
Color	2,814.8	2,483.4	2,917.2	3,714
Consumer audio equipment, total	**2,432.3**	**2,341.8**	**2,522.0**	**3,265**
Radios, total	869.5	770.0	873.0	1,197
Table, clock, and portable radios	580.5	500.0	591.0	787
A-m only	180.0	145.0	160.0	145
Fm only	7.0	5.0	6.0	12
A-m/fm	393.5	350.0	425.0	630
Automobile radios	289.0	270.0	282.0	410
Phonographs and radio-phonographs	319.6	298.4	303.5	312
Portable	148.3	147.6	150.0	152
Console	171.3	150.8	153.5	160
Tape recorders and players	700.7	730.9	743.0	893
Automobile players	220.0	200.0	188.0	210
Cassette and cartridge player/recorders	146.7	164.3	180.0	232
Reel-to-reel players/recorders	44.0	49.0	50.0	33
Tape player/radio combination	290.0	317.6	325.0	418
Hi-fi audio components	542.5	542.5	602.5	863
Stereo	487.5	480.0	507.5	688
Four-channel equipment	55.0	62.5	95.0	175
Other consumer electronics products, total	**1,097.3**	**1,223.0**	**1,514.2**	**2,518**
Antennas, TV, and radio	41.9	43.6	46.2	55
Home video players/recorders	5.0	7.0	9.9	22
Electronic organs, other instruments	230.0	240.0	280.0	478
Intrusion alarms, fire monitor	142.0	150.0	154.5	168
Electronic assembly kits	55.8	63.1	70.0	91
Microwave ovens	242.6	306.3	426.3	773
Calculators (four-function, personal)	265.0	268.0	276.0	301
Electronic watches	100.0	125.0	225.5	581
Digital clocks	15.0	20.0	25.8	49

* Includes domestic made equipment off shore products sold under U.S. labels and domestic and foreign label imports

(millions of dollars)	1974	1975	1976	1979
SEMICONDUCTORS, TOTAL	**2,345.0**	**1,801.5**	**2,220.1**	**3,533**
Discrete semiconductors, total	**888.1**	**664.7**	**744.8**	**877**
Diodes, total	285.9	218.2	223.1	245
Signal, total	46.3	34.2	33.0	29
Silicon	43.3	32.0	31.0	28
Germanium	3.0	2.2	2.0	1
Rectifier, total	147.4	103.1	102.0	116
Silicon	100.4	88.1	89.0	102
Selenium, copper oxide	22.0	7.0	6.0	6
Assemblies	25.0	8.0	7.0	8
Zener, total	52.5	45.0	49.0	53
Voltage regulator	41.5	36.0	37.0	37
Reference	11.0	9.0	12.0	16
Special-purpose, total	39.7	35.9	39.1	47
Microwave, total	28.1	25.9	29.4	38
Avalanche	0.9	1.0	1.3	3
P-i-n	6.0	6.0	6.9	8
Gunn	1.4	1.4	2.0	4
Impatt	0.8	0.7	1.0	2
Varactor	8.3	8.2	8.8	10
Mixer and detector	9.7	7.6	8.4	10
Other	1.0	1.0	1.0	1
Tunnel	3.6	2.0	1.7	1
Varactor (less than 1 GHz)	8.0	8.0	8.0	8
Transistors, total	489.9	352.8	410.4	491
Silicon bipolar, total	429.4	309.0	365.4	442
Small signal (less than 1 W)	190.5	119.5	128.0	115
Power (1 W or more)	181.8	144.3	180.7	263
Rf and microwave	32.1	26.2	33.7	44
Duals and arrays	25.0	19.0	23.0	20
Germanium bipolar, total	24.5	15.8	12.0	9
Small signal (less than 1 W)	9.0	4.5	3.0	1
Power (1 W or more)	15.5	11.3	9.0	8
Field-effect	36.0	28.0	33.0	40
Thyristors	86.3	73.7	89.3	122
Miscellaneous sensing devices	26.0	20.0	22.0	19

(millions of dollars)	1974	1975	1976	1979
Filters, networks, and crystals, total	**177.6**	**181.0**	**194.1**	**232**
Passive electric wave filters	37.4	38.5	39.2	42
Crystal filters	27.3	29.5	33.8	47
RFI and EMI filters	40.0	42.0	44.1	50
Active filters	3.6	3.9	5.0	12
RC networks	8.8	8.1	10.0	14
Delay lines	14.0	12.0	12.0	8
Quartz crystals, mounts, and ovens	46.5	47.0	50.0	59
Magnetic, total	**321.0**	**334.5**	**346.1**	**382**
Computer memory cores	32.0	30.0	28.0	21
Transformers, chokes, except TV	211.9	228.5	242.5	286
Laminated	136.9	147.8	156.7	184
Toroidal	46.0	49.7	52.6	62
Pulse transformers	29.0	31.0	33.2	40
TV components	57.0	58.0	58.6	60
RF coils	20.1	18.0	17.0	15
Microwave hardware, total	**79.2**	**82.0**	**90.3**	**113**
Mixers	11.7	11.7	13.0	17
Detectors	3.0	3.0	4.5	6
Passive components, total	30.0	31.5	34.1	43
Waveguide	8.0	8.5	9.0	10
Coaxial and stripline	22.0	23.0	25.1	33
Switches, total	9.4	10.0	11.1	14
Waveguide	2.7	2.8	3.3	4
Coaxial and stripline	6.7	7.2	7.8	10
Ferrite devices, total	21.4	21.8	23.3	28
Isolators	6.3	6.5	7.2	9
Circulators	11.0	10.7	11.0	12
YIG devices	4.1	4.6	5.1	7
Power limiters	3.7	4.0	4.3	5
Printed circuits, total	**389.3**	**292.4**	**294.0**	**420**
Single layer	64.2	34.1	49.5	55
Two layer	216.7	168.0	135.3	191
Multilayer	83.1	71.2	85.7	119
Flexible	25.3	19.1	23.5	55
Readout devices, total	**153.8**	**171.0**	**194.2**	**272**
Discrete, total	43.6	45.8	56.0	73
Gas discharge	3.8	3.0	2.8	2
Incandescent	11.0	12.3	18.0	20
Fluorescent	1.3	1.5	1.7	3
Light emitting diode	27.5	29.0	33.5	48

(millions of dollars)	1974	1975	1976	1979
Multidigit, total	110.2	125.2	138.2	199
Gas discharge	20.0	24.0	27.5	40
Incandescent	1.5	2.0	2.5	4
Fluorescent	1.8	2.0	2.5	5
Electroluminescent	2.5	3.0	3.5	5
Light emitting diode	76.0	80.0	82.5	105
Liquid crystal	3.4	8.2	12.7	27
Plasma panel	5.0	6.0	7.0	13
Relays, total	**332.8**	**321.6**	**341.8**	**413**
General purpose	80.0	75.0	79.0	100
Telephone-type	30.0	25.0	25.5	30
Crystal can	25.5	26.7	28.7	32
High-sensitivity	18.0	20.0	22.6	31
Reed	38.0	29.3	32.7	38
Stepping and impulse	6.5	6.5	5.5	3
Time-delay	21.5	19.0	18.0	21
Solid-state	11.3	11.0	14.3	22
Other	102.0	109.1	115.5	136
Resistors, total	**445.3**	**393.9**	**431.3**	**484**
Fixed, total	221.9	189.3	206.6	227
Composition	69.7	53.3	58.3	57
Deposited carbon	23.5	26.0	27.0	32
Metal film	61.7	51.7	60.3	70
Wirewound	67.0	58.3	61.0	68
Variable, total	160.2	144.8	158.5	172
Potentiometers, wirewound	35.0	32.3	33.5	35
Potentiometers, non wirewound	64.7	57.7	63.0	67
Trimmers, wirewound	20.7	17.3	18.7	18
Trimmers, non wirewound	39.8	37.5	43.3	52
Other	18.5	20.0	21.2	25
Resistive networks, total	44.7	39.8	45.0	60
Thin film	3.5	3.2	3.5	6
Thick film	39.2	33.6	38.4	47
Other	2.0	3.0	3.1	5
Switches, total	**269.5**	**267.6**	**292.4**	**360**
Small-movement snap action	51.7	53.0	55.0	66
Lighted	37.5	39.0	45.5	69
Push button	21.6	22.7	27.0	41
Toggle	16.0	14.0	16.0	18
Slide	12.0	12.0	14.0	17
Rotary	36.2	32.4	34.4	38
Coaxial	10.8	10.5	10.5	8
Thumbwheel	12.0	12.0	17.0	23
Keyboard, single key	14.0	14.0	14.0	18
Keyboard, assemblies	52.7	53.0	53.0	50
Solid state, including Hall-effect	5.0	5.0	6.0	12
Transducers, total	**83.5**	**73.6**	**75.1**	**90**
Pressure	29.2	24.7	26.3	32
Position	11.8	10.1	10.6	13
Strain	19.0	18.1	17.1	20
Acceleration	9.7	8.7	8.7	10
Other	13.8	12.0	12.4	15
Wire & cable, total	**395.7**	**361.2**	**396.3**	**469**
Coaxial cable	120.0	105.0	115.0	143
Flat cable	22.7	26.7	32.3	53
Hook up wire	128.0	114.5	120.0	137
Multiconductor, shielded	65.0	60.0	70.0	73
Multiconductor, unshielded	60.0	55.0	59.0	63

(millions of dollars)	1974	1975	1976	1979
Integrated circuits, total	**1,236.5**	**938.1**	**1,236.1**	**2,315**
Digital logic, total	611.4	364.0	458.2	634
RTL	3.3	2.0	1.0	1
DTL	45.4	36.8	34.1	30
TTL	311.3	165.2	218.6	280
ECL	35.8	28.0	37.6	65
C MOS	75.6	60.0	66.7	138
Other MOS	140.0	72.0	100.2	120
Semiconductor memory, total	297.0	256.8	343.5	705
Read only, total	90.8	74.0	106.3	167
Bipolar	36.4	30.0	40.9	65
MOS	54.4	44.0	65.4	102
Random access, total	173.3	152.0	203.7	495
Bipolar	57.5	45.5	70.5	130
n MOS	44.2	65.2	102.2	325
p MOS	68.6	36.8	24.5	20
C MOS	3.0	4.5	6.5	20
Shift registers, total	32.9	30.8	33.5	43
Bipolar	1.5	1.2	1.6	3
MOS	31.4	29.6	31.9	40
Microprocessors, total	45.9	67.7	133.6	483
CPUs	20.2	28.5	54.0	127
Associated memory	15.7	25.9	55.1	288
Input/output	10.0	13.3	24.5	68
Calculator chips, total	35.4	42.5	49.9	77
Personal, 1 chip	18.6	21.6	28.6	40
Scientific, 1 chip	10.6	16.1	17.2	30
Special, 1 chip	3.5	2.4	1.6	3
Multichip sets	2.7	2.4	2.5	4
Other digital functions	21.0	15.2	17.5	35
Analog ICs, total	225.8	191.9	233.4	381
Op amps	91.1	81.5	90.9	148
Other, total	134.7	110.4	142.5	233
Industrial	37.3	31.0	38.6	53
Communications	27.4	24.0	27.0	37
Consumer	38.6	29.4	41.1	73
Interface	31.4	26.0	35.8	70

(millions of dollars)	1974	1975	1976	1979
Optoelectronic devices, total	**81.7**	**72.0**	**92.3**	**147**
Photovoltaic cells	7.4	6.8	8.0	10
Photoconductive cells	4.4	3.3	4.2	3
Light-emitting diodes	27.5	22.5	26.0	37
Photodiodes, including arrays	7.5	4.5	6.0	8
Phototransistors, including arrays	12.5	11.0	13.0	16
Couplers and isolators	16.0	19.5	28.7	63
Silicon targets	6.4	4.4	6.4	10
Multicomponent and hybrid circuits, total	**138.7**	**126.7**	**146.9**	**194**
Op amps	15.6	15.5	16.8	18
Data-handling devices, total	42.3	38.8	45.1	58
A-d converters	16.3	12.0	17.3	24
D-a converters	15.5	15.5	16.3	19
Sample and-hold	4.0	4.0	4.0	4
Multiplexers	4.5	4.8	4.5	5
Other	2.0	2.5	3.0	6
Functional circuits	9.0	11.3	17.3	20
Modular voltage/current sources	4.5	3.9	5.7	8
Miscellaneous custom functions	51.3	48.2	52.0	72
Other	16.0	9.0	10.0	18

INDUSTRIAL AND COMMERCIAL MARKETS

(millions of dollars)	1974	1975	1976	1979
INDUSTRIAL AND COMMERCIAL, TOTAL	**23,706.6**	**25,004.9**	**27,861.6**	**39,834**
Test and measuring instruments, total	**971.3**	**1,045.4**	**1,171.0**	**1,511**
Non-microwave equipment, total	**845.6**	**913.0**	**1,025.5**	**1,327**
Spectrum analyzers	35.6	39.3	44.0	53
Frequency synthesizers	24.0	24.8	28.3	37
Function generators	12.4	12.6	14.0	18
Signal generators	33.0	35.0	37.0	44
Sweep generators	9.1	9.4	10.2	13
Pulse generators	13.0	14.3	14.8	18
Oscillators	9.3	9.3	9.4	9
Waveform analyzers, distortion meters	34.0	36.5	39.5	45
Counters, time and frequency	47.5	48.5	54.6	63
Panel meters, total	38.0	42.5	49.8	64
Analog	20.0	19.5	19.3	22
Digital	18.0	23.0	30.5	42
Noise measuring	3.1	3.5	3.9	5
Analog voltmeters, ammeters, multimeters	19.3	19.3	18.8	19
Digital multimeters, total	43.8	47.1	50.8	62
3½ digit and below	14.5	16.8	19.0	25
4½ digit and above	29.3	30.3	31.8	37
Power meters	8.5	9.0	9.9	13
Calibrators and standards, active and passive	10.2	11.5	13.0	16
Oscilloscopes, total	209.9	220.6	249.9	331
Non-plug-in	118.0	125.3	144.1	190
Plug-in, main frame only	57.6	60.3	66.7	89
Accessories and plug-ins	34.3	35.0	39.1	52
Recording instruments, total	147.8	159.5	170.9	211
Magnetic-tape	60.5	68.5	74.3	94
Strip chart	66.0	69.0	72.3	86
X-Y	21.3	22.0	24.3	31
Automatic test, total	76.1	87.8	108.4	171
IC testers	28.3	31.7	38.7	63
Component testers	8.2	10.5	11.6	15
Pc-board testers, total	39.6	45.6	58.1	93
Digital	25.8	30.8	39.8	68
Analog	13.8	14.8	18.3	25
Manual test, total	23.6	26.2	29.2	42
IC testers	5.0	6.0	7.2	12
Component testers	12.0	12.5	13.0	18
Logic analyzers	5.0	6.0	7.0	9
Logic probes	1.6	1.7	2.0	3
Amplifiers, total	42.4	50.5	62.6	84
Lab type	8.7	9.8	11.0	14
Signal conditioners	33.7	40.7	51.6	70
Phase-measuring	5.0	5.8	6.5	9
Microwave equipment, total	**125.7**	**132.4**	**145.5**	**184**
Phase-measuring	17.7	17.8	19.3	23
Impedance-measuring equipment, total	9.9	10.8	12.0	16
Slotted lines	0.9	0.9	0.8	1
Network analyzers	6.0	6.8	7.5	10
Vector voltmeters	1.5	1.5	1.8	2
Bridges	0.5	0.6	0.7	1
Time-domain reflectometry	1.0	1.0	1.2	2
Power-measuring	5.7	6.1	6.6	8
Computerized automatic measuring	7.3	7.8	8.5	16
Spectrum analyzers	17.5	18.3	20.0	23
Wavemeters	0.9	0.8	0.8	1
Frequency counters	10.0	11.0	12.0	16
Noise-measuring	1.6	1.9	2.8	3
Signal generators	12.0	13.0	14.0	17
Sweep generators	26.0	27.0	30.3	38
Modulators	0.8	0.8	0.9	1
Field-intensity meters and test receivers	5.0	5.5	6.0	8
Antenna-pattern measuring	5.5	5.5	5.6	6
Oscillators	5.8	6.1	6.7	8
Analytical instruments, total	**368.8**	**387.4**	**422.0**	**531**
Chromatographs, total	43.0	42.0	47.0	68
Gas	29.0	26.0	29.0	38
Liquid	14.0	16.0	18.0	30
Spectrophotometers, total	103.0	108.0	119.0	144
Infrared	17.0	18.0	21.0	25
Ultraviolet-visible	36.0	35.0	39.0	46
Atomic absorption	25.0	28.0	30.0	35
Other	25.0	27.0	29.0	38
Mass spectrometers	26.0	28.0	30.5	39
Nuclear magnetic-resonance spectrometers	30.0	32.0	34.5	43
Electron microscopes	17.0	18.0	19.6	25
pH meters and ion-selective electrodes	22.7	24.7	26.7	33
Spectrofluometers	11.8	12.0	12.5	15
Spectropolarimeters	1.8	1.9	2.0	3
Thermal analyzers, total	8.5	8.8	9.5	13
Differential	4.0	4.1	4.5	6
Thermogravimetric	1.5	1.5	1.5	2
Differential-scanning calorimetric	3.0	3.2	3.5	5
X-ray analysis	35.0	39.0	43.3	57
Other	70.0	73.0	77.4	91

(millions of dollars)	1974	1975	1976	1979
Data processing systems, peripherals, and office equipment, total	**16,691.0**	**17,236.0**	**18,961.7**	**27,281**
System shipments, total	7,070.0	6,253.0	6,375.0	9,625
Microcomputers	20.0	75.0	170.0	475
Portable computers	---	3.0	75.0	350
Mini (less than $50,000)	600.0	775.0	930.0	1,100
Small (up to $420,000)	900.0	1,000.0	1,100.0	1,500
Medium (up to $840,000)	1,200.0	1,000.0	800.0	1,000
Medium/Communication (up to $1,680,000)	1,450.0	1,000.0	900.0	1,300
Large (up to $3,360,000)	1,700.0	1,300.0	1,300.0	2,200
Giant (greater than $3,360,000)	1,200.0	1,100.0	1,100.0	1,700
Add-on memory, total	215.0	220.0	220.0	235
Core systems	165.0	145.0	130.0	95
Semiconductor systems, MOS and bipolar	50.0	75.0	90.0	140
Data storage devices, total	2,475.0	2,728.0	3,269.2	4,048
Disk	1,160.0	1,240.0	1,401.2	1,950
Flexible-disk	23.0	25.0	38.0	76
Drum	92.0	83.0	80.0	72
Tape	1,200.0	1,380.0	1,750.0	1,950
Input/output peripherals, total	1,364.0	1,496.0	1,593.0	1,872
Card read/punch	235.0	240.0	238.0	240
Line printers	480.0	500.0	510.0	580
Serial printers	100.0	125.0	130.0	185
Non-impact printers	18.0	32.0	60.0	95
Computer input/output microfilm	70.0	90.0	100.0	132
Optical character readers	350.0	400.0	452.0	535
Magnetic ink character readers	38.0	38.0	30.0	20
Electromechanical plotters	47.0	44.0	45.0	47
Paper tape devices	26.0	27.0	28.0	38
Key entry, total	454.0	318.0	271.0	296
Key punch/verify	225.0	125.0	95.0	75
Key-to-tape	80.0	40.0	20.0	5
Key-to-disk	79.0	75.0	71.0	55
Keyboard-to-casette/cartridge	70.0	78.0	85.0	161
Data terminals, total	953.0	1,037.0	1,135.0	1,626
Keyboard printers	130.0	100.0	75.0	75
CRT	300.0	350.0	400.0	500
Intelligent	220.0	230.0	290.0	400
Interactive graphic	68.0	70.0	72.0	135
Audio-response	10.0	12.0	13.0	16
Remote-batch	225.0	275.0	285.0	500
Source-data collection equipment, total	496.0	767.0	1,186.5	2,664
Point-of-sale systems, total	323.0	429.0	562.0	1,030
Electronic cash registers/terminals	285.0	380.0	500.0	900
Credit-authorization terminals	28.0	32.0	42.0	75
Electronic scales	10.0	17.0	20.0	55
Banking systems, total	28.0	63.0	95.0	240
Automated terminals, cash dispensers	25.0	28.0	45.0	110
Teller terminals	3.0	35.0	50.0	130
Industrial systems, total	70.0	75.0	79.5	94
Ticketing, stock quote, and other	75.0	200.0	450.0	1,300
Office equipment, total	3,664.0	4,417.0	4,912.0	6,915
Desk-top calculators, total	545.0	540.0	570.0	625
Programmable	170.0	180.0	195.0	230
Non-programmable	375.0	360.0	375.0	395
Word-processing	270.0	360.0	480.0	850
Dictation	98.0	142.0	160.0	185
Copying	1,300.0	1,500.0	1,600.0	2,000
Facsimile	75.0	90.0	110.0	135
Electronic typesetting	176.0	185.0	192.0	220
Accounting/bookkeeping	800.0	1,000.0	1,100.0	1,800
Printing/duplication	400.0	600.0	700.0	1,100
Automotive electronics, total	**182.3**	**191.0**	**229.2**	**631**
Voltage regulators	44.8	40.0	30.0	15
Anti-pollution systems	30.0	40.0	57.2	131
Electronic ignition systems	38.0	60.0	81.0	166
Fuel-injection systems	3.0	5.0	11.0	83
Safety systems, total	66.5	46.0	50.0	236
Anti-skid controls (truck and car)	25.0	33.0	40.0	150
Air-bag sensors and controls	2.5	6.0	4.0	80
Seat-belt interlocks	38.0	5.0	3.0	1
Radar collision-avoidance systems	1.0	2.0	3.0	5

(millions of dollars)	1974	1975	1976	1979
Communications equipment, total	**2,720.3**	**3,016.7**	**3,486.1**	**4,733**
Radio, total	1,144.3	1,350.3	1,594.0	2,170
Aviation mobile, including ground support	55.0	57.0	60.0	75
Marine mobile (ship and shore stations)	20.0	23.0	25.0	30
Land mobile (mobile and base stations)	570.0	610.0	690.0	900
Microwave relay, including cable systems	246.3	235.3	245.0	270
Satellite earth stations	40.0	50.0	55.0	85.0
Amateur	13.0	15.0	19.0	20
Citizens' band	200.0	360.0	500	790
Navigation systems	140.4	148.0	152.0	166
A-m and fm station	38.5	42.6	44.7	51
TV station, excluding CATV	136.3	126.3	127.6	142
Telemetry (industrial only)	23.6	28.0	31.6	44
Switching systems (central office and PABX)	260.0	280.0	308.0	400
Voice terminals (autodialers, autorecorders, etc.)	6.0	8.6	12.4	28
Paging systems	31.5	33.0	40.0	47
Intercoms	135.0	138.0	142.0	155
Laser communications systems	7.8	8.8	9.7	13
Nonbroadcast TV, total	123.3	114.1	127.1	181
CATV, total	84.2	73.8	82.7	121
Studio and head-end	6.4	6.3	8.4	10
Distribution	30.3	24.0	27.7	39
Transmission lines and fittings	34.5	27.5	25.0	37
Converters	13.0	16.0	21.6	35
CCTV, total	39.1	40.3	44.4	60
Cameras	23.1	24.2	27.2	40
Monitors	8.0	7.8	8.6	10
Auxiliary	8.0	8.3	8.6	10
Video recording units (nonconsumer)	18.6	20.0	21.2	25
Data communications, total	655.0	719.0	875.8	1,311
Modems	90.0	100.0	150.0	225
Remote concentrators	110.0	125.0	163.8	316
Message-switching systems	135.0	152.0	183.9	300
Front-end processors	270.0	282.0	307.3	390
Multiplexers	50.0	60.0	70.8	80
Industrial electronic equipment, total	**1,300.5**	**1,447.2**	**1,629.5**	**2,325**
Motor controls (speed, torque),	106.5	110.0	118.8	147
Numerical controls, total	93.7	100.5	111.2	144
Point-to-point	20.7	18.0	18.0	24
Contouring	73.0	82.5	93.2	120
Inspection systems, total	30.7	33.5	37.0	48
Ultrasonic	10.0	11.0	11.8	14
X-ray	16.7	18.0	20.0	27
Infrared	3.0	3.3	3.8	5
Ultraviolet	1.0	1.2	1.4	2
Thickness gages and controls, total	62.3	71.3	80.0	110
Photoelectric	44.2	52.3	58.5	80
Radiation-based	18.1	19.0	21.5	30
Factory data-acquisition systems, total	285.0	337.0	398.0	667
Continuous process	120.0	137.0	150.0	240
Discrete process	165.0	200.0	248.0	427
Process controllers	33.1	35.6	40.0	47
Process recorders and indicators	55.3	56.3	60.3	71
Sequence controllers, total	39.0	40.0	48.0	94
Programable	21.5	21.5	25.5	55
Hard-wired	17.5	18.5	22.5	39
Ultrasonic cleaning	51.8	56.0	61.0	77
Pollution monitoring, total	138.0	166.0	178.0	192
Air	80.0	94.0	104.0	112
Water	58.0	72.0	74.0	80
Induction and dielectric heating and sealing	28.3	29.5	31.0	36
Welding controls	9.8	15.3	18.3	23
Process-control computer systems, total	217.0	226.2	252.9	320
Digital	158.0	167.4	187.9	246
Analog	59.0	58.8	65.0	74
Power-demand control	150.0	170.0	195.0	350
Power supplies, total	**375.0**	**408.0**	**450.0**	**595**
Lab and bench type	90.0	98.0	107.0	140
Industrial heavy-duty type	60.0	65.0	72.0	95
OEM and modular type	225.0	245.0	271.0	360

(millions of dollars)	1974	1975	1976	1979
Medical equipment, total	**1,012.4**	**1,180.2**	**1,405.8**	**2,074**
Diagnostic, total	620.1	736.8	892.7	1,445
X-ray	460.3	557.0	700.5	1,192
Electroencephalographs	9.2	10.3	11.7	15
Electrocardiographs	18.0	21.0	24.0	40
Ultrasonic scanners	14.5	21.3	27.0	35
Automated blood analyzers	76.5	80.3	83.5	93
Scintillation cameras and counters	29.3	33.5	38.5	51
Audiometers	12.3	13.4	14.5	19
Patient-monitoring systems	78.3	91.3	102.0	145
Prosthetic, total	236.2	264.8	307.0	352
Hearing aids	108.0	114.3	124.8	146
Pacemakers	126.0	147.5	178.5	200
Motorized limbs	2.2	3.0	3.7	6
Therapeutic, total	52.8	57.3	61.1	82
X-ray	24.6	25.2	25.5	32
Diathermy, shortwave and microwave	6.4	7.0	7.8	10
Ultrasonic generators	8.5	9.4	10.2	13
Defibrillators	13.3	15.7	17.6	27
Surgical support, total	25.0	30.0	36.0	50
Blood-flow meters	6.0	7.0	8.0	10
Blood-pressure monitors	10.0	12.0	14.0	20
Current generators	4.0	5.5	7.0	10
Biomedical lasers	5.0	5.5	7.0	10
Nuclear instruments and equipment, total	**39.2**	**44.3**	**50.7**	**73**
Spectrometers	12.6	12.9	13.7	16
Reactor controls	13.3	14.5	17.0	25
Radiation-detection and monitoring, total	13.3	16.9	20.0	32
Detectors, including ion equipment	6.2	6.9	7.6	10
Monitors, portable and fixed	2.1	3.0	3.9	8
Personal dosimeters	5.0	7.0	8.5	14
Lasers and equipment, total	**45.8**	**48.7**	**55.6**	**80**
Gas lasers	15.0	16.0	19.2	31
Semiconductor lasers	2.7	2.9	3.6	6
Other (ruby, neodymium-doped, etc.)	18.5	19.0	20.3	24
Laser power supplies	7.2	7.8	8.7	12
Modulators	2.4	3.0	3.8	7

FEDERAL ELECTRONICS

(millions of dollars)	1974	1975	1976	1979
FEDERAL ELECTRONICS, TOTAL	**13,102**	**13,896**	**14,695**	**17,380**
Defense, total	**11,615**	**12,339**	**13,070**	**15,510**
Procurement, total	5,630	5,953	6,340	7,765
Communications and intelligence	1,015	1,066	1,145	1,390
Aircraft, related ground equipment	1,595	1,690	1,780	2,245
Missiles and space systems	2,108	2,123	2,260	2,670
Mobile and ordnance	253	310	335	460
Ship and conversions	659	764	820	1,000
Research, development, test and engineering	3,420	3,665	3,880	4,645
Operations and maintenance	2,565	2,721	2,850	3,100
NASA, total	**750**	**795**	**810**	**850**
Transportation, total	**357**	**372**	**380**	**520**
FAA procurement	162	227	230	285
FAA research and development	110	85	85	85
Highway and transit systems	85	60	65	150
Health, Education, and Welfare, total	**370**	**365**	**375**	**410**
Education systems	120	100	105	115
Health-care electronics	250	265	270	295
Energy R&D Administration, total	**10**	**25**	**60**	**90**

EUROPE MARKETS

☐ As they tossed their 1975 calendars into the waste basket, most West European businessmen muttered something like "good riddance." And as they contemplated the New Year, symbolized by the glossy new 1976 calendars on the wall, the prevalent sentiment was something approaching confidence.

That's a far cry from the scene 12 months ago. Then, businessmen generally figured they faced a tough year. They did, and then some, because 1975 will go down as the worst year since Western Europe started rebuilding after the Second World War. Instead of expanding as usual, markets shrank as a recession set in around the world. Unemployment shot up to worrisome levels. Despite the downturn in business, price indexes continued to mount as inflation pressed on.

For the electronics industries, all these troubles made the year "unusually bad for communications, components, computers, and consumer equipment," in the words of Manfred Beinder, chief economist at the ITT subsidiary Standard Elektrik Lorenz AG. Beinder's fief, of course, is West Germany, but his remark holds, by and large, for the rest of Europe as well.

The worst seems over now, on the Continent anyway, and for 1976, Western European economy watchers foresee better things. In the past couple of months, the U.S. economy has shown signs of turning upward, which portends a bottoming out of the worldwide recession. Closer to home, the pivotal West German economy has started to shake off the sluggishness that set in more than a year ago. In France, the No. 2 Common Market economy, signs are that a natural cyclical recovery has started, and it should be accelerated by the $10 billion reflation package put together this fall by Valéry Giscard d'Estaing. The United Kingdom, as usual, lags behind its two big neighbors. The British will go into the new year still sliding downward. As for Italy and the smaller countries, they'll be bolstered by the expected better times in West Germany.

In West Germany, the economy that is sure to be the most scrutinized over the next few months, it looks as if the dip is over. The country's auto makers have started to come back enough that they have announced plans to rehire thousands of workers. West German consumers, who nervously built up their savings instead of spending when Chancellor Helmut Schmidt's coalition government pumped new money into the economy earlier this year, seem to be loosening up a little on their purse strings.

While there's no revival of plant investment in the offing, there are some positive signs, and forecasters say West Germany will log a rise of some 4% next year in gross national product, discounted for inflation. However, "output levels of 1973 are unlikely to be approached again before 1977," reports Mackintosh Consultants, a British firm that produces an annual data yearbook for electronics markets in Western Europe. All the same, the expected 1976 gain in GNP is twice as good as that registered last year. "But the upswing", warns Werner Matschke, director of marketing policy at Siemens AG, "will come only hesitatingly and with some delay behind that in America."

If the forecast for West Germany does pan out, the GNP for Western Europe overall seems set to grow about 2% in 1976. That's not a boom figure by any means, but it's a welcome turnabout from 1975's no-growth number. And it's enough to banish much of the uneasiness that beset the electronics industries last year. *Electronics* surveyed the equipment markets in 11 countries last fall and wound up with a consensus forecast of $21.3 billion for 1976, an advance of 10.4% over an estimated $19.3 billion for 1975, before taking inflation into account.

Obviously, the gains won't be uniform across the board. At one end of the spectrum are the "comeback" markets—consumer electronics and components. Both registered absolute drops last year and seem set to recover this year. At the other end come the computer and communications sectors. Their growth slowed last year, but they posted gains all the same and should move up again this year. In between come industrial electronics and test and measurement equipment. They performed listlessly last year and so far seem destined to repeat that performance this year.

As always, the over-all figures cloak a considerable range of market performances among countries. At the top of the list for growth, with a forecast of nearly 14% for 1976, stands Norway, currently riding an oil boom. The poorest performer last year was the United Kingdom, where equipment markets edged up only 0.4%—actually a slide backward when this nominal growth is discounted for price inflation. This year, Switzerland and Sweden will vie with the UK for the rank of slowest grower, according to *Electronics'* forecasts.

As for market sizes, West Germany continues to simply outclass her neighbors with $6.78 billion of equipment markets in sight for 1976. France logs in at $4.75 billion, followed by the UK at $3.01 billion, Italy at $1.7 billion, and the Netherlands at $1.01 billion. Unless there's considerable political upheaval in Spain as the new king, Juan Carlos, settles in—something that so far looks unlikely—Spain should move up a notch this year into fifth place, supplanting Sweden.

Consumer

Buying pickup to buoy entertainment market

Consumers from Brest to Berlin and from Oslo to Palermo window-shopped more than anything else last year. And little wonder, what with inflation cutting down their real incomes and with newspapers filled with sobering stories about rising unemployment. As a result, entertainment-electronics producers had a very bad 1975. Their markets dwindled from $6.22 billion in 1974 to $6.07 billion in 1975.

The culprit isn't hard to spot on *Electronics'* markets charts. Color-television sets account for about half of the consumer electronics business in West Europe, and, instead of growing as usual, their sales slipped off from the $2.94 billion logged in 1974 to $2.87 billion in 1975. The big slide came in the United Kingdom, where the market has plummeted for two years in a row. But sales in West Germany dwindled 10% to just over $1 billion, and that hurts.

With the two major color-TV markets and some smaller ones turned sour, the modest gains scored in France and Italy didn't help much. And to make matters worse, the zing went out of the hi-fi markets. They had been showing strong gains in recent years and seemed on their way to sales levels topped only by color sets. But last year's gain was piddling—the market totaled $543 million, essentially the same as for 1974.

This year, though, set makers should see their markets on the rebound. To be sure, there'll be a listless market in Britain, the survey suggests. However, a pickup in West Germany seems almost certain, and France should do reasonably well, since the market there is still a young, growing one. Italy could be a surprise. After years of dawdling, the government there finally opted for the PAL color-TV system, and the country's broadcast organization RAI may get on the air with a heavy schedule of colorcasts for the Montreal Olympic games. In Spain, the *de facto* adoption of PAL should spur sales.

All told, color-TV sales for Western Europe will get past the $3 billion mark this year, according to *Electronics'* survey. And that points to a $4.47 billion year for entertainment electronics as a whole—6.5% better than the 1975 figure.

A lot of market watchers are convinced that setmakers can't count on growth rates much better than that for the years ahead. "Western Europe has gone through the phase of 15% to 20% annual growth," notes Sander de Leve, head of the central planning department of Philips Gloeilampenfabrieken, the largest West European electronics group. "We're moving into replacement markets," which just don't perform like burgeoning first-set markets.

What's more, the replacement markets aren't coming on as fast as people once thought they would. The "economic" life of color sets—the time it takes for the original buyers to junk them or turn them in on new ones—has stretched out to nine or more years, notes Johanna von Ronai-Horvath, head of market research at Schaub-Lorenz, an ITT consumer-electronics company. The long-lasting sets will postpone the coming of strong replacement markets for another couple of years, most market watchers believe. Mass markets for new "big-ticket" products like video-tape recorders and video-disk players are even further off.

Browsing. West Europeans should start turning up in dealers' showrooms in greater numbers this year. The forecast is for a $3.18 billion market for color-TV sets in 1976, up 10% from 1975. The total consumer market should total $6.47 billion, a 6.5% rise.

Meanwhile, set makers in countries like West Germany, where the color-TV penetration is high, will be trying to lure consumers into the replacement market by adding new gadgets to their top-of-the-line models—things like on-screen displays of time and channel number or sound transmission to headsets via infrared beams. And there'll be a higher percentage of portables sold as second-set buying catches on. In West Germany, portables will account for some 30% of this year's color-receiver unit sales, Schaub-Lorenz forecasters think. A clue for the years ahead is the dwindling West German black-and-white market, where better than half the sets sold this year will be portables.

Computers

Sales hold up well despite economic woes

There's no pressing urge for businessmen to invest during these trying economic times, but some investments, especially in labor-saving hardware, just can't be put off. So computer makers found their business running at reasonable levels last year, even in hard-hit Britain. "Our order book is holding up," comments John Hartley, manager of market planning for International Computers Ltd., the country's leading domestic electronic-data-processing equipment producer.

Hartley's comment applies generally, *Electronics'* survey indicates. Deliveries of computers and related equipment for 1975 tallied up to $6.61 billion—a respectable 9% over the 1974 figure. The rise, coming as it did when consumers were shunning the set makers' offerings, makes 1975 a landmark year in the annals of West European electronics. For the first time since *Electronics* started making its annual surveys in Western Europe 10 years ago, computers seem to have definitely bested consumer electronics as the leading sector. This year's forecast gain of 12.3% for computers will push the category up to $7.42 billion, nearly $1 billion better than expected for consumer electronics.

But figures don't tell the whole story. Selling EDP hardware in Western Europe "is increasingly becoming a tough struggle, particularly so when the economy is in a slump," comments Jochen Rössner, a marketing specialist at Sperry Univac in West Germany. With customers bent on saving and tending to put off decisions on investments, Rössner says, the EDP sector is feeling the effects.

"There's a tendency among users to make do with the computer capacity they already have," adds Eckard Reiman, manager for marketing planning at Sperry Univac. In a way, the two Univac men explain, the EDP business is becoming "normal" and buyers more careful than they were when they first turned to computers. Upgrading existing systems, rather than taking on completely new hardware, has become prevalent. With this kind of user psychology overhanging the market, growth rates for the EDP sector figure to stay below 15% overall for a long time. Minicomputer makers, of course, as has been their custom in recent years, can still look forward to lustier markets than manufacturers of larger mainframes. This year, sales of minicomputers seem set for a 20% surge.

Not surprisingly, IBM remains far and away the leader in Western Europe's computer market. But there'll be some noteworthy changes this year in the pack that's continually trying to nibble away at the multinational giant's 60+% share.

In France, particularly, the moves of Honeywell-Bull will be closely watched. The company, controlled by American interests for nearly a decade and most recently by Honeywell Information Systems, has come under control in principle of France's Compagnie Générale d'Electricité. The idea is to merge Honeywell-Bull with the Compagnie Internationale pour l'Informatique, the outfit set up under the de Gaulle era's Plan Calcul, and that way form a French EDP heavyweight. The French move served to kill the Unidata scheme put together by Philips, Siemens, and CII in a multinational bid to contain IBM.

In Spain, two new contenders will be on the scene. Sperry Univac has teamed up with the government holding company Instituto Nacional de Industria in a venture called Uniforesa. The company expects to start turning out 150 Univac 90/30 computers annually after its factory gets on stream toward the end of the year. The other Spanish joint venture in computers is Secoinsa, set up to produce telecommunications-switching computers. The non-Spanish partner here is Japan's Fujitsu Ltd., while the nationals include INI, the Spanish telephone company CNTE, some banks, and Telesincro, itself an affiliate of Piher, Spain's largest components producer.

Communication

Telephone hardware paces equipment buys

Time was when telecommunications-equipment makers expected they'd get nothing but busy signals from the government-owned Western European networks. But suppliers of telephone hardware in West Germany, Italy, and Switzerland have run into some wrong numbers during the past 18 months as governments in those countries reacted to the recession with cuts in post office budgets. Laments a German telecommunications marketing man: "Bundespost spending during the early years of this decade far exceeded the actual demand.

Counting up. With a $7.42 billion market forecast for 1976, West Europe's computer equipment makers are in for a 12.3% growth in demand, after a 9% rise in 1975. Sales will be buoyed by such new equipment as Thomson-CSF's multipurpose terminal.

Now we're left virtually empty-handed."

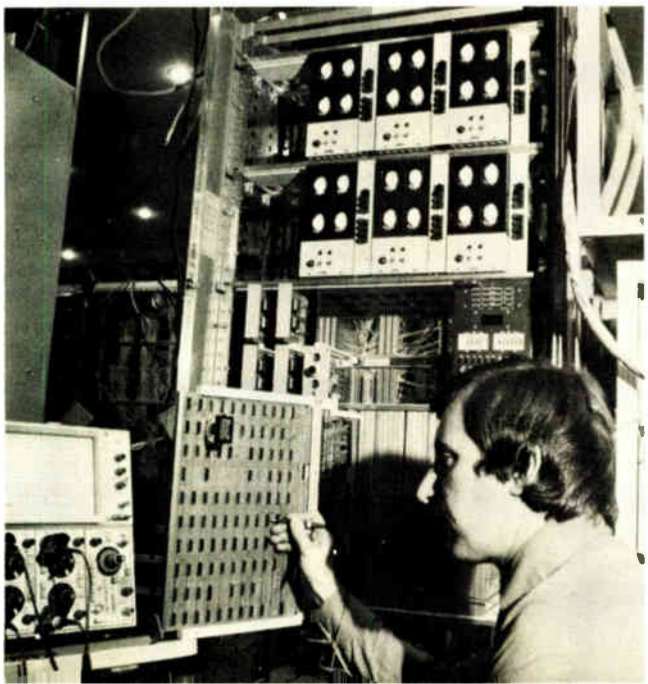
In most other countries, though, communications markets should have a solid ring this year. *Electronics*' survey spots the 1976 market at $4.34 billion. That's 14.2% better than the estimated $3.8 billion logged in 1975. And this year's expected gain is a signficant improvement over the rise registered last year, a not impressive 10.6%.

There's exceptional promise next year and for the years after for stored-program-control hardware—exchanges with space-division- or time-division-switching networks controlled by computer. Spending here added up to $400 million last year and is pegged to spurt to $585 million this year. These figures will be dwarfed in coming years as programs under way gather momentum and new ones are started.

West Germany will be a late starter, but France and the United Kingdom already have launched major programs. What's more, the smaller countries can't be counted out. In Belgium, for example, half the exchanges ordered this year were stored-program types. In neighboring Holland, the phone network has accelerated its buying of semi-electronic exchanges to the point where Philips' Telecommunicatie Industrie, which has heavy export orders as well, reports "orders for all the PBX exchanges we can produce." Italy will go onto the list soon. After two years of trials, the phone company, SIP, this year will start a gradual introduction of Italian-developed Proteo time-division exchanges into its system.

France, though, looks like the most active market for electronic switching this year. The Posts and Telecommunications Ministry has been running time-division-switching trials since 1970, and this year, CIT-Alcatel, part of the CGE group, expects $40 million worth of orders for its E-10 electronic exchanges, followed by a jump to $90 million next year. And as part of a $1 billion catch-up campaign to get the country's phone system up to par, the ministry has earmarked funds for a crash program of 300,000 lines worth of space-division exchanges. At year-end, Thomson-CSF, the ITT subsidiaries LMT and CGCT, L M Ericsson, and CGE were waiting to see how the ministry would split the business. By 1980, French stored-program-exchange suppliers hope to be logging domestic orders for some 1 million lines a year.

Exchange. One of the hottest markets in Europe is for telephone switching equipment, such as CIT-Alcatel's time-division E-10 Platon system. The telephone switching market should total $585 million in 1976, up a hefty 46% from 1975's level.



The British Post Office is holding to its program of modernizing with TXE-2 and TXE-4 semi-electronic exchanges, even though it's cutting back heavily on outlays for mechanical exchanges. And the BPO is pushing on with its System-X program to develop a fully electronic large exchange. Spending on System-X over the next few years should run about $200 million.

Defense

Military market has its ups and downs

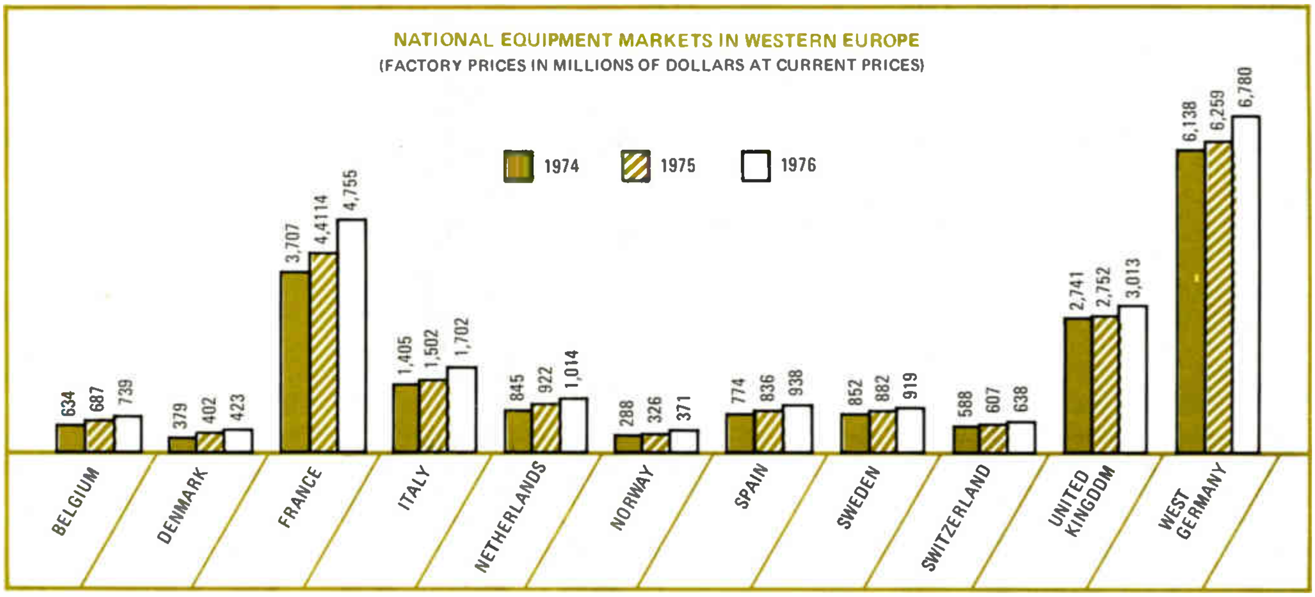
West Europe's defense-electronics producers would be a generally glum lot if they had only their home markets to depend on. By and large, defense budgets are barely keeping pace with inflation, although Italy seems on its way to becoming a major exception. What's more, outlays for "social" programs of military establishments—higher pay, better conditions for recruits, and the like—are forcing cuts in hardware procurement, points out George Arthur, an ITT-Europe executive who keeps tabs on military markets.

But a booming export market in arms is keeping West European defense-oriented companies prosperous—above all, in France. There, fully half of the orders for "professional" hardware booked in 1974 came from abroad. Based on results for the first six months of 1975, the figure climbed even higher this year, leaving French military-electronics producers well fixed for the next couple of years.

But there's concern for the long run about the stagnant domestic market. "We're worried about the lack of credits for developing advanced components," says Jacques Bouyer, the managing director RTC-La Radiotechnique-Compelec and president of the French association of semiconductor and tube manufacturers. Convinced that future arms sales abroad depend on keeping a technological edge, the association is trying to persuade the government to back an advanced components-research effort in the next five-year plan.

The strong export order books of military-electronics producers in France, Britain, and Italy, and to a lesser extent in Holland and Sweden, push up the survey figures for radar, radio communications, and navigation aids. In some cases, this kind of hardware is "consumed" when it becomes part of a complete weapons-delivery system like a plane, a ship, or a missile battery. The survey points to a total of $1.81 billion for those three categories this year.

For navaids, radar, and radio, the market totals could



spurt in late 1977 or 1978 when Belgium, Denmark, the Netherlands, and Norway start to acquire the batch of F-16 fighters they contracted for last year with General Dynamics. In depressed Denmark, they're looking forward to F-16 offset procurement as the "biggest order ever for the electronics industry."

Elsewhere, the optimism will remain muted until the offset business is ladled out. "We can bid, but we aren't guaranteed any business unless we can come in with competitive prices," warns an executive at a Norwegian electronics company. That's going to be hard to do, since U.S. hardware producers will have a big domestic run of the planes on which they can write off development costs. Unless the buying governments agree to higher costs per plane, the offset may be disappointing for electronics companies.

Components

Parts manufacturers shake off gloom

The bettered outlook for the major equipment sectors in West Europe next year should dispel some of the gloom that settled into components markets last year. Components suppliers were doubly jolted by the recession. Not only did their equipment-making customers cut back production, they also worked down their parts inventories. The end result: components markets in the 11 countries surveyed sagged 7.2% last year to $4.91 billion. This year's forecast is a climb back to $5.4 billion.

All the same, anxiety levels of West European component suppliers are still on the high side as the new year gets under way, particularly at semiconductor houses. And little wonder after the market's performance over the past 18 months or so—a flip-flop from high bookings and strong prices to bare order books and sagging prices. Prospects for 1976 are a sharp bounce upward. "We won't have a boom," cautions Gerhard Liebscher, a marketing executive at the ITT Semiconductor Group's Intermetall GmbH.

Electronics' survey confirms this reading of the market. The figures for discretes, integrated circuits, and optoelectronics total $1.33 billion for 1974. Last year's dramatic decline pushed the total down to $1.14 billion. The upward hike in sight should carry semiconductor markets to $1.29 billion.

In the roller-coaster semiconductor business, of course, almost anything can happen. Some market watchers have a hunch that a period of penury could start to emerge toward the end of 1976 if equipment makers turn back on earlier or stronger than expected. Analyzing the market last fall, for example, Piero Martinotti, European marketing director for Motorola Inc.'s Semiconductor Products division, insists that there'll be shortages across the board "if the curves hold up."

Until the expected 1976 upturn actually starts, though, semiconductor houses continue to be very edgy about price trends. Asked about price slashing, Olivier Garreta, who heads the Sescosem semiconductor division of Thomson-CSF, winces, "It's still going on."

Indeed, what has been going on has been harrowing. Prices for C-MOS packages have sagged to levels below standard TTL, for example. Memories are another area where prices have been forced too low too fast, points out Robert Blair, European product-marketing manager for Fairchild Europe. Prices for 4-kilobit RAMs are being projected for 1976 at the same levels as 1-kilobit RAMs last year. "The learning curve is not that steep," he warns.

Another learning curve that may turn out to be not steep enough is that for microprocessors. They will post the sharpest increase among ICs—up to $16.6 million this year from the $6.7 million registered in 1975, according to the survey. However, with the major U.S. semiconductor houses now challenging Intel, which has had the market practically to itself, and with European suppliers poised to come into the market, pricing policies figure to become very tough this year.

JAPAN MARKETS

☐ "Our biggest problem," observes Tashio Takai, executive vice president of the Electronic Industries Association of Japan, "is how to accommodate to slow growth. It will take time for Japanese companies to be happy with less than 10% annual growth."

Elaborating, Takai explains that "in the Japanese culture there are tales of sudden calamities such as earthquakes and thunderstorms. But this economic depression is more like Noah's flood, and we have no experience in how to deal with a long 'flood'."

Thus, even as most sectors of the electronics markets bottomed out during the spring and summer of last year, the executives of Japanese electronics companies remained subdued about the extent of the recovery for 1976. One reason is that the total Japanese economy was still sluggish during the final months of last year and may not pick up significantly until the second half of this year.

Another cause for concern is that for some products the value of domestic consumption in 1976 will barely return to levels achieved prior to the oil crisis and the international recession. Like it or not, slow growth seems to be in the cards for the Japanese electronics industries for the next couple of years.

Comparisons of total annual domestic consumption (see table) tend to mask the ups and downs within the broad electronic-equipment category. In the consumer-electronics sector, for example, unit sales of color television sets rebounded last year after a dismal 1974, but with only a 3% improvement in dollar value. Color TV may not gain as much as 4% this year, up to $1.69 billion. Sales of data-processing and office equipment continued to grow, while industrial, production and control equipment as well as test and measuring instruments both registered sales declines in 1975, according to *Electronics'* survey of domestic consumption. Industrial and test equipment are expected to grow this year, but in the case of the latter the total dollar value will barely return to the 1974 level.

Much the same trends are apparent in components consumption. Total dollar sales of $5.4 billion forecast for this year should be some 12% ahead of last year. Last year passive and electromechanical components and discrete semiconductors registered dollar value declines, whereas integrated circuits continued to grow. Pacing the IC market growth have been metal-oxide-semiconductor memories and bipolar logic circuits, reflecting the computer industry demands.

On the whole, Japanese companies have trimmed their operations in anticipation of a mild recovery, waiting for the "flood" to recede.

JAPAN'S ELECTRONICS RECOVERY

	Estimated domestic electronics consumption (millions of dollars)		
	1974	1975	1976
Consumer	4,136.9	4,367.9	4,644.9
Computers	2,707.0	3,199.4	3,724.0
Communications	1,219.8	1,341.1	1,537.9
Industrial, test, auto, medical equipment	1,327.6	1,324.3	1,502.1
Power supplies	25.0	29.4	32.0
Total	9,416.3	10,262.1	11,440.9
Semiconductors	1,171.0	1,126.0	1,316.5
Components and tubes	2,637.9	2,527.6	2,790.2
Total	3,808.9	3,653.6	4,106.7

Note: Yen value computed at 300 yen = $1. Figures are based on a survey of Japanese manufacturers and are not adjusted for inflation.

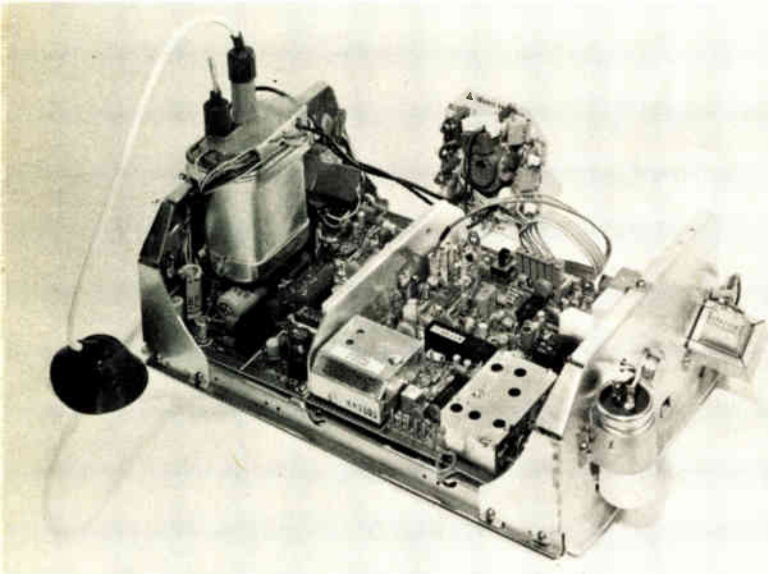
Consumer

Hi-fi, calculators, ovens to lure buyers

The Japanese consumer market has always had enough drama to satisfy even a kabuki enthusiast, who is prepared for emotions ranging from joy to sorrow to comic relief. But 1975 started out as more of an intermission than a continuation of the consumer-electronics drama. Plunged into the economic recession, consumer-products firms were struggling to get their show back to center stage, a position this $4 billion sector of Japan's electronics industry has always enjoyed.

By early summer, improvements began to show up, but profits have been hurting, and production has not returned to pre-recession capacity. All-important export markets were dull until the fourth quarter. In addition, the two products that promise dramatic growth—home video-tape systems and electronic watches—were too high-priced to make rapid advances in the sluggish market.

Because of the variety of products in the consumer-electronics category, it's difficult to generalize about sales for the coming year. According to results of the *Electronics* survey of Japanese companies, there will be an increase in this year's dollar sales of only 6%. In 1975 total consumer electronics consumption of $4.37 billion advanced slightly less than 6%. The outlook differs for



Cost cutter. Matsushita's new G-8 color-TV chassis has been designed to reduce production costs and improve reliability by cutting components count. It saves 40% in power consumption.

certain key products, however. For example:

- Color television. Estimated number of units sold domestically in 1975 is 5.5 million units, compared to 5.1 million units in 1974. Approximately 6 million to 6.3 million units should be sold domestically this year. Lower-priced sets are dominating the market, however, so that dollar value is not growing appreciably.
- Stereo components. Hi-fi audio equipment, especially separate components and so-called systems components, continued to make beautiful music at the cash registers despite the sour notes in the economy. Manufacturers anticipate a 16% gain, hitting $568.6 million this year after a good increase in 1975.
- Personal calculators. While it may seem that everyone in Japan has a calculator, saturation actually is only at about 15% and production continues to increase. Prices have declined, however, eroding dollar value last year. This year domestic consumption is expected to turn up again by almost 30% as higher-priced special-function machines gain in popularity.
- Video systems. Every year Japanese manufacturers declare that the home market in video tape recorders will open, only to be disappointed. But this year, lower prices are in the offing and serious promotion for the home market is under way. So maybe . . .
- Audio tape machines. Because of the popularity of radio-tape combinations, it's getting difficult to sort out the statistics but, generally, portable cassette tape players will decline relative to continued growth of radio-tape units. Stereo cassette tape decks will surpass open-reel and eight-track cartridges at the upper end.
- Microwave ovens. Another product that has consistently outperformed the economy, electric ranges, will continue to grow this year. Manufacturers expect an 11% increase to $374.2 million.
- Electronic watches. Prices on the Japanese market were relatively high during most of 1975, but tags are really tumbling this year, which should open up the market considerably. According to the *Electronics* poll, dollar value will jump 35% to over $116 million this year as the under-$100 units pick up speed.
- Citizens' band radio. The Japanese domestic market for CB equipment is virtually nonexistent, but manufacturers have been enjoying a boom in exports to the U.S. One estimate has 30 firms involved in CB exporting. Transceiver sales to the U.S. reached almost 3 million units last year, and could go as high as 8 million units this year.

Semiconductors

U.S. CB radio opens new chip market

While semiconductor production and sales were high throughout most of 1974, business turned sour at the end of the year, and manufacturers as well as their customers began 1975 with excess inventories. By the end of 1975, customers had worked off inventory, and plants were back to peak production again, although with lower labor forces. Microprocessor-controlled semiautomatic and automatic bonders have enabled higher production rates with smaller labor forces. Record production levels in calculators and watches, explosive growth in CB transceivers for export, and the recovery of entertainment products contributed to high demand.

For some products, however, falling prices have kept sales revenues from rising as fast as the increase in production rates. Thus the *Electronics* survey (in dollar amounts) shows a drop in discretes and only a slight gain for ICs last year. Both categories are expected to improve this year—discretes by 19% and ICs by 16%.

Meanwhile the relative market share of Japanese and United States manufacturers has remained about constant, even though 1975 was the first year that Japan's imports and direct investments were both liberalized. Perhaps the biggest change was that some U.S. manufacturers won more sales in sophisticated products.

Explosive growth this year will be recorded by a category that didn't exist until the end of 1975. The market in MOS LSI phase-locked-loop synthesizers for transceivers sold in the United States and elsewhere could hit 6-8 million units if manufacturers can crank up production. The average price will be slightly more than $3 for the synthesizers. In addition, each transceiver also takes 20 or more transistors for an a-m unit and 40 or so for a higher-priced single-sideband unit, which includes rf power transistors.

Japanese manufacturers have dominated the market for linear ICs and transistors for entertainment electronics including TV, stereo and tape, and radios. Demand was almost level in 1975, but will be much higher in 1976, especially for color TV. Development of improved multifunction ICs for this market has continued, with such circuits as the one-chip chroma IC from Nippon Electric Co.

As for computer ICs, the increased availability of

4-kilobit devices, from both Japanese and American manufacturers, is prompting the phase-in of newer computers using semiconductor memories. As a result, the growth of memory circuits will be high in 1976.

Also coming on strong are microprocessors in 4-, 8-, 12- and 16-bit versions. The most popular so far among imports and domestic units have been the 8080A-type devices. Motorola says business is picking up on its 6800 device as well. Fujitsu Ltd. has opted for a device compatible with the 6800, and Hitachi Ltd. will make the 6800 under a cross-licensing agreement with Motorola.

One company, Toshiba, is pushing a 12-bit microprocessor it has developed in p-channel and faster n-channel versions. Nippon Electric, Panafacom (a Matsushita and Fujitsu joint venture), and Toshiba have started up 16-bit microprocessors—with Toshiba claiming it has minicomputer capability. Panafacom also has a 16-bit device, composed of two 8-bit slices, inside its own minicomputers, while Hitachi and others are considering bipolar bit-slice devices. Microprocessor sales dollars will almost double in 1976 to $25.8 million, but 1977 will probably be the first year that they represent a significant portion of IC sales dollars.

Computers

Demand holds as liberalization begins

The data-processing equipment market has continued to grow despite the complexity of the competition and the calamities of the general economy. With the liberalization of the domestic market, the six Japanese companies linked by government subsidies have now all announced the results of their joint efforts to match the IBM System/370 series [*Electronics*, Oct. 30, p. 65]. This project was intended to make the domestic makers strong enough to withstand IBM after removal of government protection.

Fortunately, demand for medium- to large-scale machines has been good enough to support the new arrivals. Financial institutions, upgrading present on-line systems, and retailing and distribution enterprises, installing new systems, spurred sales along. In addition, Nippon Telegraph and Telephone Public Corp. (NTT) has revived its spending by ordering 30 large-scale DIPS II systems shared evenly by Fujitsu Ltd., Hitachi Ltd., and NEC.

Sales of small computers in past recessions have suffered because small companies tend to postpone installations. However, the number of small companies starting to use computers has increased considerably, causing the total sales to increase. As a result, dollar value will rise this year by 15% to $338.9 million.

Minicomputers had a slack year for them, but their dollar sales were expected to taper off from the 50% to 60% annual growth they experienced five years ago. Minis also benefited from the increased number of small companies now investing in computers.

While attention among the Japanese makers has been riveted on IBM's post-liberalization strategy, another American heavyweight, Digital Equipment Corp., is trying to become a stronger factor in the domestic market. DEC has announced a downward change in price structure, has extended warranties from 90 days to one year, and has expanded its service coverage. More important, the company has decided to go after end users as customers, instead of concentrating on OEM business.

Terminal sales in Japan have benefited from the increase of large- and medium-scale systems. Banking terminals and cash dispensers have also enjoyed good acceptance. Point-of-sale terminals, however, have been slow to move because retailers have tended to buy simpler electronic cash registers first.

Communications

Fax, megahertz systems, new exchanges do well

Manufacturers of communications equipment complain of poor domestic business, even though the *Electronics* survey chart shows an increase. The inconsistency is explained by the fact that nonelectronic items not included on the chart are being replaced by electronic equipment that is included. Thus, crossbar telephone exchanges hit their peak in 1973, were at about 70% of peak for 1975, and are expected to reach a crossover with rising sales of electronic exchanges in 1977.

The original five-year plans of the Nippon Telegraph and Telephone Public Corp. called for installation of 80 electronic exchanges in fiscal 1975 and 120 in fiscal 1976, but actual numbers will probably be closer to 55 and 80 respectively. Still, NTT's plans to install a total of 370 electronic exchanges during the five-year period ending in 1977 remain unchanged, which could lead to a spurt next year.

Sales of 4-, 5-, and 6-gigahertz microwave systems are decreasing. However, there is increasing demand for 11- and 15-megahertz systems to operate in parallel with cables between major cities and suburbs. Overall, domestic microwave relay systems will increase by only 4% this year, according to the *Electronics* forecast.

While the telephone company cannot increase its present budget, it is continuing to plan new services that should mean more business for equipment suppliers in the future. For example, a data-under-voice system is being developed, and there will be field trials on the Tokyo-Nagoya route. Since the bandwidth available under voice is less than in Bell's equipment in the U.S., and NTT is aiming for the same digital rate, equipment will have to be more sophisticated than the U.S. version.

Facsimile sales have been increasing at a good clip and should grow by 28% in dollar terms this year. At present two companies supply equipment to NTT: Nippon Electric for transceivers and Matsushita Graphic Communication Systems Inc. for separate transmitters and receivers. Matsushita's commercial facsimile line is not compatible with the equipment it sells to NTT, which may be slowing total facsimile sales. Soon, however, all commercial equipment operating at 4 and 6 minutes per page will be made compatible.

Industrial

Digital gear taking off

Industrial electronics manufacturers suffered declines in sales of 3% (or $21.5 million overall) during 1975, despite increased demand for pollution-prevention and -monitoring equipment. The slump in new construction, including plants, office buildings, and ships, continued, and prices have remained unchanged since the end of 1973. Nevertheless, development raced ahead on new direct digital control equipment that should increase profitability when sales pick up this year and next, as expected.

This generation of digital equipment, built around microprocessors, will increase profitability by reducing the variety of systems needed for a given range of functions. Instead, changes in software will enable each system to perform different control functions.

Already announced is a Toshiba direct digital process control system, which is built around the company's 12-bit microprocessor. Yokogawa Electric Works' system, announced in August 1975 and scheduled to start being delivered in June, is based on Nippon Electric's 16-bit microprocessor. And a Yamatake-Honeywell system developed as a joint U.S.-European-Japanese effort was announced in November 1975. Hitachi Ltd. and Fuji Electric Co. also have systems of this type using the Intel 16-bit and the Panafacom 16-bit microprocessors respectively. Hokushin Electric Co. will wait until later in the year to announce its system. All of this equipment is intended to replace analog process-control systems.

As usual, improved products appear to bring new business. Hokushin, for instance, says that a new capacitor-type electronic differential pressure gage—used mostly to measure flow—has four times the accuracy of previous units and better reliability for the same price. The company expects systems that include the new gage to bring in about $7 million additional business.

Instruments

More buys seen for 1976

Even though test-equipment sales were down about 10% overall in 1975, various categories and even companies selling in the same category fared quite differently. For example, the boom in transceiver exports appears to have been a boon to instrument companies with specialized equipment needed by manufacturers of citizens' band equipment. Takeda Riken has done well in sales of 30- and 150-MHz spectrum analyzers. Matsushita and Yokogawa-Hewlett-Packard Ltd. also did well with signal generators for the same market.

Emphasizing the mixed-bag nature of last year, Iwatsu Ltd. reports that although the oscilloscope market has been weak, its sales were better than in 1974 because the company increased its market share. Medium-size portable scopes have done well. Yet computer servicing is not as attractive as it used to be because many machines now have built-in diagnostic capabilities.

This year should be less erratic than 1975 as dollar value is predicted to increase to $338.9 million, a healthy 10% over last year.

Components

Market whims jolt sales

Japanese passive-components manufacturers present a confused picture. Although in general they are working at full capacity, they are afraid to add capacity or employees because of recent unpleasant experiences with inventory imbalances and the recession cutbacks. A graph of production by calendar quarters starting at the beginning of 1974 would be V-shaped, with the minimum occurring during the first quarter of 1975. Production at that time was only 57% of that during the same 1974 quarter. (Production during the first quarter of 1974 was 124% of that during the first quarter of 1973.) The fluctuations are intimately tied to sales of consumer products, in which about 70% of Japan's passive components are used.

There have also been large dislocations in demand and this trend will continue in the future, making planning by components companies extremely difficult. Explosive growth in demand for transceivers for the export market has created a severe shortage of quartz crystals. But use of synthesizers by CB transceiver manufacturers this year may even turn this shortage into a surplus. And innovations in other products may cause similar imbalances in component supply and demand.

Space and Defense

Some action in 3-d radar

The National Space Development Agency (NASDA), expects less of a funds increase in 1976 than it obtained in 1975. The budget for 1975 was $213 million, up about 25% over 1974. For 1976 there will be an increase of only about 15%.

As for the military, the coming fiscal year, which starts April 1, marks the final 12 months of the current five-year plan. Nothing new will be added, and some items may be scrapped as inflation raises prices and salaries. Last year the defense agency requested 22% more than the previous year, but got only 7%. For next year, 15% more than this year has been requested, but the increase will again probably be no more than 7%.

Big items purchased during fiscal 1975 included fixed three-dimensional radar from Mitsubishi Electric Corp., six of the eight required, for $8.67 million; and a mobile 3-d radar from Nippon Electric, the last of three ordered, for $6 million. Five sets of improved S-band radar from Mitsubishi cost almost $6 million. Other radars include four units of improved anti-mortar radar from Toshiba for a total of $1.33 million, plus anti-artillery radar from Toshiba for $2.5 million. □

JAPAN/EUROPE MARKETS FORECAST 1976

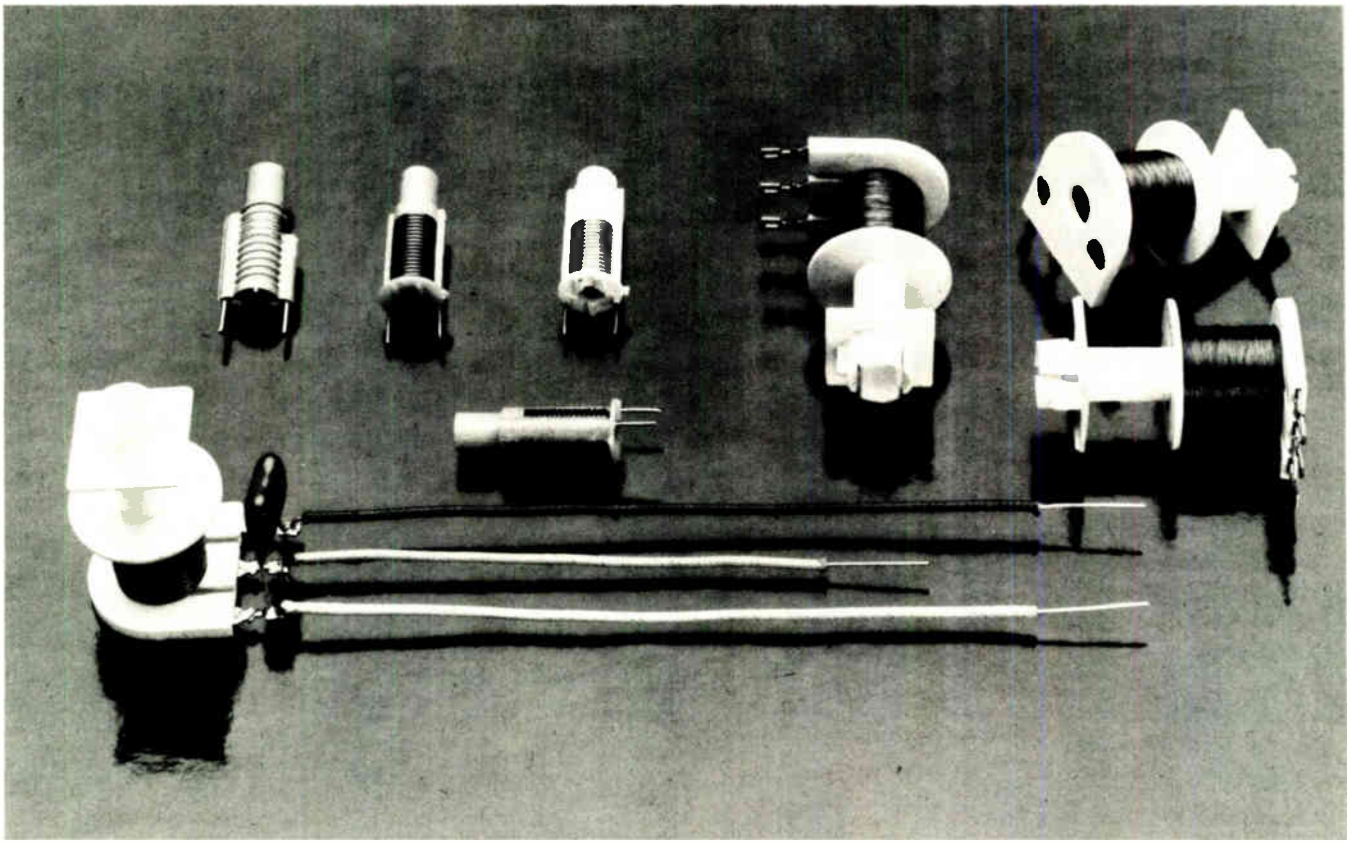
	JAPAN			WEST EUROPE		
	1974	1975	1976	1974	1975	1976
COMPONENTS, TOTAL (millions of dollars)	**3,808.9**	**3,653.6**	**4,106.7**	**5,293.9**	**4,913.5**	**5,404.7**
PASSIVE AND ELECTROMECHANICAL	**1,978.9**	**1,902.4**	**2,146.0**	**2,831.4**	**2,687.3**	**2,964.0**
Capacitors, fixed	384.5	389.0	419.7	640.0	562.3	618.5
Capacitors, variable	41.2	38.3	40.4	49.4	44.9	47.0
Connectors, plugs, and sockets	89.9	81.1	92.6	319.9	318.2	352.6
Filters, networks, and delay lines	---	---	---	53.9	52.5	57.4
Loudspeakers (OEM type)	111.9	101.0	106.5	122.2	111.8	123.3
Microphones (OEM type)	43.0	43.1	47.0	25.5	24.7	25.7
Potentiometers, composition	97.7	106.6	115.2	142.5	124.0	141.8
Potentiometers, wirewound	21.1	14.7	17.5	42.8	40.4	40.6
Printed circuit boards	162.1	133.5	175.5	308.9	317.0	346.6
Quartz crystals (including mounts and ovens)	45.0	59.1	79.6	51.3	52.9	58.7
Readout devices	66.7	78.3	90.0	27.1	29.6	36.7
Relays (for communications and electronics)	149.4	154.5	169.5	250.3	244.7	268.4
Resistors, fixed (including wirewound)	160.8	140.8	154.9	257.0	239.6	258.1
Resistors, nonlinear	18.2	15.3	18.0	31.1	27.3	30.4
Servos, synchros, and resolvers	16.7	8.3	11.7	57.0	57.7	63.0
Switches (for communications and electronics)	103.8	108.4	118.4	151.4	148.2	161.2
Transducers (pressure, strain, temperature, etc.)	15.0	16.7	16.7	---	---	---
Transformers, chokes, coils, TV yokes, and flybacks)	443.8	413.7	456.8	301.1	291.5	334.0
SEMICONDUCTORS, DISCRETE, TOTAL	**554.1**	**475.3**	**565.2**	**773.0**	**626.1**	**685.3**
Microwave diodes, all types (above 1 GHz)	7.6	7.9	8.7	14.6	15.2	15.9
Rectifiers and rectifier assemblies	119.3	95.0	111.0	122.0	102.8	114.2
Signal diodes (rated less than 100 mA, including arrays)	49.5	45.6	52.1	74.5	58.1	64.8
Thyristors (SCRs, four layer diodes, etc.)	30.4	32.4	37.2	70.8	60.8	69.3
Transistors, power (more than 1 W dissipation)	112.2	101.5	117.3	145.9	119.1	135.7
Transistors, small signal (including FETs and duals)	214.8	170.0	212.8	277.2	214.8	224.0
Tuner varactor diodes	8.3	9.6	11.3	24.7	19.8	22.3
Zener diodes	12.0	13.3	14.8	43.3	35.5	39.1
SEMICONDUCTORS, INTEGRATED CIRCUITS, TOTAL	**593.0**	**625.1**	**722.8**	**520.0**	**471.1**	**560.3**
Hybrid ICs all types	45.7	40.8	54.6	50.1	48.0	54.1
Linear ICs (except op amps)	88.5	90.2	100.6	124.4	110.9	124.8
Op amps (monolithic only)	13.6	13.6	14.8	32.6	27.0	32.5
Logic circuits, bipolar	119.2	107.7	138.5	171.9	137.0	150.2
Logic circuits, MOS and C MOS	126.4	139.8	129.3	33.8	38.9	50.2
Memory circuits, bipolar	8.5	11.5	16.0	21.3	19.2	24.1
Memory circuits, MOS and C MOS (except microprocessors)	19.0	33.9	56.5	54.6	55.0	69.1
Microprocessors (includes CPU, memory, and I/O chips)	10.5	15.4	25.8	2.3	6.7	16.6
Calculator chip sets	108.3	115.6	127.0	11.3	10.2	14.0
Watch and clock chip sets	4.1	7.9	11.4	5.1	6.6	10.8
Other special-purpose circuits	49.2	48.7	48.3	12.6	11.6	13.9
SEMICONDUCTORS, OPTOELECTRONIC, TOTAL	**23.9**	**25.6**	**28.5**	**39.7**	**42.3**	**49.0**
Circuit elements (photoconductive cells, photodiodes, etc.)	12.2	13.6	15.4	23.1	24.5	27.2
Display devices (light-emitting diodes, etc.)	10.9	11.1	12.1	15.2	16.0	19.0
Photovoltaic (solar) cells	0.8	0.9	1.0	1.4	1.8	2.8
TUBES, TOTAL	**659.0**	**625.2**	**644.2**	**1,129.8**	**1,086.7**	**1,146.1**
Cathode ray tubes (except for TV)	6.7	6.7	6.7	25.9	26.7	28.8
Camera tubes and image intensifiers	10.0	10.0	10.0	39.7	42.7	46.7
Power tubes (below 1 GHz), total	36.6	36.6	36.6	74.8	76.5	82.7
Microwave tubes, total	56.7	63.3	70.0	75.4	78.3	84.2
Cooker magnetrons	50.0	53.3	60.0	---	---	---
Receiving tubes	45.0	13.3	10.0	91.3	81.2	71.3
TV picture tubes, black and white	49.5	45.0	44.2	123.3	103.3	96.3
TV picture tubes, color	454.5	450.3	466.7	699.4	678.0	736.1
EQUIPMENT, TOTAL (millions of dollars)	**9,416.3**	**10,262.1**	**11,440.9**	**18,352.1**	**19,290.8**	**21,292.3**
CONSUMER, TOTAL	**4,136.9**	**4,367.9**	**4,644.9**	**6,222.0**	**6,072.5**	**6,468.8**
Audio tape recorders and players	439.7	477.1	469.2	517.6	478.0	483.2
Citizens' band transceivers	3.0	6.3	26.3	---	---	---
Electronic ranges (microwave ovens)	323.9	336.9	374.2	---	---	---
Hi fi equipment	332.7	489.7	568.6	535.8	543.0	577.8
Musical instruments (organs, electric guitars, etc.)	152.0	171.7	185.0	---	---	---
Phonographs and phono radio combinations	376.3	318.1	284.3	355.8	345.7	348.0
Pocket calculators (four function, personal)	145.6	117.6	152.6	30.3+	36.7+	48.0+
Radios (including car radios)	181.6	192.3	196.3	665.4	653.1	680.5
Radio/recorder combinations	390.5	386.5	413.2	263.0	302.2	324.6
TV sets, black-and-white	90.5	93.8	92.8	892.2	785.0	723.1
TV sets, color	1,576.1	1,628.1	1,692.0	2,938.1	2,871.9	3,181.0
Video tape machines (consumer)	55.0	63.1	73.7	23.8+	21.6+	29.9+
Watches and clocks, electronic	70.0	86.7	116.7	---	35.3+	72.7+

EQUIPMENT, continued	JAPAN 1974	JAPAN 1975	JAPAN 1976	WEST EUROPE 1974	WEST EUROPE 1975	WEST EUROPE 1976
COMMUNICATIONS, TOTAL	**1,219.8**	**1,341.1**	**1,537.9**	**3,433.0**	**3,795.5**	**4,335.0**
Broadcast	60.6	62.4	66.1	128.2	132.9	137.6
Cable TV	28.8	32.1	36.7	26.7	25.6	26.9
Closed-circuit TV	19.7	21.7	25.0	76.1	83.7	88.1
Data communications	31.0	36.7	46.7	75.4	91.8	105.8
Facsimile terminals	39.3	56.7	72.5	---	---	---
Intercoms and systems	23.1	32.5	30.3	117.4	121.0	133.4
Laser communications	0	0	1.0	---	---	---
Microwave relay	69.4	72.0	75.0	184.6	200.0	211.9
Navigation aids, except radar	92.0	66.5	127.3	335.2	380.0	416.5
Paging (public and private)	13.7	20.0	20.0	21.9+	24.1+	28.8+
Radar (airborne, ground, and marine)	75.9	85.3	90.5	578.6	669.9	761.9
Radio communications, except broadcast	347.1	352.8	384.0	517.1	553.5	631.2
Telephone switching, PABX[1]	68.0	71.2	70.3	219.2	242.9	302.3
Telephone switching, public[1]	117.8	140.1	172.3	310.4	399.7	584.5
Telephone and telegraph carrier	200.7	259.6	280.5	833.2	858.4	890.2
Video recorders and players (non-consumer)	32.7	31.5	39.7	9.0	12.0+	15.9+
COMPUTERS AND RELATED EQUIPMENT, TOTAL	**2,707.0**	**3,199.4**	**3,724.0**	**6,066.0**	**6,612.3**	**7,423.8**
Data processing systems, total[2]	1,762.5	2,060.2	2,362.8	2,929.2	3,161.6	3,518.9
Microcomputers (basic chassis value less than $1,500)	38.3	43.3	53.3	---	---	---
Mini (system value less than $50,000)	100.3	127.1	155.1	313.9	372.3	450.5
Small (up to $420,000)	175.5	295.0	338.9	689.4	757.0	819.4
Medium (up to $1,680,000)	447.4	472.8	519.1	980.4	1,012.6	1,099.5
Large (up to $3,360,000)	582.7	624.7	707.3	612.1	650.9	743.5
Giant (more than $3,360,000)	418.3	497.3	589.1	333.4	368.8	406.0
Add-on memories	43.3	43.3	50.0	178.0	190.5	209.2
Data acquisition	77.4	81.2	94.3	205.6	207.4	226.8
Data entry/output	175.1	221.0	255.3	545.6	595.6	657.6
Data storage	359.5	399.6	475.4	1,097.6	1,208.2	1,330.0
Data terminals	165.9	218.1	260.1	301.9	362.9	449.2
Electronic office equipment	119.6	170.3	218.4	754.8	814.3	926.3
Billing and accounting machines	47.7	70.2	88.0	359.2+	426.3+	441.3+
Calculators	71.9	100.1	130.4	303.4+	301.5+	334.8+
Office type	48.9	58.1	69.1	---	---	---
Scientific type	23.0	42.0	61.3	---	---	---
Point-of-sale	3.7	5.7	7.7	53.3	71.8	105.8
INDUSTRIAL, TOTAL	**823.4**	**801.9**	**883.4**	**1,195.8**	**1,260.0**	**1,348.7**
Industrial X-ray inspection and gauging	---	---	---	59.4	63.5	65.8
Machine tool controls	79.8	95.5	114.2	75.0	75.9	80.3
Motor controls	126.0	119.3	124.0	---	---	---
Photoelectric controls	---	---	---	51.6	48.4	51.1
Pollution monitoring	29.2	28.8	33.3	18.1+	22.8+	24.8+
Process-control systems	540.0	511.1	562.2	923.2	978.4	1,052.6
Ultrasonic cleaning and inspection	48.4	47.2	49.7	19.5	19.9	20.5
Welding (with electronic controls)	---	---	---	49.0	51.1	53.6
MEDICAL, TOTAL	**144.3**	**184.0**	**224.9**	**690.9**	**750.7**	**861.1**
Diagnostic equipment, except X-ray	39.1	42.1	46.9	195.1	215.5	245.5
Patient-monitoring	15.3	19.9	24.5	65.9	70.8	83.2
Prosthetic	11.6	11.2	12.5	19.1+	21.2+	23.9+
Surgical support	4.0	5.7	7.2	---	---	---
Therapeutic, except X-ray	5.9	6.5	8.0	35.0	40.0	45.4
X-ray equipment, diagnostic and therapeutic	68.4	98.6	125.8	375.8	403.2	463.1
POWER SUPPLIES, TOTAL	**25.0**	**29.4**	**32.0**	**221.9**	**233.6**	**242.4**
Bench and lab	5.0	6.7	8.3	24.7	25.8	27.7
Industrial heavy-duty	---	---	---	50.4	54.7	59.1
OEM and modular	20.0	22.7	23.7	146.8	153.1	155.6
TEST AND MEASUREMENT, TOTAL	**336.1**	**301.0**	**338.9**	**522.5**	**566.2**	**612.5**
Amplifiers, lab type	4.8	6.0	6.8	8.7	9.3	9.6
Analog voltmeters, ammeters, and multimeters	8.8	8.9	9.5	25.4	27.1	28.3
Analytic instruments, research or clinical	145.6	128.9	144.4	---	---	---
Automatic test equipment (IC, component, and board)	11.7	11.5	12.6	33.3	37.5	42.0
Calibrators and standards, active and passive	8.6	9.1	9.8	17.2	17.9	18.6
Counters and timers	9.5	7.7	8.4	38.8	41.7	45.0
Digital multimeters	7.9	7.3	8.7	32.4	35.0	37.8
Lasers	---	---	---	15.2+	18.0+	20.9+
Microwave test instruments	8.0	8.0	8.0	51.1	59.7	65.6
Oscillators	8.2	8.1	9.7	21.6	22.3	23.4
Oscilloscopes and accessories	38.0	34.7	39.8	93.2	98.1	106.7
Panel meters	29.9	28.6	32.5	37.1	38.9	40.7
Power meters	3.7	3.0	3.7	---	---	---
Recorders	29.5	19.1	22.2	87.3	92.6	98.1
Signal generators, analog	14.4	12.9	13.3	32.1	35.0	37.7
Signal generators, synthesizer	4.8	5.0	5.2	10.1	12.5	15.0
Spectrum analyzers (audio to 1 GHz)	2.7	2.2	4.3	19.0	20.6	23.1
AUTOMOTIVE, TOTAL	**23.8**	**37.4**	**54.9**	---	---	---

[1]Electronic or semielectronic [2]Includes stand alone minicomputers but not computers that are integral parts of process control and similar systems
+ Partial estimate (covers fewer than half of the 11 West European countries surveyed) ---No estimate available

Figures in this chart are consensus estimates for consumption of components, valued at factory prices, used to produce equipment for both domestic and export markets and of equipment with domestic hardware valued at factory sales price and imports at landed cost.

Why Zenith selected Moplen® CR-080A flame retardant polypropylene.



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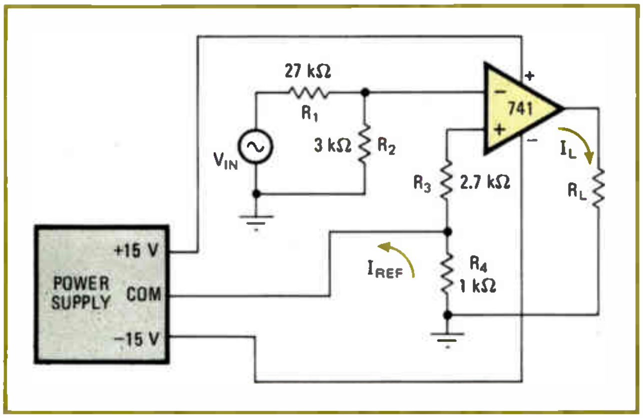
Designer's casebook

Controllable current source eliminates matched resistors

by James A. Stanko
State University of New York, Stony Brook, N.Y.

A bipolar constant-current source that has a grounded voltage source and a grounded load is usually limited in accuracy and internal impedance by the degree of matching of two or more resistors. For the circuit below, however, no matched resistors are required; linearity and internal impedance are determined solely by the operational amplifier gain, offset, and power supply rejection ratio. This circuit takes advantage of the fact that the op amp's power supply can usually be floated.



Uncritical. Load current produced by this circuit depends on input voltage, not load resistance. Circuit does not require matched resistors for accurate control of current, but power supply must float.

To understand the operation of the circuit, remember that no current to speak of flows into the input terminals of the op amp under feedback conditions, and no voltage difference exists across the terminals. Thus, the op amp drives the common terminal of the power supply to the voltage level established at the inverting input. This voltage appears across the reference resistor R_4. It is set to a suitably low value by input attenuator R_1 and R_2 to avoid thermally induced errors caused by power dissipated in the reference resistor. The values of R_1 and R_2 are chosen to provide a convenient scale factor. The reference current thus established is exactly equal to the current flowing in the load, and therefore the load current is

$$I_L = -I_{ref} = -\frac{V_{in}}{R_4}\,\frac{R_2}{R_1 + R_2}$$

The value of load current does not depend upon the value of load resistance and can be controlled by the value of V_{in}.

The minus sign in the expression for load current indicates the degenerative feedback action of the circuit. If I_L increases, the extra voltage drop through R_4 drives the noninverting input of the op amp lower and thus decreases the output.

Resistor R_3 is made equal to the parallel combination of R_1 and R_2 to minimize any error caused by input bias current. For the values shown in the figure, input voltages up to ±10 volts produce current outputs up to ±10 milliamperes.

This circuit has been used for over a year to supply current to electromagnets. In this application it is boosted by an emitter follower for greater output current and more voltage compliance. □

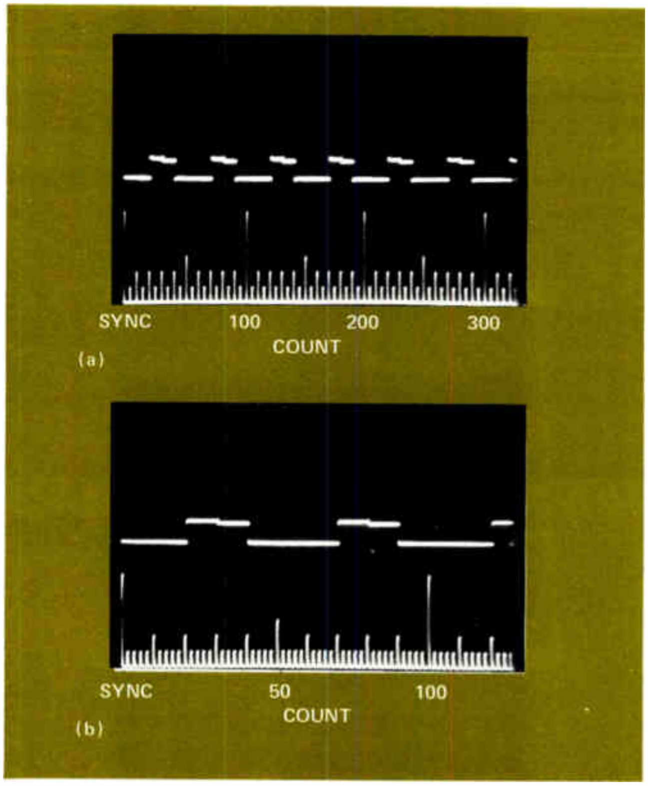
Graduated-scale generator calibrates data display

by Ken E. Anderson
IBME, University of Toronto, Canada

Scope and chart displays may require reference signals to indicate timing or counting scales. The circuit shown here is added to the display portion of a real-time digital data correlator at a cost of $3 or $4 to provide a graduated scale below the correlation display on a two-channel scope. Although it lacks the precision of a cursor, the continuous scale offers greater versatility and speed of operation. It also references the display data when stored on hard copy.

The photographs in Fig. 1 show two scales that can be generated to aid the observer in determining the pulse count or time at which a wave form rises or falls. In the lower trace of Fig. 1(a), every fifth clock pulse is indicated, and in Fig. 1(b), every second clock pulse is indicated. The upper trace in each photo shows a wave form that goes high at count 20, low at 40, high again at 70, low again at 90, and so forth. These counts can be read easily and accurately from the reference scales.

As shown in Fig. 2, the scale generator is remarkably simple. For two decades of unique graduations, two decade counters (7490) and one package of open-collector AND gates (7409) are required. These gates switch a crude voltage-divider digital-to-analog converter, generating the various pulse heights. Gate A in Fig. 2 ANDs the system clock with the basic scale unit—five in Fig. 2(a) or two in Fig. 2(b)—enabling the voltage-divider output to rise. Low gates B, C, or D (or combinations) clamp the output to appropriate levels as determined by R_1, R_2, R_3, and R_4. As higher-order counters progres-



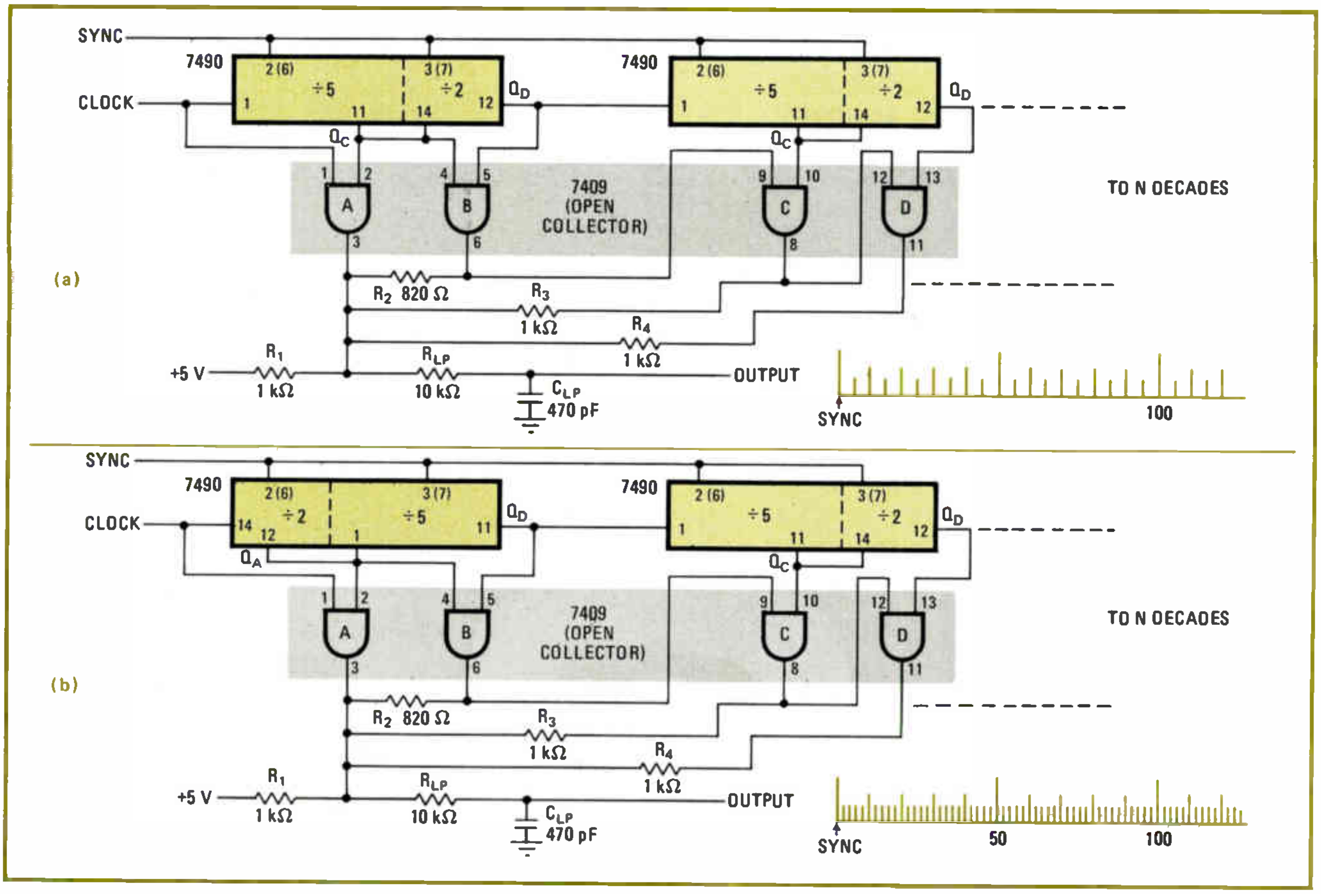
1. Measurement aids. Graduated scales are generated on dual-trace scope or chart to facilitate probing of displayed data. In lower trace (a), every fifth clock pulse has a spike; in lower trace (b), every second clock has one. From these scales, observer sees that upper trace rises at count 20 and falls at count 40. Circuits for generating scales are shown in Fig. 2.

sively flip high, taller graduations are created.

Use of the 7490's quinary and binary counters obviates the need for extensive decoding. For example, the output of gate A in Fig. 2(a) goes high on the clock high of count 4, (9, 14, 19, etc); gate B ANDs this high signal with counts 5–9 (15–19, 25–29), thus decoding count 9 (19, 29). The cascaded decade circuit decodes counts 49 and 99. For display on a scope, a low-pass filter or integrator consisting of R_{LP} and C_{LP} is added to improve the appearance of the scale by increasing the rise and fall times of the pulses. Relative pulse heights may be altered via resistor ratios of R_1, R_2, R_3, and R_4. However, to ensure adequate noise margin at inputs of gates C and D, R_1 must not be greater than R_3 or R_4.

Synchronization of the scale generator to the scope and system output is accomplished by providing a pulse to reset the counters to zero (pins 2, 3) for graduations on counts 4, 9, 14, 19, etc. or to maximum (pins 6, 7) for graduations on counts 5, 10, 15, 20. . . .

The use of this graduated-scale generator can ensure



2. Here's how. Circuits for generating graduated scales of incoming clock pulses use decade counters. Two AND gates per decade switch voltage-divider d-a converter to produce various pulse heights; the AND gates have open collector outputs. Each counter in (a) divides by 5 and then by 2 to provide scale with a basic unit of 5 counts. In (b), first counter divides by 2 and then by 5 to provide a basic unit of 2. Second counter divides by 5 and then 2 to enhance pulses at 50 and 100. Values of R_{LP} and C_{LP} shown here are chosen for use with a 10-kHz clock.

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18435 Susana Road, Compton, California 90221. (213) 537-4750 TWX: 910-346-6773 precise tagging of displayed data even when the scope is being operated in the magnify, delayed-sweep, and uncalibrated-sweep modes. Other applications include generation of a time scale for sweep calibration of scopes (when clocked by a high-precision source) and generation of a clock-pulse scale for troubleshooting cyclic sequences. The latter application is illustrated by the upper traces in the two photographs; this waveform is actually the output of the second bit of the second quinary counter (pin 8 of the second 7490). □

Triangular waves from 555 have adjustable symmetry

by Devlin M. Gualtieri
University of Pittsburgh, Pittsburgh, Pa.

The fixed-frequency triangular waveform so often required in pulse-duration modulators or sweep generators too often turns out costly to implement. Though operational-amplifier circuits can develop a triangular wave by integration of a square wave, the tips of the triangle become blunt at frequencies above 10 kilohertz unless expensive devices with high slewing rates are used. Also, though single-package voltage-controlled oscillators provide triangular output, they are not cost-effective for fixed-frequency applications, and most have high current drain. However, an inexpensive 555 timer and some transistors can generate triangular waves at frequencies up to about 100 kHz.

The circuit shown generates a triangular waveform by alternately charging and discharging a capacitor. The transistors Q_1 and Q_2 with their zeners act as a switched-current source and a switched-current sink that are activated by Q_3. When Q_3 is on so that its collector is low, the Q_1 current source is switched on, and a current i_1 charges capacitor C. The linear voltage ramp that appears across C corresponds to the charging law $dV/dt = i_1/C$.

Voltage V across the capacitor increases until it reaches a level that is two thirds of the supply voltage, which is the upper trip point of the 555 timer. The voltage at pin 3 of the timer then goes low, turning off Q_3. Since the collector of Q_3 is thus made high, the Q_1 current source is deactivated, and the Q_2 current sink is switched on. The capacitor is discharged by i_2 until the lower trip point of the 555 timer is reached, at one third of the supply voltage. At this point the 555 changes state and the cycle repeats. Thus the output voltage varies from 4 V to 8 V if the supply is 12 V.

Q_1 and Q_2 may be any high-gain pnp and npn transistors, such as 2N3638 and 2N3646. Q_3 may be any npn switching transistor, such as 2N3646. The forward voltage drops of D_1 and D_2 ensure turn-off of Q_1 and Q_2. Resistor R_2 is a symmetry adjustment, controlling the discharge rate of C by varying i_2. For the values shown, the frequency in hertz of the symmetrical triangular wave form is roughly 75/C, where C is in microfarads; thus, C determines the frequency. □

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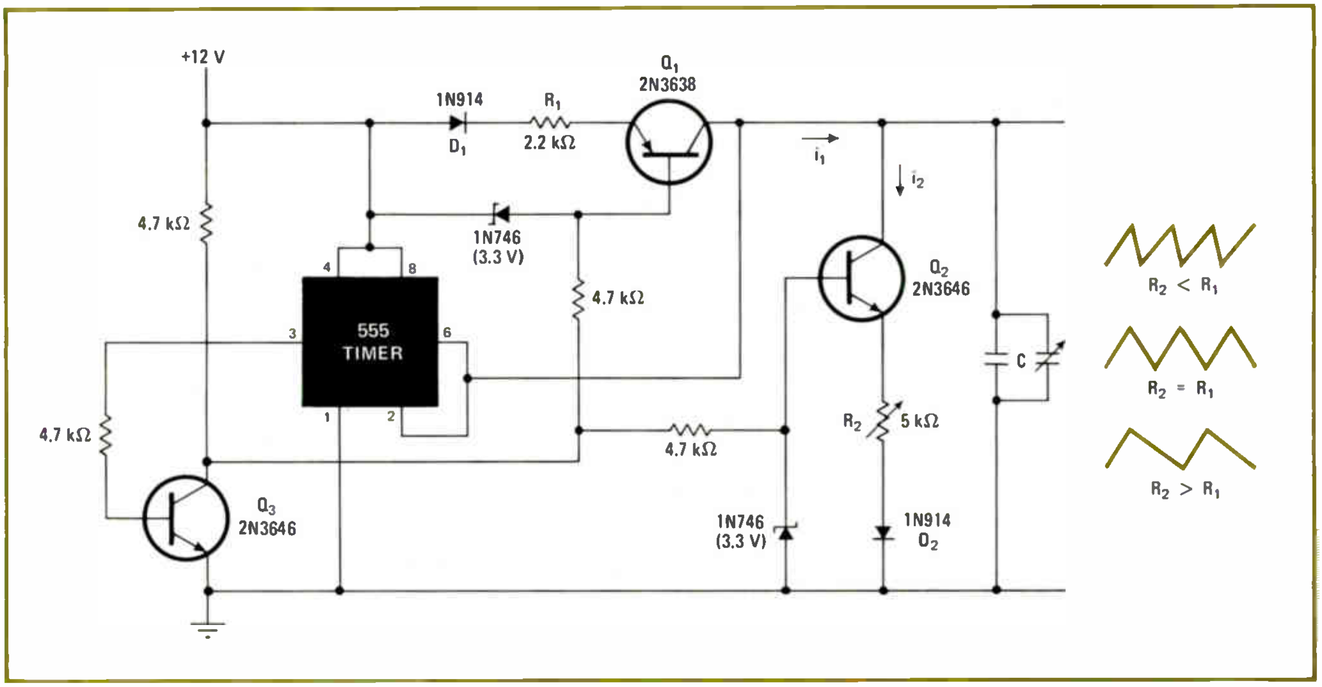


Ups and downs. Triangular waveform is generated across capacitor C by alternately charging and discharging through emitter-follower constant-current sources consisting of transistors Q_1 and Q_2 plus their zener diodes. Current sources are turned on and off by 555 timer.

EEs unite angrily over mid-career crisis

Electronics engineers of all ages agree that they face unique job and educational problems compounded by age bias in industry; less obvious to everyone is what to do about it

by Gerald M. Walker, *Associate Editor*

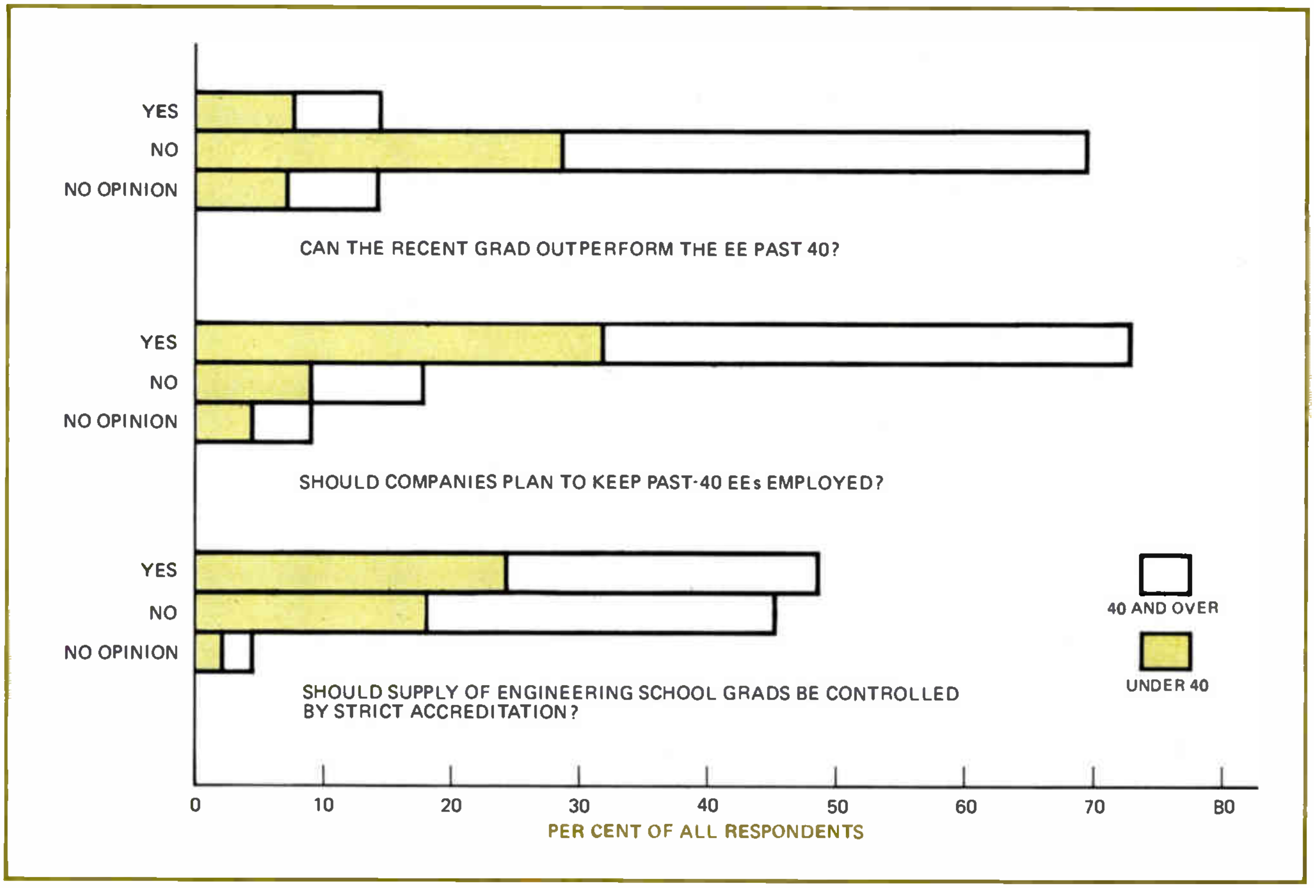
☐ An overwhelming majority of EEs over and under 40 years old recognize a mid-career crisis in their work. Moreover, they believe that age discrimination in industry contributes to the seriousness of the crisis.

This is the consensus of the readers who replied to *Electronics*' last questionnaire [*Electronics*, Oct. 30, p. 100]. The questions asked readers for their opinions on the causes of and likely solutions to the career dilemmas that confront electronics engineers as they reach 40.

Almost as many respondents were under 40 (45%) as over (55%). Yet there was remarkable agreement among them all on most of the issues raised.

For example, 92% said that they are aware of the mid-career crisis experienced by EEs. And 90% stated that age discrimination exists in hiring and firing of EEs. Less unanimity was expressed on covert on-the-job age discrimination against older engineers. Sixty-seven percent of all respondents agreed that over-40 employees are passed over for challenging new projects in favor of younger engineers.

Two questions that could have split the under-40 and over-40 groups dealt with job performance. One asked whether a recent EE graduate can outperform an EE past 40 (Fig. 1). Only 15% of the total replies said yes, while of the under-40 EEs, 19% agreed, 65% disagreed, and



1. No age difference. Engineers agreed on adequate job performance of older EE and company responsibility for keeping older EEs employed. But opinions on whether to control supply of engineering school graduates were split evenly—but again not along age lines.

17% had no opinion. The other question—"Should companies take steps to keep EEs past 40 employed, even if younger engineers are available who are as capable of performing the same job?"—also produced a unified response. Seventy-three percent of respondents of all ages said yes, 18% said no, and 9% had no opinion. Again there was very little difference of opinion between the EEs under and over 40 on this subject.

The most controversial issue raised by the questionnaire, as it turned out, had to do with controlling the supply of engineering-school graduates by strictly enforced accreditation standards. Forty-nine percent favored controls, 46% were opposed, and 5% had no opinion. However, close as it was, this vote was not split along age lines. Surprisingly, 52% of EEs *under* 40 favor controlling the supply of graduates and 43% oppose doing so, while 47% of the over-40 group would control the supply, and 48% would not.

In this sampling, the younger engineers appear more interested in getting a hand on the spigot controlling the number of practitioners than are the over-40 engineers, supposedly the ones endangered by the newcomers.

What to do about it

Over four fifths of the respondents in both age groups felt that the mid-career crisis is unique to the EE career as compared to other professionals or even nontechnical craftsmen. Yet no clear picture emerged of what engineers might do to reduce or eliminate age discrimination in employment on the one hand and lessen the possibility of their technical obsolescence on the other.

The questionnaire asked what action EEs could take to cause companies to reevaluate their attitudes and policies toward older EEs. But none of the suggested answers to the question received strong support (Fig. 2). Nor did any one course of action dominate the ideas put forward in the space provided for comments. Persuasion through the Institute of Electrical and Electronics Engineers got the highest percentage of votes (45%), but many comments indicated lack of faith that the institute could accomplish anything that would help the working EE. The second highest vote was for promoting stronger Federal legislation against age bias, but again, numerous comments denounced "more Government interference" in private enterprise. On the whole, there was a standoff on these two actions.

By far the most frequently mentioned alternate action was formation of a strong, militant union. Variations on this idea were suggestions for a guild, bargaining association, or an "AMA-type" organization to deal with companies on behalf of engineers. Once again the opinions of the under-40 and over-40 EEs were not very different. More younger respondents favored IEEE action (48%) than did older respondents (43%).

The only question that clearly divided the younger from older EEs was how strongly each group felt about the reasons for age bias. Sixty-two percent of the over-40 group and 52% of the under-40 group, a 10% spread, said that age bias exists, no matter what the professional competence of the older engineer. Also, 30% of the over-40 respondents and 40% of the under-40 group believed that only the older engineer who has not kept up to date in technology has difficulties in finding a job or gaining promotions.

As for what they do about avoiding professional obsolescence, engineers favored the pragmatic, short-order-cook approaches. Update courses at engineering schools and company-sponsored courses, usually to meet immediate needs rather than long-range goals, got the most mentions—52% and 49% respectively (Fig. 3).

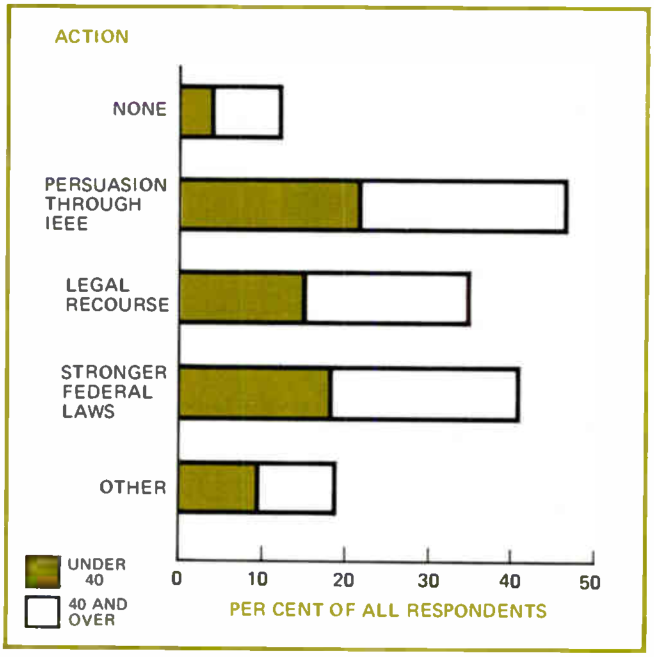
Significantly, the more formal, longer-range action—a postgraduate degree—drew less than one third of the replies while the open-ended category, "Other," got over half the responses. In this group were mentioned the least formal techniques of continuing education—reading the literature, individual home study, and keeping current through technical publications.

Respondents resoundingly rejected one of the possible solutions to the mid-career problem—retirement after 20 years. Just 15% of the returns agreed with the proposal, 78% turned it down, and 7% had no opinion. More EEs past 40 were against early retirement than those under 40—80% and 75% respectively.

No one seemed particularly worried over the possibility that wide use of microprocessors could reduce the number of EEs of all ages required by industry. Only 17% thought the problem might arise. Most EEs pointed out that new technologies in the past tended to increase opportunities, not restrict employment.

Emotions rise in the comments

The statistical results of this survey give a good indication that the mid-career crisis is bothering EEs of all ages. However, the comments by respondents provided a vent for the truly passionate feelings engineers have developed toward their careers, employers, engineering schools, IEEE, and their fellow engineers. Anger, frustration, disillusion, hostility, and militancy marked much



2. Action. Though EEs believe that age discrimination exists in hiring and firing practices, they are divided on how best to combat bias. The alternative most mentioned was to unionize.

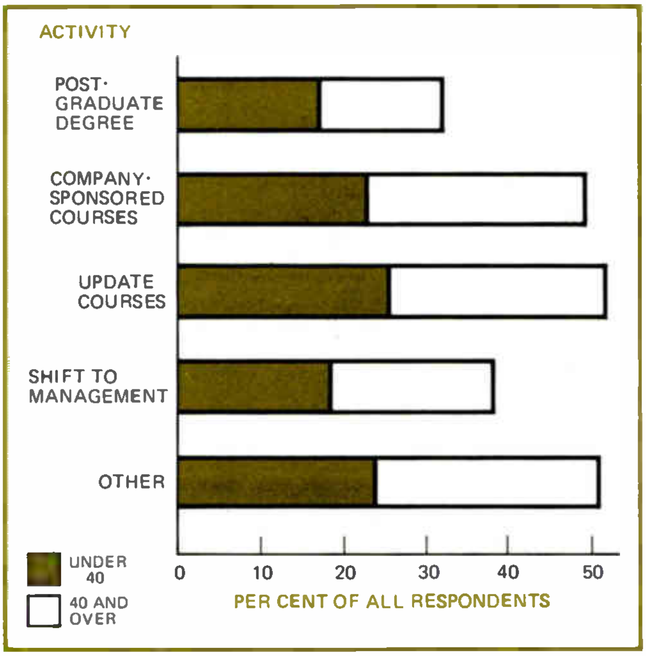
of what these EEs had to say. Others felt that hard work and dedication are still virtues that will see the competent engineers through the mid-career years.

Between these two poles were the somewhat muffled moderates. Among the latter was a 39-year-old design engineer in avionics who suggests, "[The] cause of discrimination must be identified. Claiming obsolescence of older engineers appears to be a standard honest, but unfounded excuse. Ask companies to prove that the older engineer is obsolete. Ask companies to be more specific on what skills are being referred to; and ask that they show that new graduates have these skills."

One of the most revealing statements was submitted by a 39-year-old engineering department manager for a California equipment systems company. "There is very real age discrimination in the hiring of engineers," he says. "Having recently been in a position to hire engineers I can attest to the fact, and I can explain how it happens. Initially, you sit down with a large pile of resumés. With the highest of principles and without bias, you separate them into two piles, qualified and unqualified. You soon learn that a great many of the over-40 engineers are in the unqualified pile and that all of the over-40 engineers who are qualified are too expensive for your opening. Eureka! You can save a lot of time by automatically putting all the over-40 engineers in the unqualified pile in the first place."

Comparison of the EE career with other professions and hourly workers often provoked pro-union remarks, which ran from moderate to militant.

For example, a 52-year-old East Coast EE states, "Unionize—I never thought a few years ago that I would ever contemplate such a 'disgusting' idea." Says a 45-year-old unemployed design engineer, "Unionize, and forget the cries about professionalism, which does not exist anyway." A 37-year-old industrial controls consulting engineer concurs: "Professionalism isn't working. Let's try a strong, strong union like the garbage men, the cops, and the teachers." "Violence," asserts a 32-year-old Ph.D. from the Midwest, "is the political voice which alone is heard through the channels of bureaucracy today!" And an unemployed EE of 41 chimes in: "Engineers need a union—a cross between AMA and teamsters. Butt heads and shut plants to protect seniority. Management unrestrained by unions will and does [expletive deleted] the unorganized laborer."



3. Keeping up. Most respondents have chosen the short-range means—company courses and update courses—of avoiding professional obsolescence. Favorite alternative was home study.

Who participated

Most of those replying to *Electronics*' survey on the EE's mid-career crisis—49%—came from engineering management, including project and program leaders. And the largest percentage in both age groups are currently employed by space, missiles, or aircraft type companies. Computer and communications manufacturers were the next largest categories of employer

As for geographic location, California, New York, and Massachusetts were most heavily represented, with 27%, 9%, and 8% of the respondents respectively. Among nonmanufacturing firms, the highest percentage (9%) came from consultants—sometimes a euphemism for unemployed. Just 2% of all respondents said they were unemployed; they were 1% of the under-40 group and 4% of the over-40 group.

Among the proponents of self-help was a self-employed engineer from Los Angeles, who wrote, "I am 49. In 1973 I was out of a job and not interested in corporate management, it was then that I realized that I was technically outmoded. So I retreaded myself—fast. Now I have a consulting group which handles tough design problems, and I personally handle the toughest. So there is hope where there is determination."

A 36-year-old Ph.D. in the South turns the union issue around, commenting, "The problem is the EE, not the company. Let's not join the unions in forcing waste, inefficiency, and incompetence onto employers."

Most of the comments, however, focused on other causes such as the educational system. "Engineering faculty members look out for their own jobs by keeping students uninformed on what it's like in industry," charges a New Englander aged 31. Another target was company management. "As I sit here, 37, unemployed for a year, I find myself thinking of the way industry cares only for the almighty dollar and not for employees," laments a Midwest engineer.

Far more vehement, a 32-year-old senior engineer for a computer company charges: "For years companies have exploited engineering employees by appealing to their pride, 'You are a professional.' Now it is time for both young and old to unite and hold industry and the country hostage for the damages."

Perhaps the less bombastic statement of a 30-year-old EE from Ohio carries the ultimate message even better. He suggests, ". . . realization by management that EEs are not pieces of furniture or capital equipment, which in turn requires realization of the same thing by engineers themselves." □

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Semilog paper is short cut to finding filter frequencies

by Marc Damashek
Clarke School for the Deaf, Northampton, Mass.

Semilogarithmic graph paper provides a handy way to estimate center frequencies and band-edge frequencies in the design of filter banks. It's also a convenient way of finding fractional roots and powers of numbers.

Both applications make use of the fact that a straight line on semilog paper represents the functional relation that can be stated as:

$$\log y = a + bx \qquad (1)$$

or

$$y = y_0 k^x \qquad (2)$$

where y is 10^a and k is 10^b.

For example, an engineer may want to design a filter bank in which the ratio of successive center frequencies ($f_0, f_1, \ldots f_{N-1}$) is constant:

$$f_1 = cf_0$$
$$f_2 = cf_1 = c^2 f_0$$
$$f_3 = cf_2 = c^3 f_0, \text{ etc.}$$

or, in general,

$$f_n = c^n f_0 \qquad (3)$$

Equation (3) has the same form as Eq. (2), so a semilog graph of the frequency of each filter stage, plotted against the number of that stage, is linear. Therefore the frequency of the first stage can be plotted at abscissa zero, the frequency of the last stage can be plotted at abscissa (N – 1) where N is the total number of stages in the filter, and when the two points are connected by a straight line, the frequencies of all intermediate stages can then be read at a glance.

Thus in Fig. 1 the line A illustrates how to estimate center frequencies given a requirement for seven channels total, with a lowest-channel center at 80 hertz and a highest-channel center at 500 Hz. The line connecting points (0, 80) and (6, 500) shows that the intermediate frequencies are 109, 147, 200, 271, and 368 Hz.

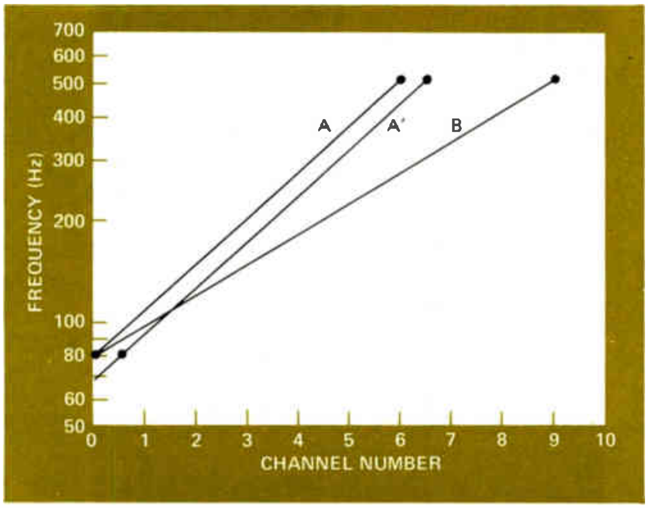
It should be noted that this graphical technique circumvents the need for some fancy calculation. For instance, it is not necessary to compute c, which in this case is:

$$c = (500/80)^{1/6} = (5/2)^{1/3}$$

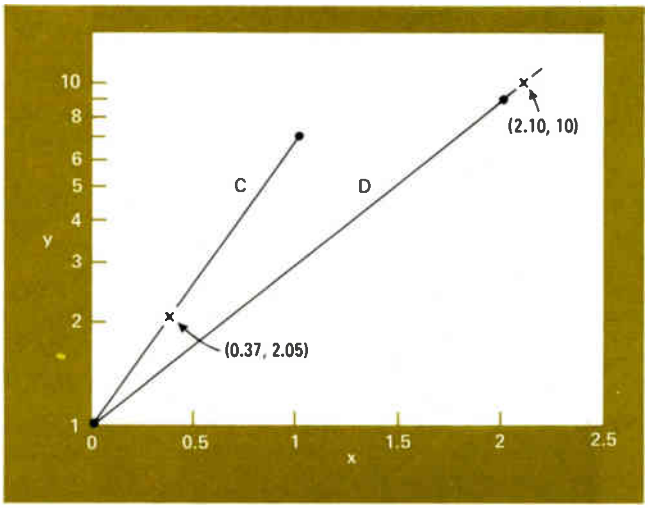
The method lends itself to quick appraisal of alternative filter schemes; for example, to find frequencies for a scheme with 10 channels instead of seven, line B is drawn connecting the point (0, 80) with the point (9, 500). Even if a calculator were at hand, it could not possibly give such a meaningful representation of the desired information in so short a time.

The line that connects the points (½, 80) and (6½, 500), which is labeled A′ in Fig. 1, gives band-edge frequencies that equal the geometric means between successive center frequencies for the seven-stage filter. This sort of information is of interest in the design of constant-Q filters.

Use of semilog paper to estimate fractional roots and powers corresponds to letting y_0 equal unity in Eq. (2). Figure 2 illustrates the technique in finding the value of



1. Filter frequencies. As graphic aid in design of filter banks with constant frequency ratio between stages, line A determines frequencies for a seven-channel system and line B determines them for a 10-channel system, both covering the range from 80 hertz to 500 Hz. Line A′ determines band-edge frequencies for the seven-channel system. The error in reading frequency values is about 0.5%.



2. Roots and powers. Lines C and D illustrate use of semilog graph paper to provide quick solutions for values y and x in equations $y = 7^{0.37}$ and $10 = 3^x$, respectively.

$7^{0.37}$. If:

$$y = 7^x$$

some known relations are:

$$1 = 7^0$$

and

$$7 = 7^1$$

Therefore $y = 7^{0.37}$ is found by drawing a straight line connecting (0, 1) and (1, 7) on the semilog paper. Where x is 0.37, y is found to have the value of 2.05.

As a final example, to find x in the equation $10 = 3^x$ (i.e., to find $\log_3 10$), draw line D to connect the points (0, 1) and (2, 9), and extend it out to y = 10. At y = 10, x = 2.10. □

Oscilloscope displays contents of RAMs and ROMs

by James A. Blackburn
Wilfrid Laurier University, Waterloo, Ont., Canada

The contents of random-access and read-only memories can be represented graphically on any oscilloscope that has an X-Y mode and a Z-axis control input. And the cost of parts for the system that produces this useful display is less than $50.

The scope photograph in Fig. 1 displays the storage in a RAM that is configured as 256 4-bit words. Each word appears as a square in a 16-by-16 checkerboard on the CRT, and each square consists of 16 dots; all 16 of the dots shine with a single intensity that corresponds to the magnitude of the word. That is, the intensity of the CRT beam is modulated so that (in this case) the maximum possible brightness represents a 1111 word and minimum brightness represents a 0000 word. This makes it possible to assess the memory contents at a glance.

The system can also be used as a pattern generator merely by loading the RAM with appropriate data. The gray scale provided by intensity variation lets you shade in pictures, though full-contrast alphanumerics can, of course, also be displayed. And by viewing the display of a RAM that has been loaded through the filter, you can evaluate digital filter designs.

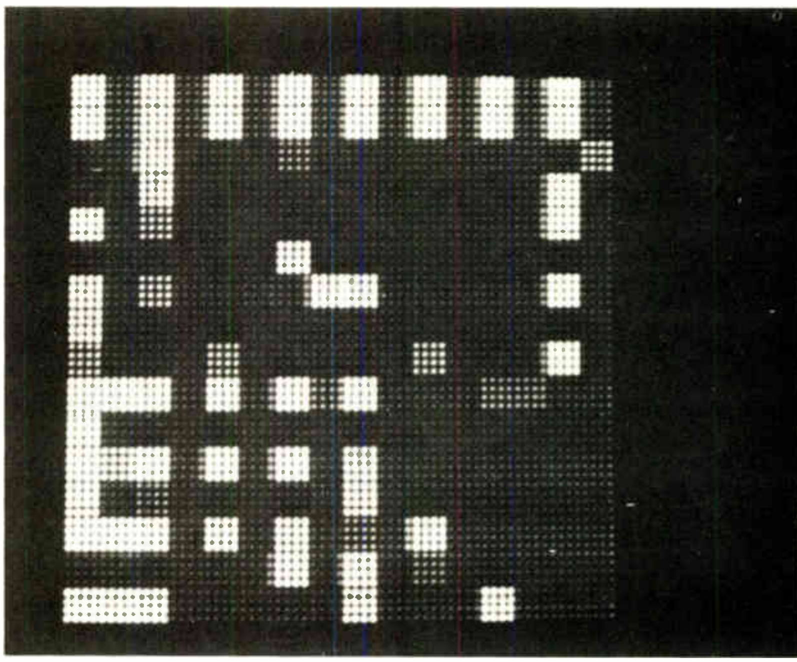
The digital graphic display circuit is shown in Fig. 2. A clock circuit feeds a 6-bit binary counter whose output in turn drives a second 6-bit counter. The outputs of these 12 flip-flops are connected to Motorola MC1406 digital-to-analog converters that use Analog Devices' AD580 reference-voltage sources. The d-a converters feed MC1741 op amps that function as current-to-voltage converters to drive the X and Y deflection amplifiers of the oscilloscope. As the CRT beam is sequentially stepped along a series of horizontal lines, 64-by-64 beam coordinates are defined. Final over-all image size is directly adjustable by means of the oscilloscope vernier controls (channel A and time).

The 64-by-64 array is subdivided so that each memory word occupies a 4-by-4 submatrix on the display. The scan circuitry thus must deliver the same read address to the RAM for groups of four points along a given horizontal line, and in addition, must repeat each line four times before incrementing the corresponding address bits. The logic shown in Fig. 2 performs this indexing sequence.

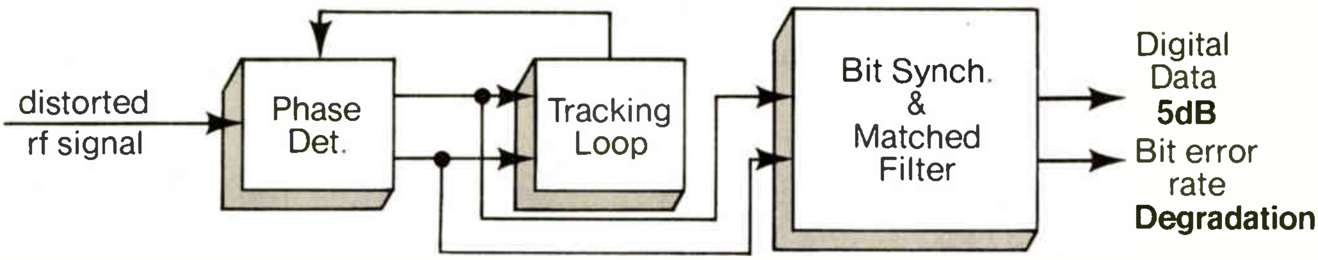
The Signetics 2606 n-channel static RAM outputs are fed to the d-a converter that generates the appropriate beam-modulation voltage to drive the Z input of the scope. The two lowest-order bits of this converter are held high because the memory delivers only a 4-bit word. Because the MC1406 responds to $\bar{w}$, where w is the input 6-bit word, a memory word of 0000 results in maximum output voltage, whereas 1111 yields zero volts. Fourteen intermediate equally spaced voltages are also possible, depending on the value of w. High levels at the Z input produce low beam intensity, and therefore spot brightness is directly proportional to the magnitude of the memory contents at the selected address.

The Z voltage may be set to the required value for full blanking of empty memory cells by adjustment of the 10-kilohm trim resistor that is in series with the reference voltage of the Z d-a converter. On the Hewlett-Packard 1220A oscilloscope that was used in these studies, a Z input of about 5 volts blanks a trace of any in-

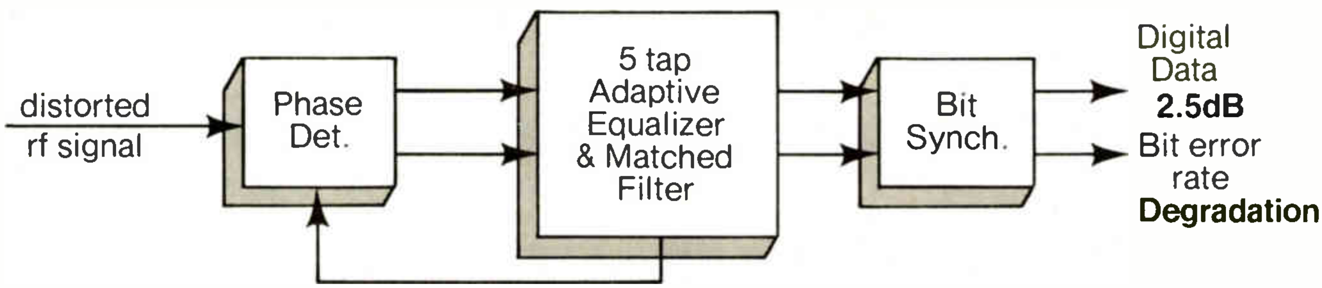
1. Word picture. The 16-by-16 array of intensity-modulated squares in this scope photo represent the 256 words stored in a random-access memory. Each square consists of 4-by-4 dots with equal brightness that is proportional to the magnitude of the word. Shown here is a random bit pattern that occurred at turn-on of the RAM.



Space Data Distortion



One-Half Off.



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(1) Stilwell, J. H. and Ryan, C. R., Performance of a High Data Rate Adaptive QPSK Modem Under Media Distortions, paper presented June 1975.

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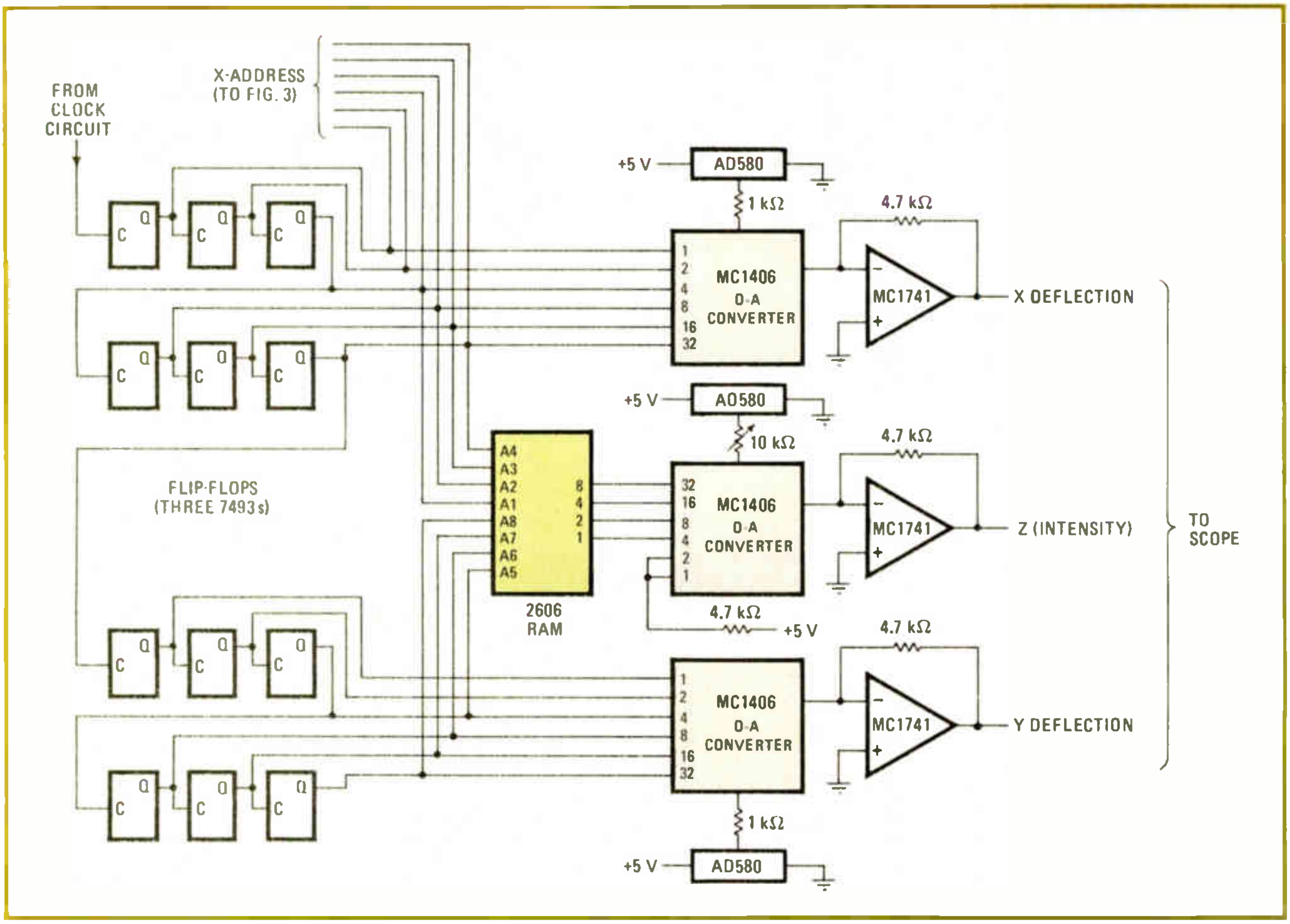
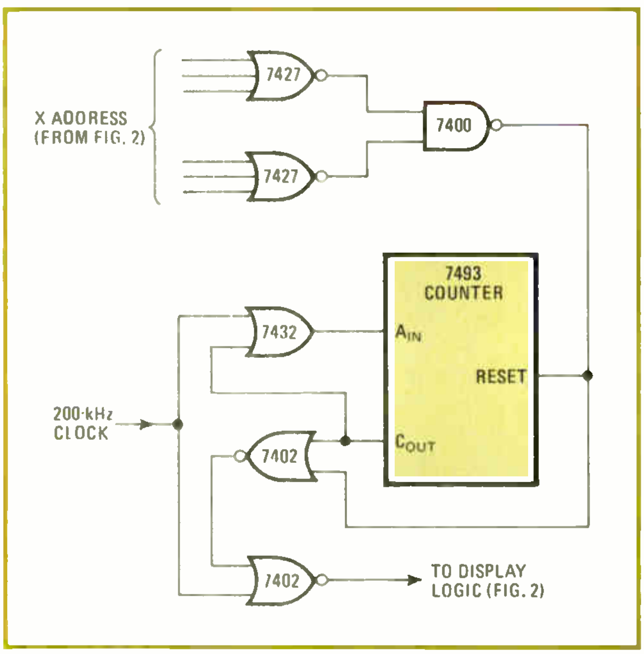


2. The inside story. Circuit displays RAM contents on laboratory oscilloscope by generating checkerboard of intensity-modulated squares. Each square represents a stored word, and its brightness is proportional to magnitude of word: 0000 is represented by fully-blanked square, 1111 by maximum brightness, and 14 intermediate magnitudes by proportionate intensities. Power supply, reset, chip-enable, and read/write connections are omitted for clarity. The digital-to-analog converters require 20-pF and 1-kilohm compensation.



3. Clock circuit. Counter and logic elements insert a "wait" at beginning of each horizontal line of raster to prevent distortion and/or loss of display. Delay has negligible effect on raster timing.

tensity. Thus, the combination of the scope beam-intensity control and the trim resistor makes it possible to set the display contrast to a suitable level.

In the interests of low cost, the widely available type 741 op amp is used throughout. However, the relatively slow speed of this device causes some display loss and distortion when switchback to the beginning of the next line occurs. The circuit shown in Fig. 3 compensates for this speed limitation by inserting a "wait" at the beginning of each line. To create this pause, the binary counter (7493) is enabled whenever an X address of 000000 is generated, while at the same time, the output NOR gate is disabled with a high input. When the output from the counter goes high, the clock stream is again passed through the final NOR gate. For the oscilloscope and ICs chosen, a four-cycle delay is optimal. With a clock frequency of 200 kilohertz, the added time per raster is essentially negligible.

The typical display shown in Fig. 1 represents a random bit pattern created when the RAM is powered up. Since the refresh rate in this example was 46 hertz, a flicker-free display was obtained. □

Engineer's Notebook is a regular feature in Electronics. We invite readers to submit original design shortcuts, calculation aids, measurement and test techniques, and other ideas for saving engineering time or cost. We'll pay $50 for each item published.

Engineer's newsletter

How to squeeze a bit extra into an 8-bit transmitter

A ninth bit can be squeezed through a standard eight-bit universal asynchronous receiver/transmitter by using the ninth bit to control the UART's parity mode, says Jeffrey Mattox, chief engineer of Heurikon Corp., Madison, Wis. When using, say, Western Digital's TR1062 or General Instrument's AY-5-1013, Mattox says, simply connect the EPE (even parity enable) line to the ninth bit (D_9). If the EPE line is high, parity is even; otherwise it is odd. At the receiver, permanently wire the parity mode for odd parity by grounding the EPE line. Then watch the PE (parity error) line at the receiver for the ninth bit.

If D_9 is zero, the transmitting UART EPE line will be low, so transmitted parity will be odd. Since the receiver is set for odd parity, no parity error will be detected, and PE will be low. But when D_9 is high, a parity error will result, and the receiver will switch the PE line to high. **Thus, PE at the receiver corresponds to the value of EPE at the transmitter.** However, notes Mattox, be careful to load the transmitter only when TRE (transmitter output register empty) is true, to assure that the UART completely transmits a word prior to loading another.

Expect to wait for your CB license

If you or some other member of your family received a citizens' band transceiver for Christmas, you'd better plan on a considerable wait while the FCC processes your license application. You should have no trouble in eventually getting the license, but realize that **the FCC is now handling more than 300,000 requests per month.** The backlog is continuing to grow and will probably take a step-function increase after the holidays. The application form for the license (fee $4.00) should have come in the same box with the equipment.

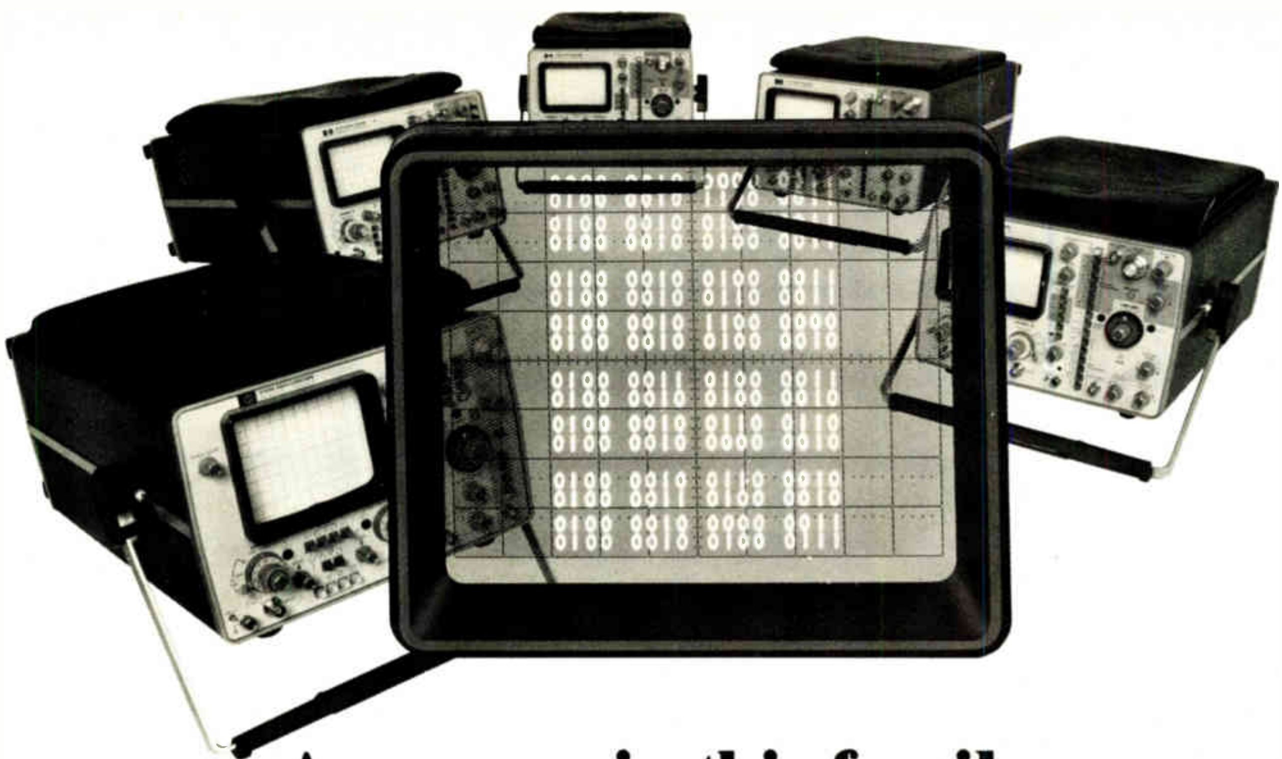
Cyanide's a killer environmentally, so do without it

If your shop has a silver-electroplating operation for such parts as connector contacts or lead frames, you're probably well aware that the Environmental Protection Agency has stringent regulations against even traces of cyanide and silver in the effluent. Silver-plating baths based on cyanide have been widely used, but extreme care in treating the effluents is required to live up to the regulations. Now, Technic Inc., Providence, R.I., says it can help you get the same quality plating without cyanide by using a new solution called Techni-Silver Cy-less DEL. The company claims it is **the first generally available cyanide-less silver-plating solution.**

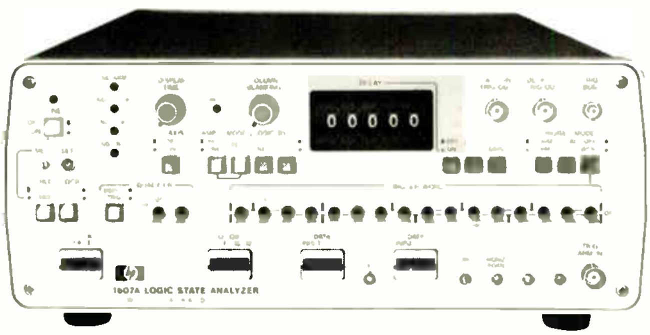
Two for your design files

We recently received some manufacturers' literature that deserves special mention: Superior Electric's "Design Engineer's Guide to dc Stepping and ac Synchronous Motors," and Spectral Dynamics' "Understanding and Measuring the Shock Response Spectrum." Both are **lucid, well illustrated, and worth having on hand.** Write to Superior Electric Co. at 383 Middle St., Bristol, Conn. 06010, and to Spectral Dynamics Corp. at 4255 Ruffin Rd., P.O. Box 671, San Diego, Calif. 92112.

—Stephen E. Scrupski



Any scope in this family gets you started in the data domain.



Pick any one of these HP scopes. With the optional Logic State Switch, and the 1607A Logic State Analyzer, you have an economical and convenient way to time-share the display between traditional time-domain measurements and the new data domain. Select the data domain and your scope's CRT displays the results of your measurements in 1's and 0's. Select time domain and you have a display of electrical waveforms. It gives you a digital test setup that lets you perform both functional and electrical measurements with the same instrument. You'll have:

Data Domain PLUS third-channel trigger view in the 100 MHz 1740A. This scope lets you see the trigger signal along with the other two channels so you can make accurate timing measurements from the trigger signal to events on either or both channels and see the trigger point. Large display, 1 mV sensitivity to 40 MHz on both channels...and it's only $1,995* (plus $105* for the Logic State Switch).

Data Domain PLUS Dual-Delayed Sweep, microprocessor and digital readout in the 275 MHz 1722A. Put this scope in your lab and you have a partner that takes care of dial settings and calculations. It gives you a direct digital readout of time, frequency, voltage, and percent. This plus Dual-Delayed Sweep for rapid, accurate timing measurements. Price is $4,750* (plus $150* for the Logic State Switch).

Data Domain PLUS Dual-Delayed Sweep and 200 MHz in the 1712A. This low-cost high-frequency scope gives you the measurement convenience and accuracy of Dual-Delayed Sweep, and scaled voltage output for direct readout of time intervals on your DVM. And it's priced at just $2,950* (plus $150* for the Logic State Switch).

Data Domain PLUS 275 MHz in the 1720A. Here's real bandwidth value in a dual-channel scope. It has exceptionally stable triggering and it's priced at just $3,500* (plus $150* for the Logic State Switch).

Data Domain PLUS general purpose in the 200 MHz 1710B. Here's another scope with real bandwidth value. It gives 200 MHz bandwidth at $2,900* (plus $150* for the Logic State Switch).

Pick the scope with the Logic State Switch (option 101) that best fits your needs and your budget. Then add the 1607A (priced at $2,750*) and you're ready to begin tackling problems in both the time and data domain. Contact your local HP field engineer for all the details.

*Domestic U.S.A. prices only.

Data/Time Domain Oscilloscopes

086 2

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For Technical Information circle 120 on Reader Service Card-For Immediate Applications Assistance circle 121 on Reader Service Card

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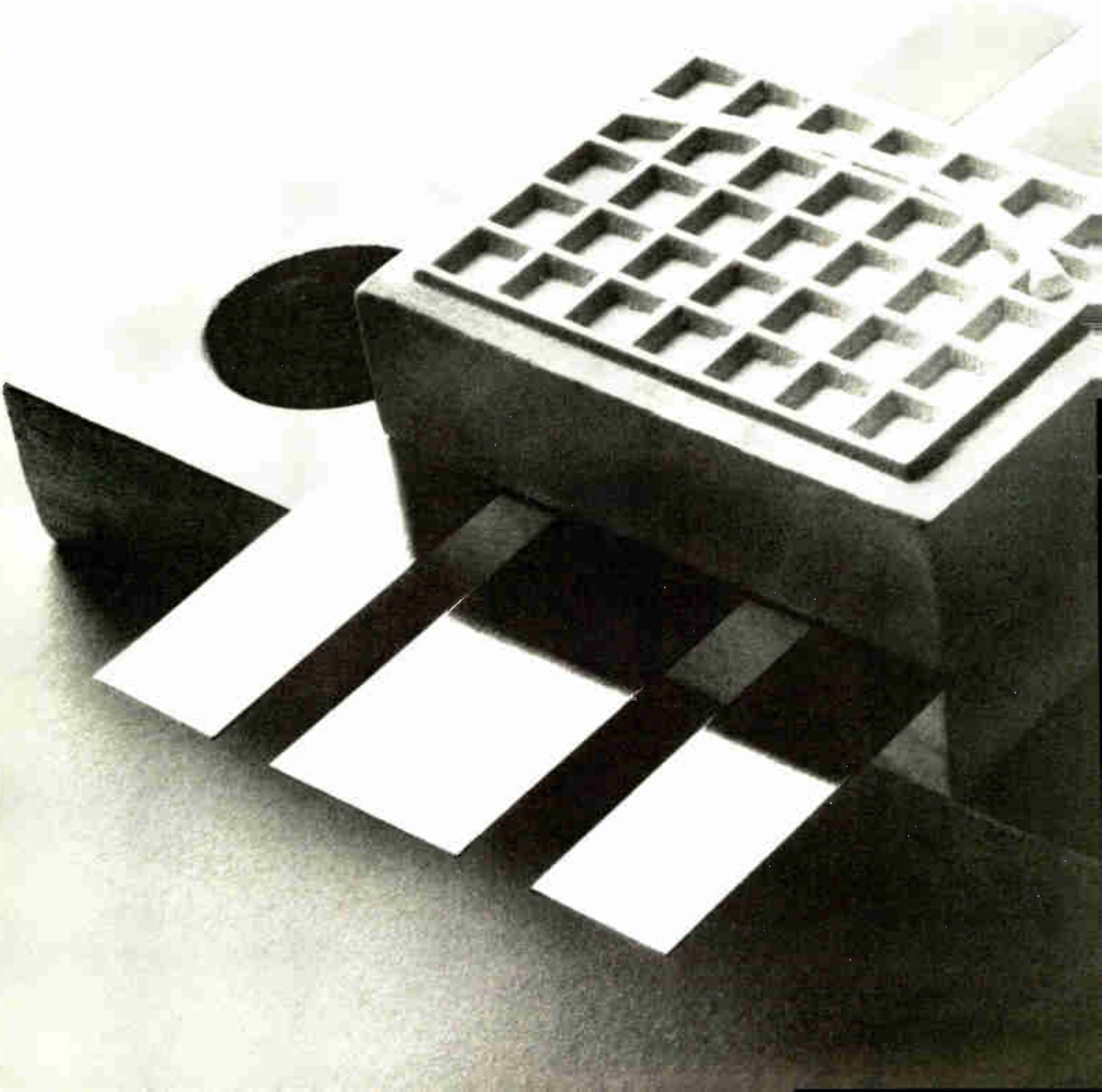
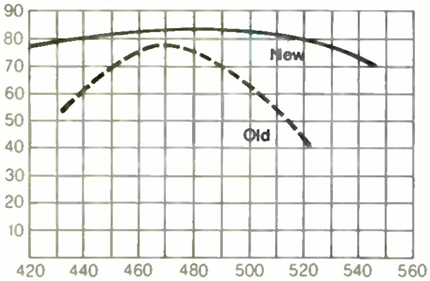


Power Out vs Frequency.

75 W P_C Rating, 12 V, Land Mobile



CM75-12 delivers flat out power in the new power square package; same lead spacing, no trade-offs, no kidding.

And the shape of the future in RF power is square. From C.T.C. The only RF/Microwave transistor manufacturer who both designs and mass produces its own package. We've dominated the conventional packaging scene and now we've blown the lid off. A whole new concept in RF power packaging that delivers up to 50% more power from the same dice, in identical lead spacing, with up to twice the bandwidth and up to 30% increase in power dissipation. And parts by the carload at announcement. Rugged, reliable, infinite VSWR, everything you've come to expect from C.T.C. For immediate requirements, call collect. Communications Transistor Corporation, a wholly owned subsidiary of Varian Associates, 301 Industrial Way, San Carlos, California 94070. (415) 592-9390.

The Powerhouse in RF Power.

	Pkg.	V_{CC}	P_O(W)	P_G(db)	P_D(W)	Freq (MHz)
CM75-12	TRB67	12	75	5	250	450-512
BM150-12	TRB67	12	150	5	350	150-175
BM100-12	TRB67	12	100	5	275	150-175
DM40-12	TRB45	12	40	4 5	160	800-900
C2M100-28A	TRB67	28	100	7	250	225-400
CD2876	TRB39	25	25	6.6	87	750-1000

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Circle 123 on reader service card

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The PDP 8/A-800 is designed for OEMs who need fast FORTRAN IV and floating point

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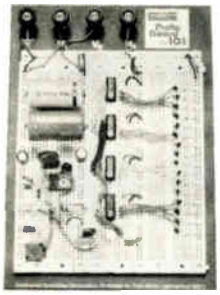

Proto-Board 103. 2250 solderless terminals save you time on every circuit you design.

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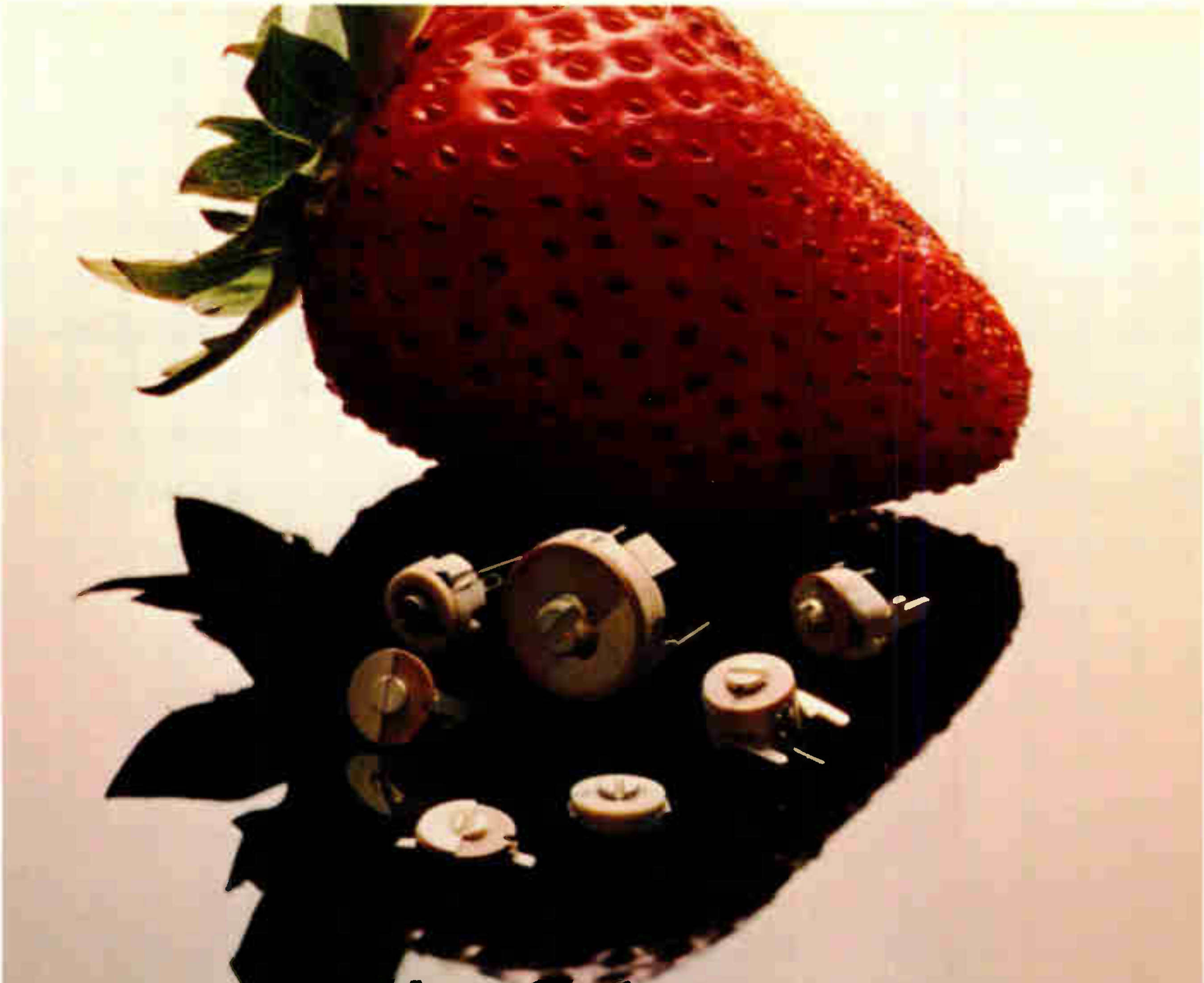

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New "Cricket" sub-miniatures: Interchangeability plus full 6 amp rating.

Cutler-Hammer introduces a broad new line of quality sub-miniature switches whose specifications meet industry standards for size, terminal spacing and bushing height. They're rated 6 amps. They're fully interchangeable. They feature high torque bushings. They're competitively priced. And they're available right now. For more information on new, interchangeable sub-miniature switches, call your Cutler-Hammer sales office or Stocking Distributor. Just ask for "Cricket."

Flat Lever. Designed for comfortable, finger-tip control. Keyed bushing prevents switch rotation.

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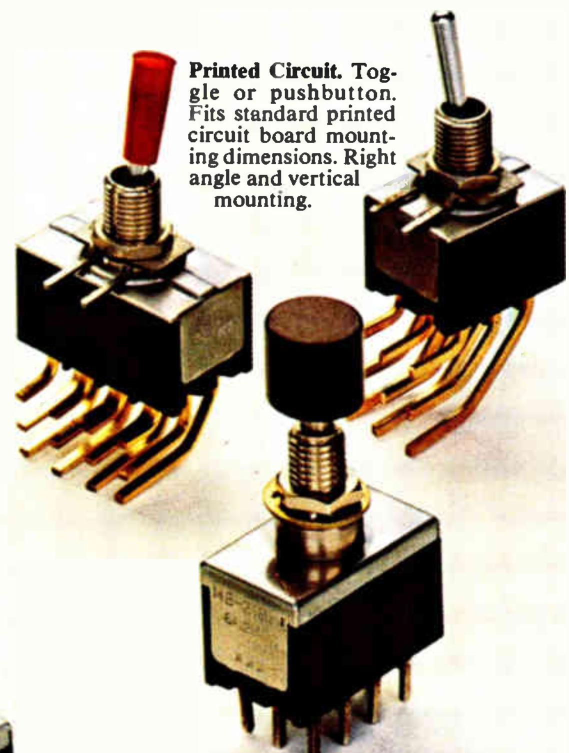

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Circle 128 on reader service card

Signetics starts I^2L family

FIFO memory handles data synchronization in tape systems, and character generator/checker can be used with floppy disks; both operate at 10 MHz

by Bernard Cole, San Francisco bureau manager

Using a novel circuit design and 5-volt, 10-megahertz integrated-injection logic, Signetics Corp. is introducing two peripheral devices to fill a performance niche in the marketplace. Designated the 8X03/04 Deskew first-in-first-out memory and the 8X01 cyclic-redundancy-character generator-checker, the devices are the first in a family of Signetics I^2L products that this year will include a direct-memory-access chip, a 64-word-by-9-bit FIFO memory, a 16-word-by-8-bit last-in-first-out memory, and a 16-word-by-8-bit multiplier [*Electronics*, Dec. 11, 1975, p. 29].

Stan Bruederle, advanced-product planning manager of the Signetics logic division, says the Deskew FIFO is designed specifically to deal with data-synchronization problems encountered in magnetic-tape systems. "In most of these, data is recorded in parallel fashion," he says; "that is, one bit of each word is recorded on a separate track. But the inherent properties of magnetic tapes and the misalignment of read heads can cause skewing during data recovery. And in systems using high-speed drive and high-density recording techniques, data-skewing can be a big problem."

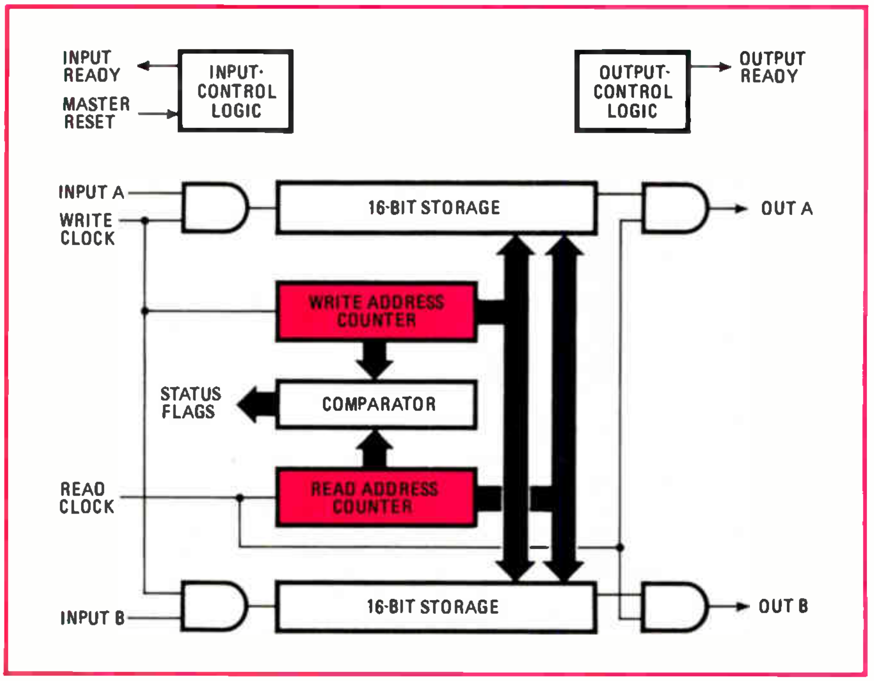
Clever design. The I^2L Deskew FIFOs, with their 10-MHz data rate, 400-milliampere requirements and asynchronous read-write capabilities, are aimed particularly at the high-speed situations. The 8X03/04 shown in the diagram consists of all the necessary logic for one track of information, but with two inputs for each track. Associated with each input are 16 bits of storage. Both inputs have one common clock. For data recorded by group-coded techniques, one input is used for input data and the other for storing error information associated with each track.

"Data is clocked into the first available cell addressed by the write-address counter," says Bruederle, "and after each write cycle, the write-address counter is updated and points to the next available cell. During a read cycle, the read-address counter points to the cell where the first bit of data is written in. At the end of the read cycle, the read-address counter is updated to point at the next available cell."

In addition, cascading to longer words can be accomplished without external circuitry. "When in that mode," says Bruederle, "data is stored in the first available cell of the first chip, then transferred to the first available cell of the second chip, and so on.

Signetics is also using its I^2L capability in the CRC generator/checker for use with floppy-disk and other disk systems, cassettes, cartridges, and data-communications systems. The 8X01 has a 10-MHz data rate, 5- and 0.8-volt power supplies, separate preset and reset controls, automatic right justification, and a pattern match specified by the synchronous-data-link-control (SDLC) protocol. The 8X01 requires a maximum supply current of 60 mA, has a preset-to-data-output delay of 85 nanoseconds, a preset-to-error-output delay of 110 to 125 ns, and a recovery time of 60 to 90 ns.

Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif. 94086 [338]

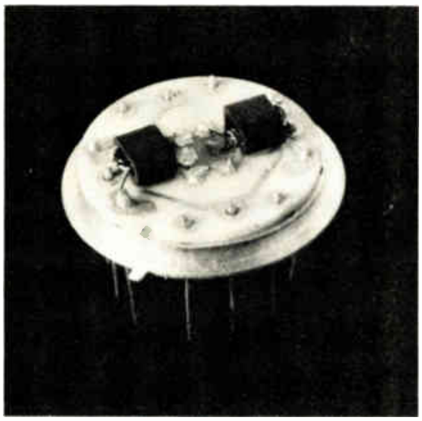


Microwave

Hybrid modules for industry

Communications, telemetry building blocks meet space, military reliability specs

High reliability is not exclusively the demand by military and space environments; it's sometimes needed in industrial applications as well. That's why Raytheon Co. has introduced a line of broadband ra-



dio-frequency/intermediate-frequency modules offering high reliability and geared to markets ranging from data communications to industrial telemetry.

Thick-film and hybrid technologies provide designers with a family of off-the-shelf high-reliability rf/i-f building blocks. Called Hypaks, they are available in either a TO-8 can (shown above) or in flatpacks measuring ⅝ inch square or ⅜ in. by ½ in. Depending on the type, some are available in only one of the packages.

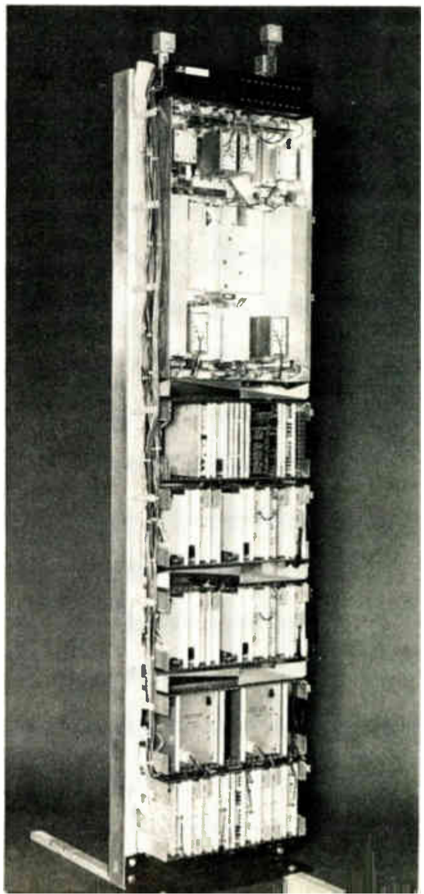
According to the company, a complete line of modules eventually will include all that's needed to build a high-performance receiver. Available now are a series of two-way power dividers, double-balanced mixers, rf switches, three-way power dividers, modulator/mixers, 180° hybrid junctions, couplers, 90° quad hybrid series, and rf amplifiers.

All of these modules operate somewhere in the range from 5 to 1,000 megahertz. Raytheon says their environmental testing in accordance with military standards, includes shock, vibration, centrifuge, moisture resistance, high-temperature storage, and operating life. Mean time between failure for the modules is claimed to be typically 10^6 hours. For functionally similar conventional modules built with discrete components, the company says the MTBF is about 2×10^5 hours.

Prices for the Hypak modules, which include military-type screening, range from $30 to $100 per module in quantities of 1,000. Delivery times are from two to seven weeks. If nonstandard devices are required, delivery time is extended to 14 weeks.

Raytheon Co., Microwave & Power Tube Division, Industrial Components Operation, 465 Centre St., Quincy, Mass. 02169 [401]

Digital radio system works in 10.7-to-11.7-GHz band



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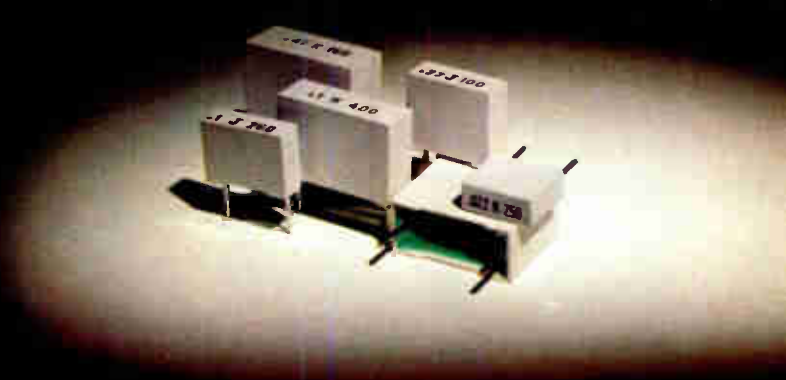

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Circle 131 on reader service card

New products

A solid-state digital microwave radio system from Collins Radio, the first of a completely new line of digital microwave products, consists of two components: the model MDR-11 microwave digital radio and the DMX-13 digital multiplexer/demultiplexer (muldem). The radio, which has been type-accepted by and conforms to the requirements of the FCC, operates in the 10.7-to-11.7-gigahertz band. It uses eight-level phase-shift keying to carry two DS-3 signals on a single polarization within the 40 megahertz allocated by the FCC. A DS-3 signal is a Bell System digital signal containing 672 channels; thus the radio can carry 1,344 digitized voice channels within the bandwidth that is allocated to it.

The DMX-13 muldem can handle up to 56 T1 lines, each of which is composed of 24 voice channels. The unit is compatible with Bell System DS-1 and DS-3 signals. Interfacing between the DMS-13 and the MDR-11 is by means of the Bell System standard DSX-3 cross-connect point.

The system has a receiver noise figure of only 8 decibels measured at the preselector filter input. Built into the system is an eye-pattern detector for the quick checking of over-all system performance. An order-wire service channel is also included in the main bit stream. The system is housed in two 7-foot racks that measure 8.85 inches deep.

Collins Radio Group, Rockwell International, Dallas, Texas 75207 [402]

Microwave signal generators have burnout protection

Two microwave signal generators—one for L-band, the other for S-band—are equipped with output isolators to prevent damage when testing high-power systems. Burnout protection is up to 1.5 kilowatts peak for the 0.8-to-2.4-gigahertz model 1605B-T and 1 kW for the 1.8-to-4.6-GHz model 1606B-T. Also included in the generators is a model 1020-T modulator for

Design with the complete flat cable/connector system.

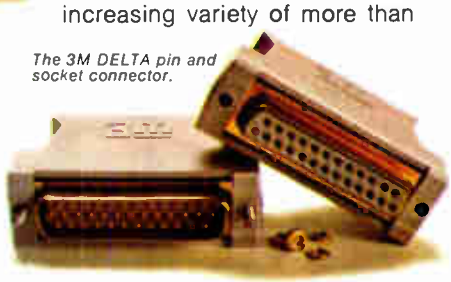
Assembly-cost savings are built in when you design a package with "Scotchflex" flat cable and connectors. But more important, 3M Company offers you the full reliability of a one-source system: cable *plus* connectors *plus* the inexpensive assembly aids that crimp the connections quickly and securely (with no special operator training required).

The fast, simple "Scotchflex" assembly sequence makes as many as 50 simultaneous multiple connections in seconds, without stripping, soldering or trimming the cable after assembly.

Connector units provide positive alignment with precisely spaced conductors in 3M's flat, flexible PVC cable. The connector contacts strip through the insulation, capture the conductor, and provide a gas-tight pressure connection.

With cable, connectors and assembly tools from one design and manufacturing source, you have added assurance the connection will be made surely, with no shorts or "opens."

And "Scotchflex" now offers you more design freedom than ever. From stock you can choose shielded and non-shielded 24-30 AWG cable with 10 to 50 conductors, and an ever-increasing variety of more than 100 connectors to interface with standard DIP sockets, wrap posts on standard grid patterns, printed circuit boards, or headers for de-pluggable applications. 3M's DELTA "D" type pin and socket connectors are now also available. For full information, write Dept. EAH-1, 3M Center, St. Paul, MN 55101.



The 3M DELTA pin and socket connector.

3M COMPANY

3M's "Scotchflex" line.

"Scotchflex" is a registered trademark of 3M Co.

square-wave, pulse, and frequency modulation. The units can produce pulsed outputs with durations from 0.2 microsecond to 400 μs, delays from 300 μs to 2,000 μs, and repetition rates from 10 hertz to 10 kilohertz. Both units provide uncalibrated outputs of at least +10 dBm (10 milliwatts) and calibrated outputs from +6 dBm down to −130 dBm. The 0.8-to-2.4-GHz model 1605B-T sells for $4,050; the 1606B-T is priced at $4,100.

Polarad Electronic Instruments, 5 Delaware Dr., Lake Success, N.Y. 11040. Phone (516) 328-1100 [403]

Microwave oscillator is crystal-controlled

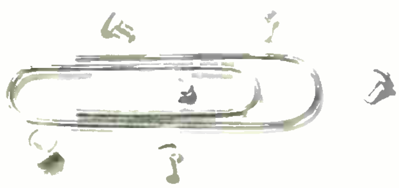
Offered with outputs in the frequency range from 1 to 2 gigahertz, the model EY-243 is a crystal-controlled microwave oscillator with a maximum frequency variation of less than 0.005% over the range from 0°C to 50°C. Output power is 5 milliwatts into 50 ohms, and maximum input requirement is 125 milliamperes at 28 V dc. Harmonics and subharmonics are at least 26 dB down, and spurious signals are at least 65 dB below the carrier. The model EY-243 measures 5.2 by 3.2

by 2.2 inches. It sells for $495 in quantities of one to three. Delivery time is typically six weeks.

Microwave Technology, 840 West Church Rd., Mechanicsburg, Pa. 17055. James M. Griffith (717) 697-4681 [408]

C-band Impatt diodes put out up to 3 watts

The model 5082-0608 silicon double-drift Impatt diode puts out up to 3 watts over the range from 5.9 to 8.4 gigahertz. The double-mesa device has a typical efficiency of 11%. A lower-power companion



device, the 5082-0607, has a typical efficiency of 10.5% and is rated at 1.5 W across the same band. In small quantities, the 5082-0608 sells for $250, while the lower-power unit has a $150 price. Delivery is from stock for one to 10 units.

Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [404]

Two-way power dividers are small and light

Weighing only 2.8 grams and housed in a flatpack that measures 0.125 by 0.38 by 0.50 inch, two-way power dividers of the PDF-2A series cover various ranges between 50 kilohertz and 1 gigahertz. The compact devices mount on stripline and printed-circuit boards for such applications as signal splitting, signal combining, and the formation of multicoupler and beam-forming networks. A typical unit in the series, the PDF-2A-250, has a range from 10 to 500 megahertz, coupling of 3 dB, isolation of 30 dB, amplitude balance of 0.1 dB, phase balance of 1°, insertion loss of 0.5 dB, VSWR of 1.3, and impedance of 50 ohms. The unit sells for $17 in small quantities. Other standard couplers have frequency ranges of 50 kHz to 100 MHz, 2 MHz to 200 MHz, and 100 MHz to 1 GHz. Custom models can be supplied.

Merrimac Industries Inc., 41 Fairfield Pl., West Caldwell, N. J. 07006. Frank Weber (201) 228-3890 [407]

25-watt cw traveling-wave tube weighs only 0.75 lb.

A miniature 25-watt cw traveling-wave tube amplifier has a small-signal gain of 50 dB over the range from 7.0 to 17 gigahertz. The tube, which weighs only 0.75 pound, uses a helical slow-wave structure and is focused with samarium-cobalt magnets. The F-2131's collector is isolated and may be depressed up to 50% of the cathode voltage for increased efficiency. Price is $4,500; delivery time is 60 to 90 days.

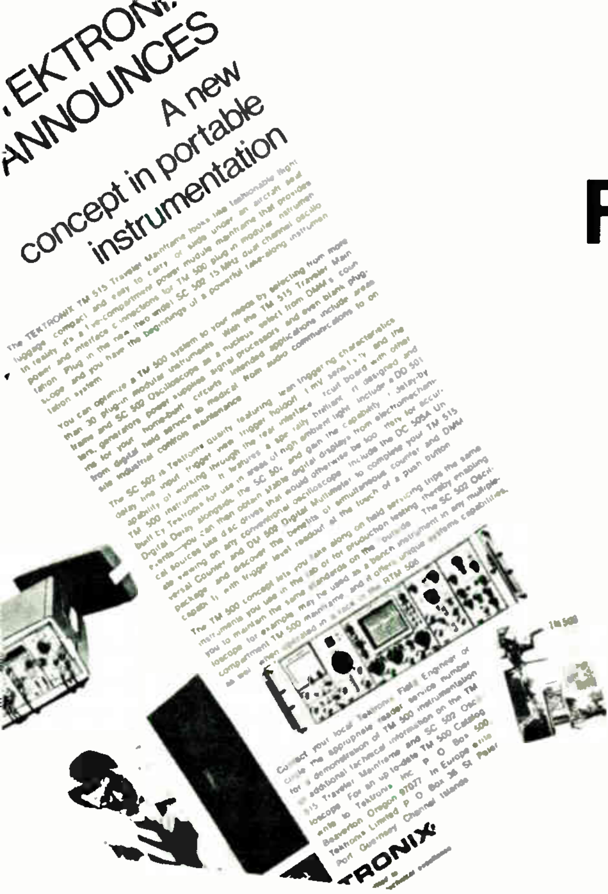
ITT Electron Tube Division, 3100 Charlotte Ave., Box 100, Easton, Pa. 18042. Phone (215) 252-7331 [406]

TOPICS

Microwaves

A line of precision adapters for mating 7-mm connectors with SMA or type N units is available from stock from **Weinschel Engineering, Gaithersburg, Md.** The adapters span the frequency range from dc to 18 GHz. . . . Two new spst microwave switches from **Hewlett-Packard Co., Palo Alto, Calif.,** reduce insertion loss by 20% over currently available types. The switches use p-i-n diodes in shunt across a 50-ohm line. . . . Believed to be the highest-power frequency-agile X-band magnetron available today, the VMX-1057 by **Varian's division in Beverly, Mass.** can deliver 400 kW. It can change frequency by 500-MHz in 30 milliseconds.


If you design with ECL or TTL, You need to know about Tektronix TM 500
If You're into High Speed Logic.
The TM 500 Concept
If you can't bring your troubleshooting into your lab, roll Tektronix TM 500 to the problem.
• digital multimeters
• counters
• generators
• amplifiers
• power supplies
• oscilloscopes
• a blank plug-in for your own circuitry
• and more
The TEKTRONIX Rollabout Configuration of TM 500 modular instruments helps you conveniently take your test and measurement laboratory right to the problem . . . whether it's routine maintenance, calibration, repairs, QC or production testing, or whatever. TEKTRONIX TM 500 modular instruments are designed to fulfill your needs in such widely divergent areas as computer circuitry and data handling equipment, numerically controlled machines, laboratory instrumentation, communications equipment, and medical instrumentation.
The modular Rollabout Configuration provides up to six operating test and measurement instruments which you can tailor from a growing line of 29, plus the TEKTRONIX portable or plug-in oscilloscope of your choice . . . all on a SCOPE-MOBILE cart. TM 500 modular instruments can work together through a common interface circuit board within their mainframe enclosures and they can also function totally independently. Some are general purpose such as DMMs, some are highly specialized such as those for oscilloscope calibration. They comprise a test and measurement system that is difficult to duplicate with monolithic instruments.
The TM 500 Product Line is a growing, compatible family of 29 plug-in modular instruments, accessories, and one, three, four and six-compartment mainframes providing the common power supply. The modular Rollabout Configuration can accommodate two TM 503 3-compartment mainframes. Select the plug-ins from 11 signal sources, 5 counters, 2 digital multimeters, 5 power supplies, 3 signal processors, 1 oscilloscope and an X-Y monitor. There's also a blank plug-in kit to make it more convenient for you to assemble the specialized circuits you require. A TM 500 modular Rollabout Configuration lets you take the instrumentation you need where you need it.
Find out what TM 500 instrumentation can do for you. Send for the TM 500 Booklet A-3072 with full specifications and suggested selections of instruments for typical applications. Or contact your local Tektronix Field Engineer for a demonstration of how TM 500 instruments can solve your needs. Write to Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077. In Europe write Tektronix Limited, P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.
TEKTRONIX
It makes audio communications measurements too... Tektronix TM 500
Tektronix TM500 a line of 29 test instruments that go six-in-a-rack including custom circuits.



Find out what TM 500 can do for you.

While any TM 500 plug-in modular instrument can be operated as an independent unit purely on the basis of its performance, the systems capability of the TM 500 Product Line is what makes this instrumentation especially valuable to you. TM 500 instruments plug into mainframes providing a common power supply and an interface circuit board allowing them to "talk" to each other and work together.

Often a TM 500 system allows you to optimize your instrumentation far beyond the capabilities of a collection of monolithic instruments. Some systems applications merely call upon three or four independent units working side by side to fill a basic need like oscilloscope calibration. Others, such as production testing setups, can be accomplished best by several instruments working into one another through the common interface circuit board of their power-module/mainframe. Openendedness is achieved through two sizes of blank plug-ins, into which you might assemble control devices or circuits for your own special needs. Tektronix provides Instruction Manuals, Applications and Construction Notes, and technical consultation to whatever level of sophistication you require.

TEKTRONIX TM 500 is an extensive family of instrumentation that includes six power-module/mainframes, more than 30 plug-in modular instruments, and numerous accessories. Some instruments are intended for broad versatility, some for state-of-the-art performance, some for special purposes. They include multimeters, counters, oscilloscopes, power supplies, amplifiers, a variety of generators, a logic analyzer, and the blank plug-ins. Use the TM 500 Catalog to get full specs, articles offering insight into applications techniques, and a form to put your name on the Tektronix mailing list for Applications and Construction Notes.

For further information on what TM 500 Instrumentation can do for you, ask for a demonstration; a Tektronix Field Engineer will contact you. Ask for literature, and you'll get the comprehensive TM 500 Catalog shown below.

To write or phone: Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077, (503) 644-0161 ext. 5542. In Europe: Tektronix Limited, P.O. Box 36, St. Peter Port, Guernsey, Channel Islands.

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committed to technical excellence

Instruments

Microwave tests get easier

Hardware/software add-on lets spectrum analyzer do stimulus-response testing

Although automatic microwave-frequency measurements on linear devices have long been possible through the use of computer-controlled network analyzers, nonlinear measurements have involved tedious point-by-point tests and curve-fitting to the measurements. Adding the Option 300 hardware and software package to a Hewlett-Packard model 8580B automatic spectrum analyzer now permits a user to perform difficult swept-frequency tests on both linear and nonlinear components over the range from 1 megahertz to 2.6 gigahertz.

Among the tests made possible by Option 300 are swept intermodulation (IM) distortion measurements on amplifiers and mixers and other measurements with dynamic ranges as high as 120 decibels. A source-control unit that can multiplex up to three sources and a microwave application program called CTEST that performs measurements defined by users on an automatic-test-procedure form are included in Option 300.

The 8580B test system with Option 300 is used as a stimulus-response tester. It controls signal sources by varying frequency from 1 to 2,600 MHz and amplitude over a 79-dB range to a maximum of +10 dBm.

Measurements are performed by sweeping either frequency or power. Among parameters measured are harmonic distortion, IM distortion, attenuation, conversion loss or gain, gain compression, and conversion loss versus local-oscillator power.

Some other measurements include return loss and VSWR, plus incident and transmitted power. With customer-generated programs using high-level Basic or Fortran languages and additional equipment such as a digital voltage source or digital voltmeter, the 8580B Option 300 can be programed to measure noise figures of amplifiers, carrier suppression of modulators, and tuning sensitivity of voltage-controlled oscillators.

Option 300 adds $8,000 to the price of a model 8580B in the U.S. A typical model 8580B equipped for component test is priced at approximately $230,000.

The 8580B automatic spectrum analyzer itself measures absolute frequency and is used to characterize mixers, doublers, and other frequency-conversion devices at frequencies to 18 GHz. It employs a calibrated receiver with programable tuning and bandwidth; tuned frequency range is 10 kilohertz to 18 GHz and receiver bandwidth is selectable from 10 Hz to 300 kHz.

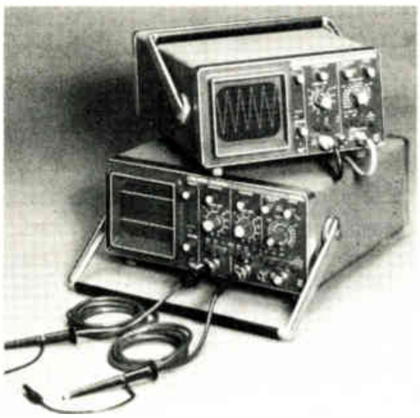
Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. 94304 [351]

Low-cost 15-MHz scopes have 2-mV sensitivity

Two 15-megahertz oscilloscopes from Philips—a dual-trace instrument and a single-channel unit—have sensitivities of 2 millivolts per division and prices of $650 and $495, respectively. The instruments' prices have been kept down by including only those features deemed necessary to a majority of users.

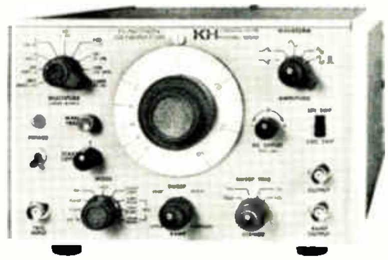
Thus, although the scopes include both television-frame and -line triggering, 18 sweep speeds, and an external X-axis input, they do not have vertical-channel delay lines or uncalibrated verniers on their Y-axis controls. The single-trace PM3225 also lacks an X-axis vernier. The input impedances of the vertical and horizontal channels is 1 megohm shunted by 25 picofarads. The instruments can be operated from line voltages of 110, 127, 220, or 240 V ac ±10% at 46 to 400 Hz. The single-trace unit weighs only 8 pounds, 2 ounces, while the PM3226 is slightly heavier at 9 lb 10 oz. Delivery of both scopes is from stock.

Philips Test & Measuring Instruments Inc., 400 Crossways Park Dr., Woodbury, N. Y. 11797. Phone (516) 921-8880 [353]



3-MHz function generator has linear and log sweeps

The model 5300 function generator is a 3-megahertz instrument with nine modes of operation, including an exponential ramp function that can be used for logarithmic sweeping. In addition, a linear ramp function provides linear sweeping. The generator, which spans the frequency range from 30 microhertz to 3 MHz, produces ramps and pulses, as well as sweeps, bursts, and continuous-wave sinusoids, and square and triangular waves. The main output of the 5300 can put out 20 volts peak to peak when open-circuited, or 10 V pk-pk across 50 ohms. The ramp output has a maximum volt-

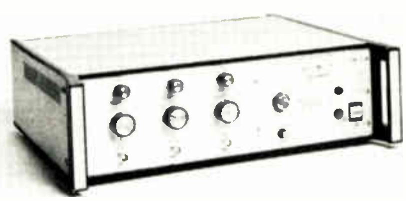


age of 10 V and an output impedance of 200 ohms. The output voltage can be offset by up to ±5 V dc. The generator sells for $695; delivery time is 60 days.

Krohn-Hite Corp., Avon Industrial Park, Avon, Mass. 02322. Ernest Lufty (617) 580-1660 [354]

Fixed-voltage pulser has very short transition times

A special-purpose pulse generator from E-H has a fixed output amplitude of −10 volts into 50 ohms, as well as a rise time of less than 200 picoseconds and a fall time of less than 500 ps. Repetition rate is variable from 10 hertz to 1 megahertz. Intended for use as a standard for determining the transient response of high-speed components, the model 125B has less than 5% peak-to-peak distortion and its falling edge has a particularly clean return to the base line. External drive, trigger output, and gating features are provided as are controls for varying the pulse width and delay time. The generator is expected to be used in time-domain reflectometry, in the evaluation of the transient response of measuring instruments, and in the testing of such fast devices as pulse transformers, cables, delay lines, and high-frequency diodes, transistors, and ICs. The 125B sells



for $5,995; delivery time is 30 days.
E-H Research Laboratories Inc., Box 1289, Oakland, Calif. 94604. Phone (415) 834-3030 [355]

Error-rate test set checks T1 carrier systems

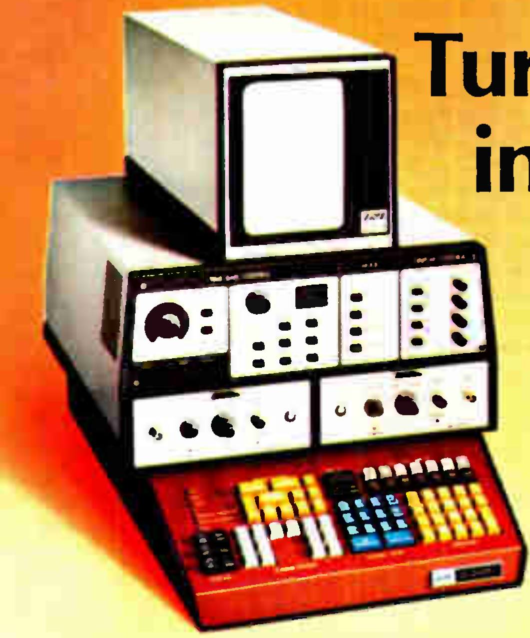
Combining a test source with an independent receiver, the model 271C error-rate test set is intended for the testing of digital transmission systems or components that are compatible with DS-1 (Bell System T1

carrier system) signals. The test set generates T1-compatible pseudorandom signals and measures bipolar violations, as well as logic errors. It can inject controlled bipolar violations into T1 data streams for the testing of automatic protection switches.
Bowmar/Ali Inc., 531 Main St., Acton, Mass. 01720 [356]

Data-transmission test set operates up to 9,600 bauds

Consisting of a selected character and test-sentence generator, a distortion generator, a character-error-rate tester, a tone generator, a decibel meter, and a volt-ohm-milliammeter, the model 2056 data-transmission test set provides field or in-plant analysis of data-transmission equipment operating at speeds up to 9,600 bauds. Able to work in the ASCII, EBCDIC, BCD/EBCD, and Baudot codes, the portable unit can check out modems, monitor on-line systems, mea-

NI 2001 Programmable Calculating Oscilloscope



Turn your waveforms into more useful data...quickly!

Just key in conversion factors...

read out engineering units

If you have used the NI 2001, or seen it demonstrated, you know that there is no easier way to acquire, process and manipulate electrical data without interfacing with a mini-computer or programmable calculator. All of its convenience and versatility is contained in a single mainframe that combines the capability of a digital oscilloscope and a microprocessor.

Whether you're performing a simple calculation or programming complex sequences, the 81-key interactive keyboard of the NI 2001 combines function and convenience never before attainable. Eight groups of color-coded controls put required commands at your fingertips. Consider, for example, what you can do using just the group of 14 keys of the NUMERIC ENTRY section of the keyboard, shown above. This group of keys eliminates the need for a separate calculating unit. In conjunction with other keyboard controls they give the NI 2001 complete calculating power to let you perform any arithmetic function. It operates on entire arrays of data as well as individual numbers.

More than a simple calculator, the NUMERIC ENTRY keys let you convert waveform measurements (or constructed waveforms) into any desired units to make processed data immediately useable. You can instantly convert waveform data to units of power, current, energy, acceleration, velocity, displacement, torsion, temperature or any other engineering, scientific or biological units to meet your needs. You can even convert instantly to metric units. You just key in the conversion factors and the results are displayed on the CRT in desired units. This group of keys is also used in searching for voltage levels or horizontal positions.

See how you can increase your productivity with the simplified signal analysis and accuracy of the NI 2001. Send the reader service card or write Norland Instruments, Department F-1.

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sure telephone-company line losses, and exercise teleprinters and video terminals. It is priced at \$2,750, and delivery time is 30 to 45 days.

Digitech Data Industries Inc., 66 Grove St., Ridgefield, Conn. 06877. Lawrence J. Kovarovic (203) 438-3731 [358]

TOPICS

Instruments

A dielectric breakdown tester, the model BKD-100-1, has been announced by **Grand Transformers Inc., Grand Haven, Mich.** The unit tests components and apparatus to UL, CSA, and NEMA standards. . . . A 50-MHz pulse generator with rise and fall times of less than 4 ns has been introduced by **Dytech Corp., Santa Clara, Calif.** The model 850 sells for \$465. . . . A four-channel plug-in module has been added to its AMC Digiscope line by **E-H Research Laboratories Inc., Oakland, Calif.** With four of the new model 1304 plug-ins, the Digiscope becomes a 16-channel, 50-MHz, dual-threshold analyzer. . . . The model 110C pulse generator from **Systron-Donner Corp., Concord, Calif.**, is a 50-MHz unit with an output amplitude of 20 V and a rise time of 5 ns. Price is \$1,250. . . . An ac-dc laboratory-standard current calibrator with selectable ranges from 100 μA to 10 A is accurate within 0.01% on dc and 0.05% on ac up to 10 kHz. The \$1,495 instrument is made by **Valhalla Scientific Inc., San Diego, Calif.**

The rugged 3968A gives you 8 channels, FM and/or direct, and all your data winds up on ¼-inch tape.

In tough situations like this, you can make good use of an eight channel recorder that's compact and rugged and still maintains laboratory performance.

So those were the ground rules we set when we designed the HP model 3968A. It's compact because it packs eight channels of data on ¼-inch instrumentation tape. It's built tough, with modular construction that gives you the latitude to change from FM to Direct, or Direct to FM with just one plug-in board.

The 3968A gives you direct frequency response to 64,000 Hz; FM to 5,000 Hz. Six record/reproduce speeds provide a 32:1 time base compression or expansion for flexibility and easy data analysis. For easy operation, HP built in a calibration source that works with push-button convenience.

Other standard features include tape/tach servo, flutter compensation, TTL remote control and voice annotation capability.

The price is right (8 channel FM base price $8800, USA domestic price only). And HP's exceptional new 3968A Instrumentation Recorder is the one eight channel machine that lets you have all that capability and still wind up with everything on a ¼-inch tape. 11601

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1501 Page Mill Road, Palo Alto, California 94304

Circle 147 on reader service card

Data handling

Microprocessors get design aid

Rockwell's Assemulator debugs and tests systems on line

As the demand for microprocessors increases rapidly, so does the need for simple tools to integrate the design of hardware and software around the microprocessor in the development of prototype systems. Among the latest to market such a tool is Rockwell International with its Assemulator, which debugs and tests microprocessor-based equipment in real time throughout the development cycle.

Described as a system-development tool for Rockwell's 8-bit microprocessors, the machine is expandable to handle the division's entire line, from one-chip units to the 16-bit processor when it becomes available. Besides assembling, debugging, and modifying programs in which 8-bit devices are used, it does many other tasks. These include real-time software checkout of system peripherals, encoding of programable electrically alterable ROMs, generation of ROM mask codes, and even acceptance-testing of devices and boards.

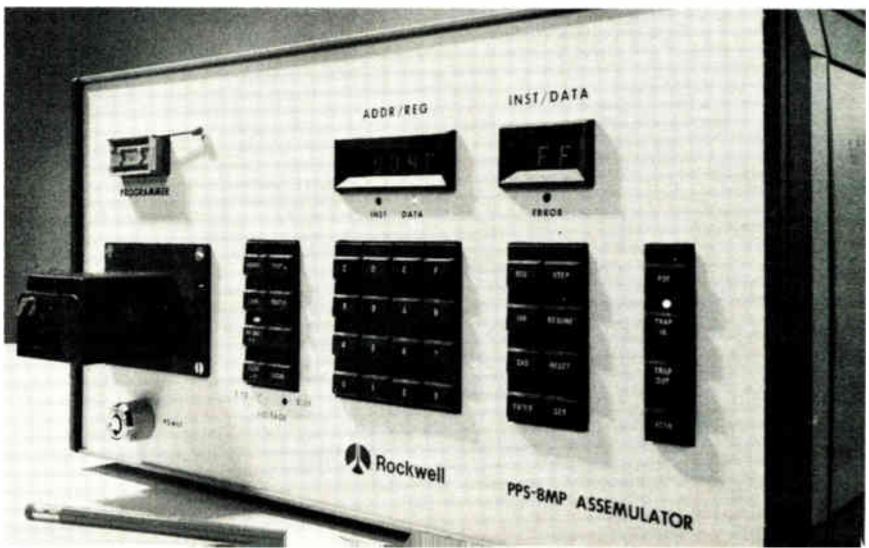
The Assemulator can emulate a part of system hardware before it is built, thereby allowing an economical advance look at ultimate performance. Although Rockwell's Microelectronic Device division is just now introducing the standard product, it has been building a similar custom unit since 1973. J.E. Bass, director of microprocessor and OEM marketing, explains that the division originally had only a few very large customers, but the Assemulator is being sold to broaden the market.

Bass says that the prototype-development system seems to be a factor of growing importance in the customer's choice of microprocessor. "It could be that he's buying his microprocessor on the basis of which design tool he's most comfortable with," says Bass.

Components of the basic machine are a PPS-8 central processing unit, 6,000 bytes of random-access memory, interfaces for teletypewriter and other terminals, four input/output ports, a hexadecimal control-panel keyboard, a chassis with power supply, and card slots for additional prototype boards.

A floppy-diskette system, to become available as an option early this year, will make possible a more powerful second-generation system and will upgrade the Assemulator into a "totally integrated design center," says Bass. He notes there is a trend to make such systems perform additional support functions such as producing documentation printouts and wiring designs. Motorola, for example, says it is planning to expand the options for its Exorcisor—including a user's system emulator and a system analyzer.

At an off-the-shelf price of $3,450, Rockwell's Assemulator not only does its prototype-development job,



says Bass, but also can serve as a general-purpose computing system. The next step would be to add a cathode-ray-tube option for less than $2,000 to give the system an interactive graphics capability.

Microelectronic Device Division, Rockwell International, 3310 Miraloma Ave., Anaheim, Calif. 92803 [361]

Key-diskette system is aimed at low-volume sites

Intended for use at low-volume sites in distributed data-processing networks, the model 77 remote-entry system is a dual-station key-to-diskette subsystem that provides up to 485,000 characters of storage on removable diskettes. The model 77 allows one or two operators to enter, edit, verify, and store data. The stored data can then be transmitted in a batch to a central processor, whether someone is attending to the subsystem or not.

Conversely, data can be transferred from the host processor to the diskettes in attended or unattended modes as well. Off-line capabilities of the subsystem include diskette copying and formatted printing to an optional line printer. A basic model 77 subsystem rents for as little as $328 a month. However, a typical unit with communications, two diskettes, a single keystation, the optional local-format feature, and a 62-line/minute printer will rent for $585 a month on a one-year lease, including maintenance. The purchase price for that configuration is $20,118. First customer shipments are scheduled for spring.

Data 100 Corp., 7725 Washington Ave. S., Minneapolis, Minn. 55435. Phone (612) 941-6500 [363]

Kit module can be used for microprocessor design

Offering an immediate method of putting into operation a complete, self-sustained microprocessor system, the PS-710 F-8 kit module is a

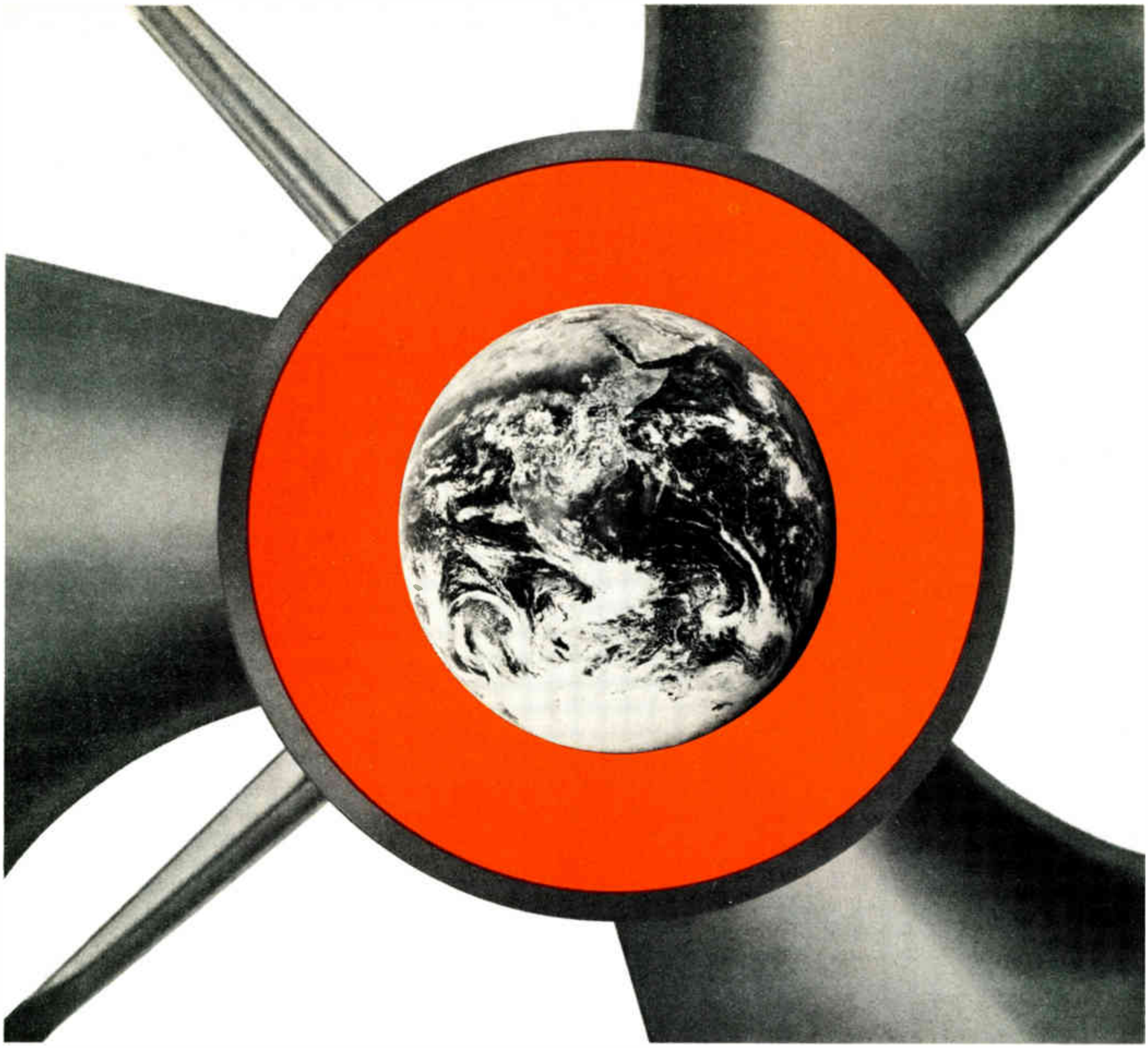
Circle 151 on reader service card

fully assembled printed-circuit card with sockets to accept the devices from the F-8 microprocessor kit. The card can be used for prototype and development systems or as a standard hardware module for production systems. All necessary functions are available on a standard edge-connector to permit memory expansion. The module also contains a crystal-controlled clock and a flexible data-terminal interface. Price of the PS-710 is $65 in quantities of 1 to 25.

Pronetics Corp., P. O. Box 28582, Dallas, Texas. Phone Harold Mauch at (214) 276-1968 [364]

30-megabyte disk-controller has $9,995 price tag

A 10-platter, moving-head disk system is designed to add low-cost storage capacity to Data General's Nova and Eclipse, Digital Computer Controller's D-116, and the



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18514

New products

Keronix IDS-16 minicomputers. Called the 4091-N by Datum Inc., the disk drive and controller combination sells for $9,995. Principal applications include business, data-acquisition, and time-sharing systems with medium-size storage requirements. The unit has a storage capacity of 30 × 10^6 bytes with a recording density of 2,200 bits per inch. Average random-access time is 55 milliseconds; data is recorded on 20 surfaces at 100 tracks per inch, 203 tracks per surface. Transfer data rate is 312,000 bytes per second; write frequency is 5 megahertz ±0.3%. Storage media are IBM 2316-type disk packs that rotate at 2,400 revolutions per minute.

Datum Inc., 1363 South State College Blvd., Anaheim, Calif. 92806. Phone (714) 533-6333 [365]

Modular microcomputer is priced below $1,000

Although aimed initially at the "serious-hobbyist" market, a modular microcomputer called the Jupiter II "can easily be used for engineering development work or highly reliable business systems," says Dennis Brown, president of Wave Mate. Priced below $1,000, the Jupiter II is a complete system that can be ordered in kit form or assembled. The user can add simple peripherals and employ the system for accounting and bookkeeping, scientific, and mathematical computations, and other applications.

Wave Mate, 1015 W. 190th St., Gardena, Calif. 90248. Phone Dennis Brown at (213) 329-8941 [367]

Editing recorder is driven by a microprocessor

A Philips-type cassette is combined with a tape drive and control electronics in a compact desktop console to make a microprocessor-driven recorder called the AJ730. The recorder handles a wide range of data-preparation, word-processing,

New products

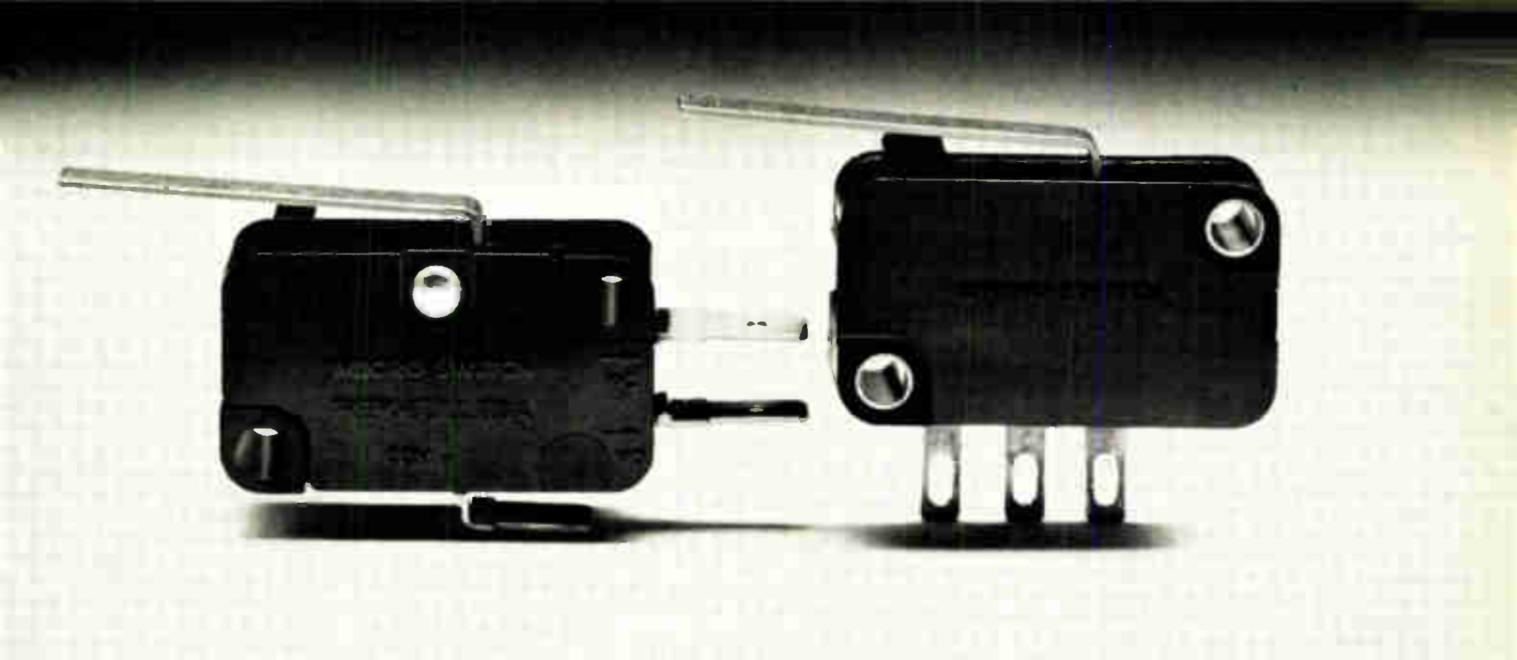
and teleprocessing tasks. With the AJ730 and a terminal in off-line mode, an operator can record data or text, use the 730's search and line-edit features to correct and update previously entered material, and print as many copies of data or text as desired. On line, the AJ730 is equipped to operate as a store-and-forward device or as the central unit in an automatic data-collection network. The recorder leases for as little as $85 per month.

Anderson Jacobson Inc., 1065 Morse Ave., Sunnyvale, Calif. Phone (408) 734-4030 [366]

TOPICS

Data Handling

Ampex Corp., Marina del Rey, Calif., has announced the addition of a 32-kilobyte add-on memory, which is totally transparent to and pin-compatible with the Data General Nova 2 computers. Offered in 16-kiloword modules, the ARM-2 sells for less than $2,000. . . . **Electronic Product Associates Inc., San Diego, Calif.,** is offering the Micro-68—a $430 microcomputer built around the Motorola M6800. . . . **Teletype Corp., Skokie, Ill.,** has added a keyboard display and line-printer system to its family of private-line terminals. The new devices run at 2,400 and 4,800 b/s. . . . **Delta Data Systems Corp., Cornwells Heights, Pa.,** has introduced its model 5270 lightpen/terminal system that is said to greatly reduce the time and effort needed to select an item on the display screen.



One of these is a new solid state switch. It's important that you can't tell which one.

The switch on the left is the V3. A mechanically-actuated snap-action switch the size of a postage stamp. It was an industry first when MICRO SWITCH introduced it in 1943. And it's gone on to become the industry standard, with hundreds of millions in use worldwide.

The switch on the right looks like the V3. Mounts like the V3. It's even actuated like the V3. And that's exactly where the similarities end. Because it's all solid state inside.

Designed around a Hall-effect integrated circuit perfected by MICRO SWITCH, the XL has been made to provide every benefit of true solid state design without the necessity of getting out of mechanical control.

Because the XL is all solid state, there are no contacts to bounce or become contaminated. And the Hall-effect integrated circuit has been performance tested through over 12 billion operations without a single failure. Unlike standard mechanical switch designs, the XL can also interface directly with other solid state components. Its 20MA output eliminates the need for amplifiers, in most applications. And you can order it with either current sinking or current sourcing outputs.

It needs very little force for actuation—down to 10 grams. Even less with a lever. And the choice of actuator styles is the same as for the V3: over 500 different actuators in all. Including simple pin plunger, straight lever, simulated roller or roller lever.

Power supply requirements are also flexible. 5 VDC or 6 to 16 VDC with built-in regulator, over a temperature range of −40°C to +100°C.

So the XL obviously offers some unique advantages. It's just one of a wide range of MICRO SWITCH solid state designs that do. Including a complete range of magnetically operated solid state position sensors, like the ones pictured here.

If you'd like more information on the XL, or any of the other MICRO SWITCH solid state switches, call your nearest MICRO SWITCH Branch Office or Authorized Distributor. Or write for literature.

We'll tell you the advantages of solid state design in your particular application.

And about a switch that looks very familiar. But works like nothing you've ever seen.

Products shown are actual size.

MICRO SWITCH

FREEPORT, ILLINOIS 61032

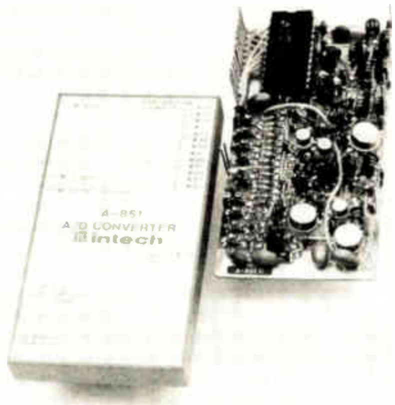
A DIVISION OF HONEYWELL

MICRO SWITCH products are available worldwide through Honeywell International.

Subassemblies

A-d converters need no tweaking

The A-851 family of analog-to-digital converter modules has two basic models: the A-851-10 which has a resolution of 10 bits and a conversion time of 1.5 microseconds (corresponding to about 667,000 conversions per second), and the A-851-12 which makes 12-bit conversions in 2.5 μs (400,000 per second). Both models are housed in compact 2-by-4-by-0.4-inch modules and are designed to operate without adjustments or external components. Their performance may be enhanced, however, by the addition of potentiometers to trim offset and gain.



For both units, the maximum quantizing and nonlinearity errors are half a least-significant bit (LSB), and the maximum differential noninverting error is likewise less than ±½LSB. Temperature variations are ±10 ppm/°C maximum for offset and gain, and ±20 ppm/°C maximum for nonlinearity. Power-supply sensitivity is ±0.01%/%, maximum. The new a-d converter family derives its speed and linearity from an improved successive-approximation conversion technique. Other advantages of the design are direct compatibility with TTL and operation with no missing codes.

The converters have only one input range: -10 V to +10 V. Single-quantity prices are $350 for the 10-bit unit and $450 for the 12. Delivery is from stock.

Intech Inc., 1220 Coleman Ave., Santa Clara, Calif. 95050. Bill Jumper (408) 244-

Optoisolator has linear output

The CLM-6200 LED-photoconductor isolator features a linear output characteristic over the input-current range from about 0.5 milliampere to 30 mA. It is intended for a wide variety of analog applications and has a rise time of 3.5 milliseconds and a fall time of 12 ms. A companion device, the CLM-6500, which is intended for agc applications, has a maximum output resistance of 300 ohms with a 16-mA input, and a minimum resistance of 10 megohms with no input. Both units have isolation-voltage ratings of 2 kilovolts. The CLM-6200 sells for $3.25 for one to 99 pieces; the CLM-6500 goes for $3.40 in similar quantities. Delivery is from stock.

Clairex Electronics Division of Clairex Corp., 560 South Third Ave., Mount Vernon, N. Y. 10550. Gerald F. Smith (914) 664-6602 [384]

Broadband amplifiers get cheaper and better

While producing hybrid broadband amplifiers specifically for cable television systems, TRW Semiconductors has been selling the same type of device for general-purpose instrumentation applications [*Electronics*, Feb. 7, 1975, p. 142]. Now a new line, already being sold to CATV customers, provides further improvements, including lower distortion and wider bandwidth, at reduced cost.

The new devices are even more extensively characterized than previous TRW hybrid amplifiers for general-purpose uses in low-frequency radar, single-sideband, and other radio and telemetry equip-

4051 personal computing:

Ask a BASIC question, get a Graphics answer.

Compare Tektronix' 4051 to any other compact computing system. There's a Graphic contrast.

Wide-ranging performance right at your desk. BASIC power. Graphics power. Terminal capability. You've got instant access to answers, all from one neat package.

Easy-to-learn, enhanced BASIC. We took elementary, English-like BASIC, and beefed it up for more programming muscle. We've designed it with MATRIX DRAW, features like VIEWPORT, WINDOW, and ROTATE, to help you get your teeth into Graphics almost instantly.

There's a Graphic contrast. The 4051 will handle most application problems. But for your most complex problems, the 4051's Data Communications Interface option can put you on-line to powerful Graphic applications that no stand alone system can tackle.

Just $6995.* Less than most comparable alphanumeric only systems. Including 8K workspace, expandable to 32K, with 300K byte cartridge tape drive, full Graphics CRT, upper/lower case, and all the BASIC firmware.

Talk to Tektronix today! Your local Sales Engineer will fill you in on our 4051 software. Our range of peripherals. Our flexible purchase and lease agreements. And he'll set up a demonstration right on your desk. Call him right now, or write:

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Information Display Group
P. O. Box 500
Beaverton, Oregon 97077

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ment. Rise times, for example, are only 5 to 10 nanoseconds. Combined with broad bandwidth, this feature makes available a single off-the-shelf amplifier that can handle many pulsed applications.

Three new models are available: the CA2800, which operates from 10 to 400 megahertz with 17 decibels of gain; the CA2810 for 10 to 325 MHz with 33 dB of gain; and the CA2818 for 5 to 150 MHz with 18 dB of gain. The units have power-output ratings up to 800 milliwatts.

Priced from $35 to $55 each in quantities, the new units are significantly cheaper than their predecessors. For example, the CA2810 sells for $43.50, compared to the earlier CA870 at $62.60. Delivery is from stock.

TRW Semiconductors, 14520 Aviation Blvd., Lawndale, Calif. 90260. Warren Gould (213) 679-2561 [382]

Philbrick adds six f-v converters

Teledyne Philbrick has announced six precision frequency-to-voltage converters with typical nonlinearities of approximately 0.002% of full

scale plus 0.002% of signal. Two of the units cover the frequency range from 0.01 hertz to 13 kilohertz, two others span 0.1 Hz to 130 kHz, and the remaining two go from 1 Hz to 1.3 MHz. In all three ranges, one of the units is an economy version and the other has tighter temperature and linearity specifications. Small-quantity prices begin at $79 for the low-cost versions of the low-frequency units and goes as high as $163 for the precision high-frequency model. All six units can be set by the user to produce an output

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Ceramic Power. Ceramic insulated, fireproof, *and* low cost. Both wirewound and glaze constructions. Fusible and TC compensating versions available.

Molded Wirewound. Saves space and money over other 1 and 2W devices. From 0.1Ω up. Fusible, and TC compensating versions available.

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For the broadest choice in resistors for all types of applications, write or call TRW/IRC Resistors, an Electronic Components Division of TRW, Inc., 401 N. Broad Street, Philadelphia, Pa. 19108, Tel. 215-922-8900.

TRW® IRC RESISTORS

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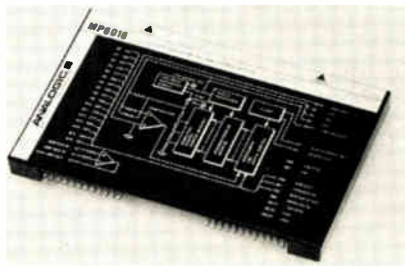
voltage of ±10 V for any frequency span within its operating range.
Teledyne Philbrick, Allied Drive at Route 128, Dedham, Mass. 02026. Frank Goodenough (617) 329-1600 [385]

Stable a-d converter resolves 16 bits in 16 μs

Analogic's latest analog-to-digital converter is an outgrowth of some work the company did for the CERN nuclear research facility in Europe. The 16-bit modular device is a stable converter with a clock rate that can be adjusted from 1 microsecond per bit to 2.5 μs/bit and an NBS-traceable absolute accuracy within 0.003% of full scale. The unit's relative accuracy is twice as good, and its temperature coefficients are all very low: differential linearity is 1 ppm/°C, gain is 6

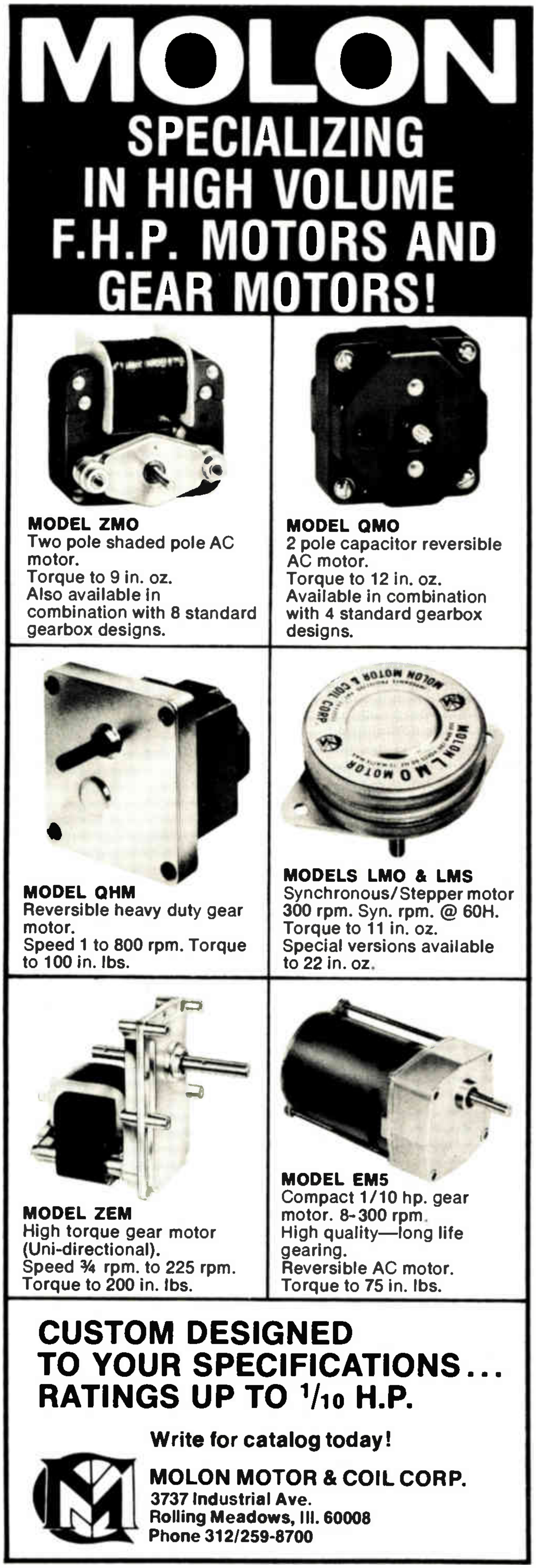


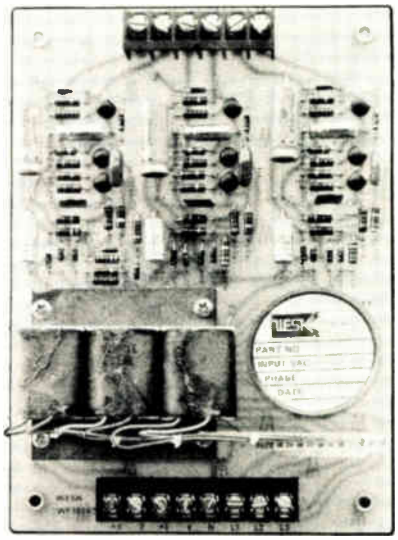
ppm/°C, and offset is 1.5 ppm/°C.

Since any 16-bit converter must ultimately drift out of tolerance, the MP8016 has been designed for easy recalibration in the field. The recommended calibration interval is six months. To increase the converter's flexibility, it can be short-cycled to provide word lengths below 16 bits (as low as eight bits) at a time saving of from 1 to 2.5 μs per bit. The unit sells for $640 in hundreds.
Analogic Corp., Audubon Rd., Wakefield, Mass. 01880. Phone (617) 246-0300 [386]

Modules control SCRs in 1- and 3-phase systems

A pair of SCR-firing circuit modules—one for single-phase circuits, the other for three-phase appli-





cations—is capable of controlling any power SCR, usually with ratings of 10 amperes and above. Typical applications are in adjustable-speed dc motors, arc-welding equipment, electrical heaters, and in lighting control. Principal features of the units are the maintenance of a negative bias on the SCR when it is not being fired, thus effectively preventing false triggering; fast firing; and the use of a magnetic amplifier for signal isolation.

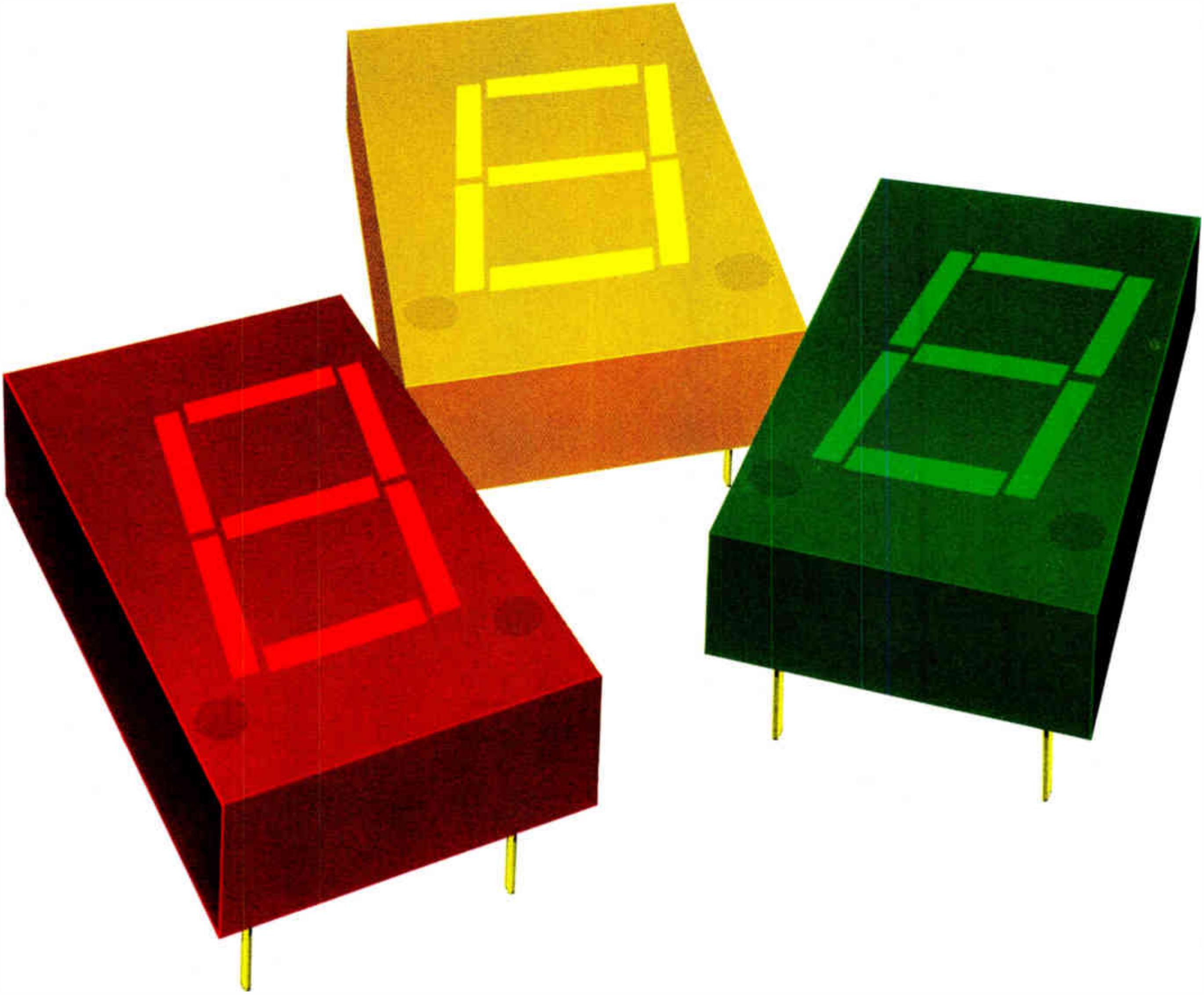
Wesk Electrical Equipment Mfg., 5682 Research Dr., Huntington Beach, Calif. 92649. Phone (714) 897-9910 [387]

Multiplier stays accurate over military temp range

The model 4204S analog multiplier is a hybrid device that uses a proprietary log/antilog technique and laser trimming to maintain its high accuracy over the military temperature range from −55°C to 125°C. The unit's maximum error at 25°C

0.25% ±0.02%/°C MAX

SURPRISE!



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At 20mA our new High-Efficiency red display is 5 times brighter than our standard red displays. Just 3mA per segment gives you all the brightness you need and makes it ideal for battery powered applications. These large .43" displays are offered in High Efficiency Red, Yellow, or Green and are readable up to 20 feet. The 5082-7650 (High-Efficiency Red), -7660 (Yellow), -7670 (Green) are available in standard DIP packages with left-hand d.p. and common anode configuration. Just $3.95* each in quantities of 100. Contact Hall-Mark, Schweber, Wilshire or the Wyle Distribution Group (Liberty/Elmar) for immediate delivery, or write us for more information and our new application note on contrast enhancement.

01503 *Domestic USA price only.

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is 0.25% of full scale, and its worst-case temperature drift is 0.02%/°C over its operating temperature range. The four-quadrant multiplier achieves this level of performance without the addition of any external components.

For enhanced performance, external trimming resistors may be added to reduce the room-temperature error to 0.1% of full-scale output. The 4204S has a maximum output offset error of 5 millivolts, a slew rate of 1 volt per microsecond, and a full-power bandwidth of 20 kilohertz. Small-signal (−3 dB) bandwidth is 250 kHz.

The multiplier is housed in a 14-pin, hermetically sealed, dual in-line package. It sells for $72 in small quantities and $59 in hundreds.

Burr-Brown, Box 11400, Tucson, Ariz. 85734. Phone Joseph Santen at (602) 294-1431 [388]

TOPICS

Subassemblies

Two signal-processing modules—a multiplier and a log/antilog converter—have been introduced by **Tau Systems, Newton, N. H.** The pair is designed to work together and to interface with voltage- and current-controlled active filters, oscillators, and amplifiers. . . . **Acronetics, Sunnyvale, Calif.**, announces the availability of 11 voltage-tuned filters which, between them, cover the frequency range from 25 MHz to 1 GHz. . . . Two digital-to-analog converters—an eight-bit unit and a 10-bit model—have been developed by **Intech Inc., Santa Clara, Calif.** The devices sell for only $15 and $22 each, respectively. . . . A new digital readout from **Dialight, Brooklyn, N. Y.**, contains a 0.27-inch LED, a decoder/driver, and a latch mounted on a small pc board. . . . A line of high-speed synchro-to-digital converters from **Astrosystems Inc., Lake Success, N. Y.** can make 12-bit conversions of multiple synchro inputs while tracking at 2,000° per second.

Discover how these auto-multimeters keep you out of trouble.

On the surface they may look like any well-designed digital multimeters.

Now look closer. What else do you see?

There . . . the Fluke name!

That indicates unusual performance.

We designed both the Fluke 8600A and the 8800A with auto range, auto zero, and auto polarity. **And every parameter is fully protected.** This means you can accidentally overload the instrument with too much current . . . too much voltage . . . or too much resistance!! . . . and you're still okay.

Another way you stay out of trouble: MTBF on each instrument is a minimum of 10,000 hours.

Now, the specs.

The 26-range Fluke 8600A, ~~$[illegible]~~ We packed this 20,000 count multimeter with five ranges of volts from 200 mV through 1200 V ac and dc. Five ranges of current, 200 μA to 2 A ac and dc. And six ranges of resistance from 200 ohms to 20 megohms.

Basic dc accuracy is a fully credible 0.02%. Options include built-in automatic rechargeable battery pack for up to 8 hours off-line operation. Digital output is also offered.

The 0.005% Fluke 8800A, ~~$[illegible]~~ This digital multimeter features five ranges of dc volts from ±200 mV to ±1200 V. Four ranges ac from 2 V to 1200 V. And six ranges of four terminal resistance from 200 ohms to 20 megohms. For complete isolation the input resistance is better than 1,000 megohms on lower ranges and 10 megohms on the higher ranges.

For critical resistance measurements the instrument provides completely isolated four terminal ohms with less than 4 volts open circuit from 200 ohms through 20 megohms.

So there are the specs.

Impressive? We think so. But remember—specs are one thing. That name on the panel, however . . . it's what makes a Cadillac a Cadillac. And a Fluke a Fluke.

For details, call your nearest Fluke sales engineer. Or simply dial our hot line.

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Circle 167 on reader service card

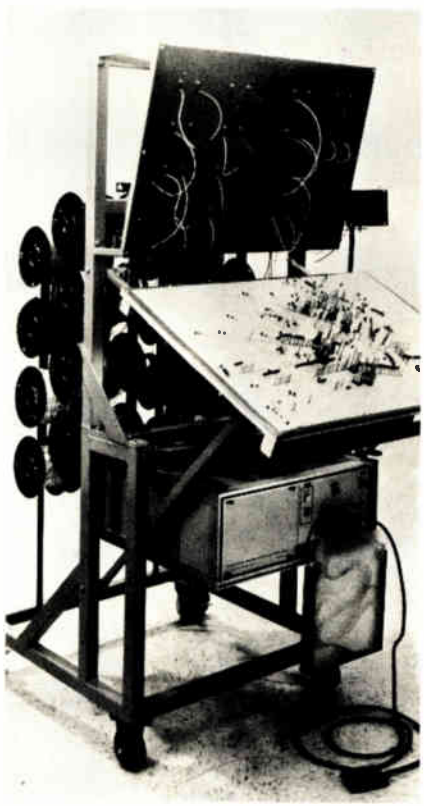
Packaging & production

Harnessing aid cuts wiring cost

Tape-programed system indicates wire count and run number on readout

Unlike the automated and semiautomated wiring of IC panels and backplanes, cable harnesses are still wired about the same as they were 10 years ago. Cables are manually laid out and wired on large wooden panels called formboards, which have harness-wiring paths outlined by nails. This process is slow, subject to error, and expensive.

A programable harness director from Electrovert Inc., can significantly increase the speed of wiring harnesses and lead to higher quality. One of these new machines has already cut wiring time of a previously manually wired harness from about two hours to an hour and six minutes—a saving of 54 minutes or 45%.



The harness director is built into a rolling metal frame that houses three units: a wire storage/dispenser, a formboard, and a controller fed by paper tape. The storage/dispenser consists of reels of wires or tubes of pre-cut wires feeding through holes in a large vertical board at the top of the unit. Each wire-feed hole is represented by an indicator light. On the formboard, individual harness paths are outlined by light-emitting diodes in addition to the usual nails or wiring combs.

When the system is programed and connected to a suitable formboard, the operator steps on a pedal to select the desired reel of wire, indicated by a light in the wire-dispenser panel. At the same time, LEDs indicate the desired wire-routing paths on the formboard. The operator then lays the wire along these paths. During this same cycle, a digital indicator on the right side of the dispenser shows the wire count and the run number.

The machine is available in two basic systems, similar except for their wire-storage/dispensing mode. System 1127 has a capacity of 96 reels. System 1128, which uses a tube-storage feed for precut lengths of wire, has a capacity of 130 tubes.

Programing consists of conversion of a wire-run list into a numerical code, which, in turn, is punched into paper tape. A complete programing service is available from the company. Prices for the harnessing aids range from $9,000 to $12,000, and delivery time for both units is two to four weeks.

Electrovert Inc., 86 Hartford Ave., Mt. Vernon, N.Y. 10553. Phone (914) MO-4-6090 [391]

Vertical wiring system wraps twisted pairs simultaneously

An automatic vertical wiring system from S P I is offered with a dual wire-wrap tool for wrapping both

Synertek Announces Fastest N-Channel RAMs*

POWER (Icc, mA)

Speed (access time T_A, ns)	30	35	50	70	80	90
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175						X *
200						X *
250				X		
275					X	
300						
350		X				
400	X		X			
500			X	X		

To: Tom Byram
SYNERTEK
3050 Coronado Drive
Santa Clara, CA 95051

☐ Please give me a quote on ________ each (quantity) of the device(s) circled.
☐ I've put a big X in the box I need filled. Please tell me if you can build a part to those specs. My application is ________________.
My estimated annual usage would be ________ pcs.
☐ Please quote on above units for *full mil temp* range.

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Please call me at ( ) ________________

The 150ns 2102. The ~~30mA~~ 15mA* 2102.

Synertek offers as many 1K RAM speed/power combinations, as you have speed/power problems.

The announcement is simple. We're in production on the broadest line of 2102-type 1K static RAMS in the business. Speeds as high as 150ns and Icc's as low as ~~30mA~~. 15mA*

Ordering is simple, too. If you're walking around in a jungle of 2102 part numbers, here's a better way. Forget about MK4102-6's, AM91L02's, TI4033's and even 2102's. Just circle the speed/power combination on the chart above that fits your application, clip your business card to the coupon, and shoot it to us. We'll send you prices and the Synertek part number that matches right away.

If there isn't an "X" in the box, circle it anyway. We probably have a part that meets your specs.

If you're really in a hurry. Call Tom Byram or Jack Balletto at (408) 241-4300. They'll give you all the information you need and the name of your closest Synertek rep or distributor. Also ask them about the new 2101, 2111 and 2112 256X4 high speed and low power static RAMs coming soon.

* just announced! our 15mA 21L02 Series!

Synertek

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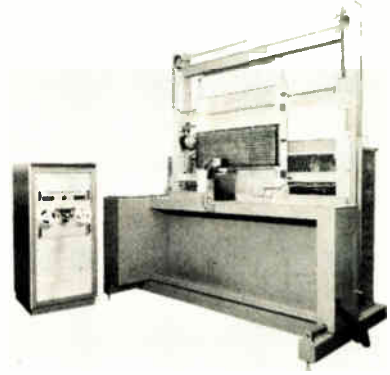
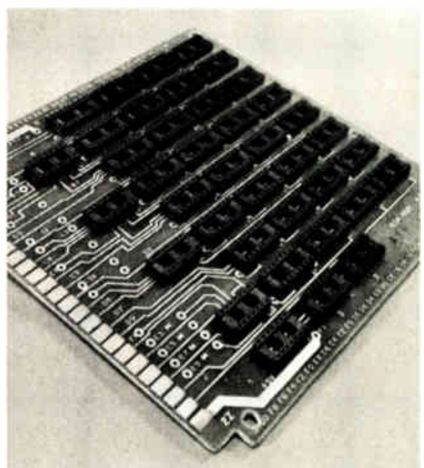


wires of a twisted pair or coaxial cable simultaneously. With this tool, throughput is twice the level of single-wire methods. The system, which is controlled by the S P I 1800 Computrol numerical control, can accommodate panels up to 36 by 48 inches; it is believed to be the largest vertically oriented moving-table wiring machine available. The system is available for all standard wire gauges and pin spacings down to 30-gauge wire and 0.1-inch centers.

Automated Equipment Division of S P I, 1906 McGaw Ave., Irvine, Calif. 92714. Phone (714) 540-7755 [393]

DIP socket will not allow solder-wicking

A low-profile dual in-line socket is fabricated with a band of solder resist in the terminal which effectively prevents solder from wicking up into the contact area. Available with either tin- or gold-plated phosphor-



bronze contacts inserted into a glass-filled polyester thermoplastic housing, the socket has a maximum height of 0.175 inch and a maximum width of 0.400 in. The socket, which has a face-wipe design for maximum wiping action, has press-fit legs so that it will not fall out of the printed-circuit board during handling subsequent to insertion.

Berg Electronics Division, Photo Products Department, Du Pont Co., Route 83 South, New Cumberland, Pa. 17070 [394]

Channel circuits cut breadboard-wiring time

A breadboard-wiring method that requires only seven hours to produce a complete 200-component board from a schematic diagram uses wiring channels, solder-through-insulation wires, and general-purpose printed-circuit boards. The general-purpose boards are customized (or programed) by means of the channels. The channels are plastic wiring ducts within which a wiring pattern is laid down. The channel, which resembles a multipin dual in-line package, is installed on the board where it completes the desired circuit when all component leads are brought to it by the printed conductor pattern. Not only does the method require less time than conventional approaches, it also makes changes easier. To reconfigure a circuit, one merely unsolders a wire and resolders it elsewhere. Soldering can be done by standard wave-soldering equipment or with a simple hand iron. An introductory kit that contains a component board, a seven-inch channel, and instructions sells for $45.

Chanex Inc., 153 N. Rampart St., Los Angeles, Calif. 90026 [395]

DIP socket programer is easily stored

Individual programing of dual in-line sockets is made possible by means of a plug-in device called the

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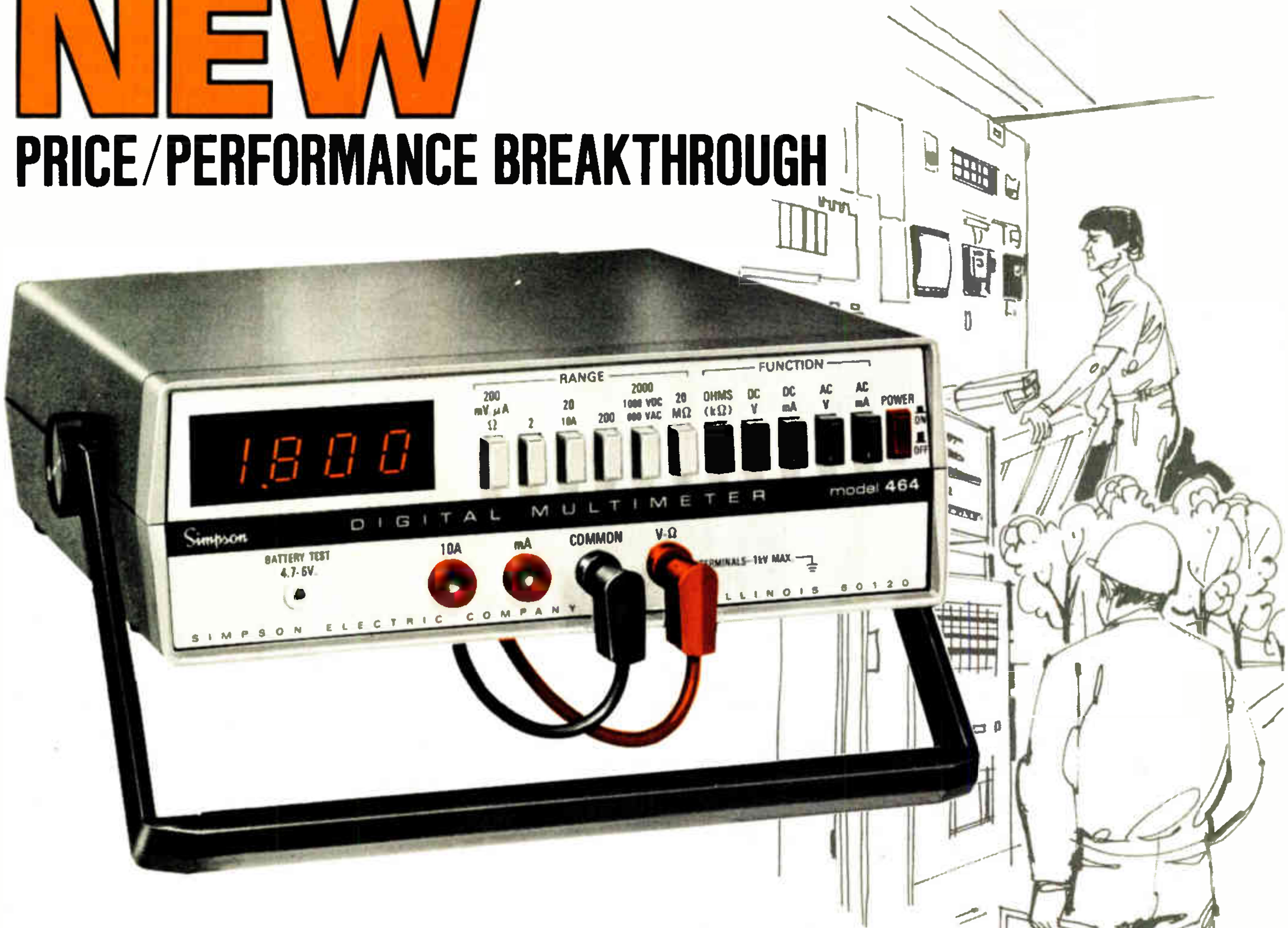

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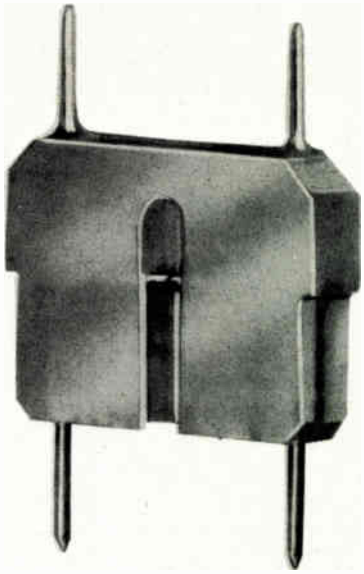
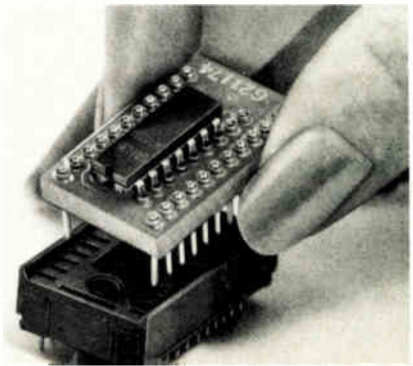


Dipatch. Essentially a jumper with standard DIP dimensions, the Dipatch has two plastic pins sticking out of its back. Thus, it can be easily stored by simply sticking the plastic pins into any convenient DIP location. The pins are spaced 0.3 inch apart to fit across a standard DIP, and the package is narrow enough for stacking on 0.1-in. centers. Effectively, seven of these devices convert a 14-pin DIP into a switch. The price of the Dipatch varies from 15 cents to 50 cents each, depending upon quantity. Free samples are offered by the manufacturer.

Aries Electronics Inc., P. O. Box 231, Frenchtown, N. J. 08825. Phone (201) 996-4096 [396]

Adapter mates 0.3-inch ICs with 0.6-inch sockets

An adapter plug that permits the use of ICs with 0.3-inch widths in sockets with 0.6-inch spacing is



Circle 176 on reader service card

offered for IC packages with 18 and 24 leads. Accommodating both round and flat leads, the adapter plugs are especially helpful for increasing the usefulness of existing test equipment that might otherwise become obsolete. They sell for $1.50 to $4.50 each.

Garry Manufacturing Co., 1010 Jersey Ave., New Brunswick, N. J. 08902. Harry A. Koppel (201) 545-2424 [397]

Controlled-impedance board works with ECL circuits

A line of logic panels, designed for work with fast emitter-coupled logic, allows as many as 180 ECL circuit positions to be interconnected. The board has controlled-impedance transmission planes to minimize radiation and reflection and their resulting problems.

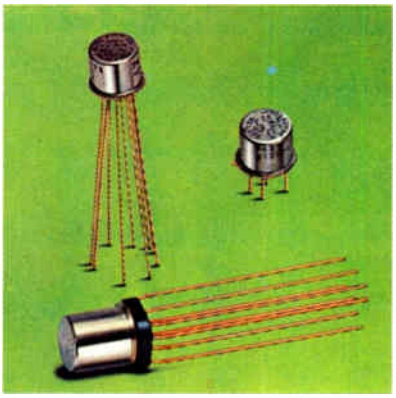
Interdyne, 14761 Califa St., Van Nuys, Calif. Bob Lindstrand (213) 787-6800 [398]

TOPICS

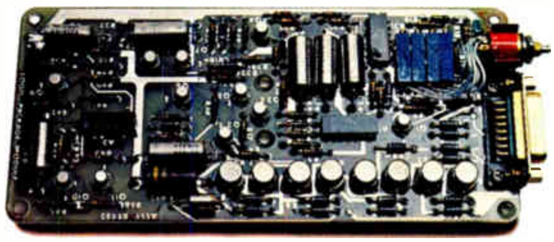
Production

A free sample of the recently developed low-profile socket line known as the US-2 is being offered by **Scanbe Manufacturing Corp., El Monte, Calif.** The sample package contains a 16-pin socket that is noteworthy for its anti-wicking barrier. . . . A New England printed-circuit house, **Circuit Service Co., Lowell, Mass.,** says that it will deliver finished circuit boards in just three days—including plated-through holes, complete camera work, and infrared solder reflow. . . . **Alford Manufacturing Co., Winchester, Mass.,** announces a new line of low-cost precision adapters. The microwave units are all sweep-tested and calibrated at several frequencies. . . . By using selective gold plating, **Cambion Corp., Cambridge, Mass.,** is able to keep down the cost of new IC sockets while retaining the advantages of 30 microinches of gold where it is needed.

A big hit: Teledyne TO-5 relays.



Improve shallow depth operation. Counter target decoys. Enhance rejection of false echoes. Tough goals for any torpedo acoustic guidance/control system. But Northrop did it — turning misses into hits — with a little help from Teledyne TO-5 relays.



Logic Package Module for NT 37C Torpedo Guidance System (with 8 Teledyne TO-5 Relays)

Whenever military, commercial or industrial switching jobs call for high packaging density, low power consumption and low heat dissipation — coupled with high reliability — we answer the need with our TO-5 relays. They're less than half the size and weight of 1/2 crystal can relays, and use up to 75% less coil power. What's more, our TO-5's are all-welded, hermetically sealed, and fully qualified to MIL-R 39016B, "L" and "M" levels.

And you have your pick from a wide selection of TO-5 relays — including ultra-sensitive types, maglatches, internal suppression diodes and drive transistors, and many contact arrangements.

In short, there's a Teledyne TO-5 relay ready to meet your requirements. For full data or applications help, contact your local Teledyne Relays people.

We're sure to make a big hit with you, too.

NT 37C Torpedo
Courtesy of Northrop Corp.

TELEDYNE RELAYS

3155 West El Segundo Boulevard, Hawthorne, California 90250
Telephone (213) 973-4545

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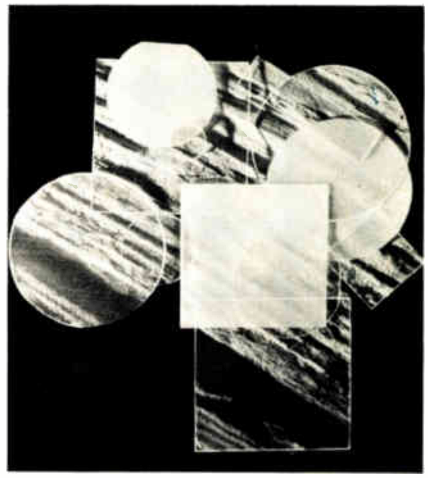

Sapphire substrates for microelectronic applications come in a variety of sizes, shapes, and finishes. Produced in squares from 0.5 by 0.5 inch to 3 by 3 in. and circles from 0.75 to 3 in. in diameter and 0.010 to 0.80 in. in thickness, the substrates are said to have high dielectric constant, controlled orientation, and good electrical, physical, and thermal properties. Three surface finishes are available: ground to 5 microinches, optically polished to less than 1 microinch, and an epitaxial scratch-free finish suitable for silicon-on-sapphire applications.

Tyco, Saphikon Division, 16 Hickory Dr., Waltham, Mass. 02154 [476]

Glass-reinforced polypropylene for engineering applications comes in two grades. Adell PPGF has a 20% glass content, and Adell PPGF 30 has a 30% glass content. Both grades have physical properties that suit them to demanding applications in under-the-hood automotive parts, appliance parts, and other industrial uses. These properties include stiffness, impact and tensile strength, and low creep, water-absorption, and mold-shrinkage values.

Adell Plastics Inc., 4530 Annapolis Rd., Baltimore, Md. 21227 [477]

Coolant for use in cutting silicon, glass, and ceramic materials is called Aremco-Cool 558. The water-soluble fluid is suitable for cooling when machining, dicing, grinding, slicing, and drilling these materials and others used in semiconductor

Dialight sees a need:

Need: A new computer-grade switch at a price you can afford.

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Dialight's low cost 554 series switches are available in a wide selection of rear panel and front bezel mounting types. Switches are available with silver or gold contacts for wide range of applications; operating life is 250,000 operations.

Fingertip grips permit easy cap removal . . . lamp replacement is from front of panel . . . no special tools needed.

Caps are available with or without underlying color filter in ⅝″ and ¾″ square, ⅝″ x ¾″ and ¾″ x 1″ rectangles. At Dialight it's your choice because we see your need.

DIALIGHT

Dialight, A North American Philips Company
203 Harrison Place, Brooklyn, N.Y. 11237
(212) 497-7600

Circle 179 on reader service card

New products international

processing. The coolant permits high thermal conductivity, along with good lubricating characteristics, allowing high cutting speeds with a minimum of edge-chipping and internal damage. The residue from evaporation is easily redissolved in its own solution of water. Aremco-Cool 558 is available in liquid from stock at $10 for a 1-gallon sample and $30 for 5 gallons.

Aremco Products Inc., P.O. Box 429, Ossining, N.Y. 10562 [478]

High-purity germanium crystals up to 6 centimeters in diameter, as well as radial-gradient crystals, are being made by a new GE process. The 6-cm size allows the benefits of high-purity germanium to be ex-

tended to larger radiation detectors. The radial-gradient type, consisting of an n-type core with a p-type outer layer, operates at about half the depletion voltage of a similar-size p-type detector. When used in the new 6-cm diameter, the radial-gradient configuration is expected to permit manufacture of very large coaxial detectors that will operate at practical voltages.

General Electric Co., 1 Belmont Ave., Bala Cynwyd, Pa. 19004 [479]

Solder fluxes for electronic and other industrial requirements come in six different compositions to per-

TI's New TMS 4051 The fully TTL compatible 4K RAM in the 18-pin space saver package

Available now in the 18-pin space-saver package: A fully TTL compatible 4K RAM. In addition to the high board density achievable with the compact 18-pin package, board space is also minimized because the TMS 4051 is fully TTL compatible and fewer parts are necessary. Fewer parts, less wiring, and a smaller PC board mean the TMS 4051 will save you money.

Easiest 4K dynamic RAM to use.
The TMS 4051 is fully compatible and will plug directly into your Series 74 TTL system. No longer is a high voltage clock driver needed to interface from TTL to MOS. All TMS 4051 inputs (including the single clock) and output interface directly with TTL.

Reduce parts. Save PC board space.
In addition to eliminating the need for clock driver ICs, the TMS 4051 requires no external address multiplexers or address registers. The on-chip address registers provide full direct addressing eliminating system timing headaches. The TMS 4051's common data I/O eliminates the need for an external I/O multiplexer making it ideal for bus-oriented and microprocessor based systems. And the space saver package alone yields as much as 30% board savings over 22-pin 4K RAMs.

TI's 18-PIN 4K RAM FAMILY

		ACCESS TIME (MAX)	READ OR WRITE CYCLE (MIN)
TMS 4051	TTL CLOCK	300 ns	470 ns
TMS 4051-1	TTL CLOCK	250 ns	430 ns
TMS 4050	HI-LEVEL CLOCK	300 ns	470 ns
TMS 4050-1	HI-LEVEL CLOCK	250 ns	430 ns
TMS 4050-2	HI-LEVEL CLOCK	200 ns	400 ns

Availability is now.
TMS 4051 adds to TI's pioneering experience and volume production of 4K RAMs. TMS 4051 uses the same proven single transistor cell design as TI's popular TMS 4030 and 4060. Result: High density. High yield. Lower cost to you. The TMS 4051 is available in 300 mil wide 18-pin plastic and ceramic packages.

Proven reliability.
The TMS 4051 uses TI's reliable N-channel silicon gate process, the same as TI's other RAMs. And TI has proven field reliability.

For a 24-page reliability report of TI's 4K RAM family or a data sheet, write on your letterhead to: Texas Instruments Incorporated P.O. Box 5012, M/S 308, Dallas, Texas 75222.

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Transene Company Inc., Rte 1, Rowley, Mass. 01969 [480]

An epoxy coating for thumbwheel switches builds resistance to solvents and other plastic-degrading solutions that are found in some adverse environments. The solution, usable on all EECO switch products, is being offered as a standard option.

EECO, 1441 E. Chestnut Ave., Santa Ana, Calif. 92701 [378]

Thick-film resistor compositions called the Birox 1600-series are said to offer ease of processing in manufacture of hybrid microcircuits, resistor networks, and attenuators. They are compatible with platinum/silver and palladium/silver conductors. With terminations made of these conductors and a wide range of resistor geometries, the 1600-series compositions offer temperature coefficients of resistance of less than 100 ppm/°C.

Electronic Materials Division, Photo Products Department, Du Pont Co., Wilmington, Del. 19898 [379]

Heat-sensitive strips monitor a range of temperatures at eight different temperature levels. Pressure-sensitive, the strips easily affix to any surface to monitor specified temperatures within a tolerance of ±1%. Each of the eight temperature points turns irreversibly black if that level is exceeded.

Signalarm Inc., 375 Cottage St. Springfield, Mass. 01101 [380]

Careful there . . . you're likely to start something.

Just a "flutter" of pressure . . . and SNAP!

Less than 2 grams of force actuates this Cherry snap-action miniature switch. Outside, the external aluminum actuator is purposely 2⅜" long to provide this unusually low operating force. Inside, an extra internal actuator further reduces operating force while maintaining solid contact mating pressure for reliable performance.

The "flutter force" switch is only one of Cherry's E22 series of unique miniatures. All are rated 3 amps, 125 VAC. All are also available in gold "crosspoint" configuration for low energy solid state circuits.

A switch in your hand is worth two in the tree, so . . . SNAP UP A FREE SNAP-ACTION SAMPLE.

Just TWX 910-235-1572 . . . or PHONE 312/689-7700 and ask Frank to give you facts on miniature switches . . . or circle appropriate reader service number.

E22-75HX
5 grams LIGHT FORCE actuation
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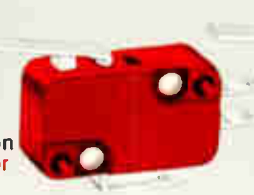
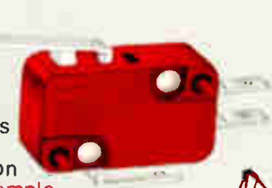


E22-55HX
3.5 grams LIGHTER FORCE actuation
Circle No. 103 for Free Sample

E22-85HX
Less than 2 grams "FLUTTER FORCE" actuation
Circle No. 104 for Free Sample



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New literature

European markets. The third annual "Mackintosh Yearbook of West European Electronics Data" is a 140-page report on the electronics industries of 13 countries. Issued every fall, the yearbook consists mainly of data on imports, exports, production, and market projections for Austria, Belgium, Denmark, Finland, France, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and West Germany. The report sells for $90, and can be ordered from Mackintosh Publications Ltd., Victoria House, Victoria St., Luton, Beds. LU1 5DH England. Circle 421 on reader service card.

Microelectronics. A 16-page booklet from 3M Co., P.O. Box 33600, St. Paul, Minn. 55133, is primarily devoted to ceramic packaging and beam-tape assembly techniques.

Entitled "Microelectronics Interconnections and Packaging," the booklet includes information on dual in-line, high-power, multilayer, and display packages. [422]

Laser theory. A technical note entitled "Second Order Nonlinear Effects" presents a theoretical discussion of various properties of some common laser materials. Tech Note 501 is expected to be of interest to chemists, spectroscopists, and users of dye, ion, and solid-state lasers. Written by Tom Nowicki, it is available from Interactive Radiation Inc., 406 Pauling Ave., Northvale, N.J. 07647 [423]

Terminal blocks. A 36-page catalog

Want to simplify control system design?

Try the MP12 Microcomputer.

DESIGNED FOR CONTROL — If you're designing control elements into a process or industrial control system, consider the MP12 Microcomputer. It's a highly versatile, powerful system that makes the job easier than ever before. Fully operational CPU. Easy-to-use standard interface cards. Plus a complete basic software package.

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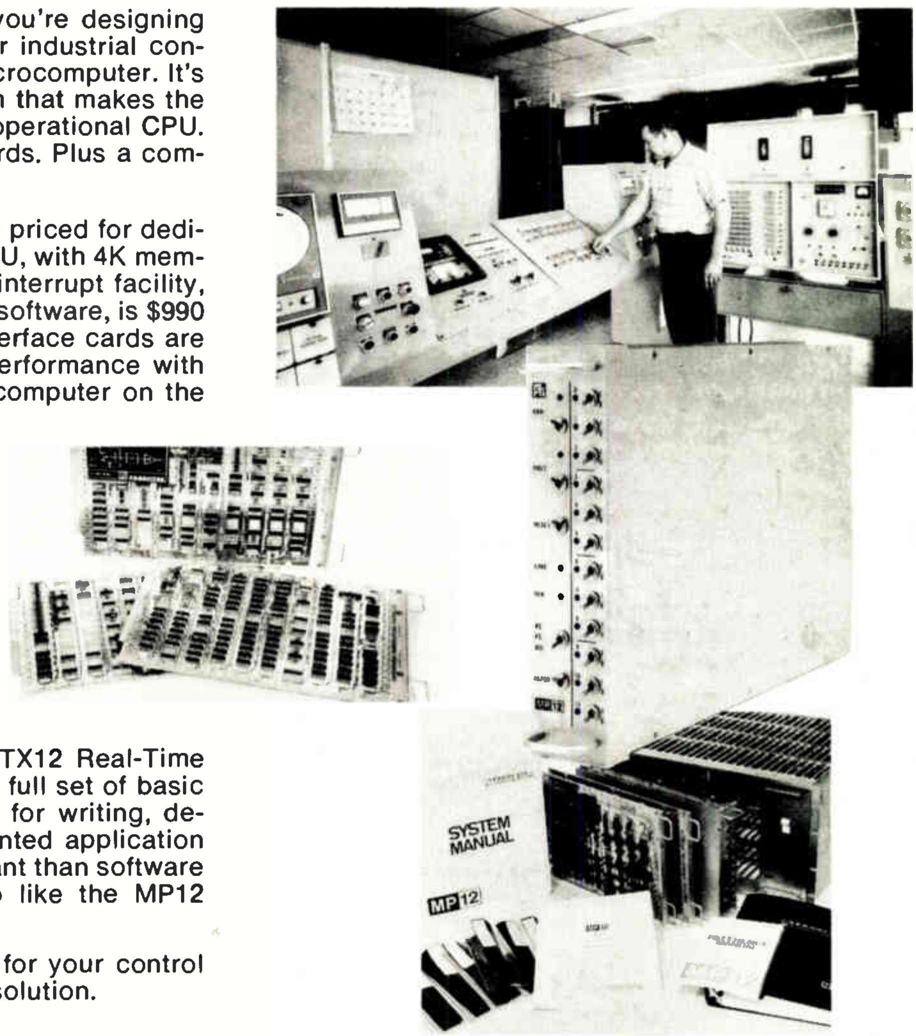

EASY INTERFACING — Interfacing to peripheral equipment and process control devices is a snap with the MP12 Microcomputer. Standard interface cards allow you to interface directly to the CPU or wire wrap your own custom interface electronics. Cuts engineering time and money drastically.

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Series 90 shown with personality module installed and with optional MOS PROM erase light.

Close-up of Series 90 control panel.

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The Series 90 can also duplicate PROMs directly from pre-programed master PROMs, with corrections if necessary.

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Pro-Log's exclusive and field-proven programing technology protects against MOS PROM data dropout caused by improper or inadequate programing pulses.

Tailor it to your needs.

We have standard options to interface it with TTY, paper tape readers and punches, or computers.

Low-priced.

A Series 90 control unit costs $1,800. Personality modules range from $350 to $550.

We have other microprocessor-based instruments and microprocessor subsystems, too.

Our instruments include analyzers for systems using 4004, 4040, 8008, 8080 and 6800 microprocessors.

Our microprocessor subsystems include 4004 and 4040 logic processors and 8008, 8080, and 6800 microcomputers.

For more information on the Series 90, including a complete list of the many personality modules currently available, send for a copy of our PROM User's Guide.

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—V_{os} is 0.15mV. **MAX.**
—Bias current is 2.0 nA. **MAX.**
—And CMRR, PSRR, GAIN and R_{in} DIFF are all quoted **MIN.**

The point is, we know the designer's op amp problems: accuracy and repeatability. That's why we specify exactly what they'll do, **MAX.**

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Precision Monolithics, Incorporated
1500 Space Park Drive, Santa Clara, CA 95050
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of terminal blocks and strips, complete with ratings, dimensions, wire sizes, material specifications, and accessories can be obtained from Electrovert Inc., 86 Hartford Ave., Mount Vernon, N.Y. 10553 [424]

Almost everything. "The 1976 Industrial Purchasing and Engineering Manual" from Mouser Electronics, 11511 Woodside Ave., Lakeside, Calif. 92040, covers a wide array of electronic components, test equipment, and production tools. The 48-page catalog lists such diverse items as alligator clips, drill bits, drafting aids, switches, signal generators, solid-state relays, and panel meters. [425]

Metrication management. A multi-element information package that sells for $95 is intended to aid manufacturing management in changing to the metric system. The package includes: a 120-page management-action plan; a 90-page learning course; an 80-page corporate-training plan; and scheduling charts to aid in the changeover. Case histories and studies of previous transitions of this type are also included. "Manufacturing Management Metripack" is available from American Machinist, 1221 Avenue of the Americas, New York, N.Y. 10020 [426]

Thermostats. A line of precision snap-acting thermostats, the 3000 series, is described in a 16-page catalog. Drawings of each model are included, along with electrical and thermal specifications and performance qualifications under all conditions. Values are given in metric as well as English units, and the back cover has a fahrenheit-to-celsius conversion chart. Elmwood Sensors Inc., 1655 Elmwood Ave., Cranston, R.I. [427]

Accelerometers. Features of semiconductor strain-gage accelerometers are stressed in a 26-page manual, but it is also a general instruction booklet and selection guide for all types. The manual describes a range of accelerometers

The **RIGHT** Flexible Disk Drives and Systems Are Made At Remex.

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The **right** drive has a unique high reliability design — die cast frame — supported lead screw head positioning — operator interlock for media protection — and a foolproof write enable feature.

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Circle 191 on reader service card

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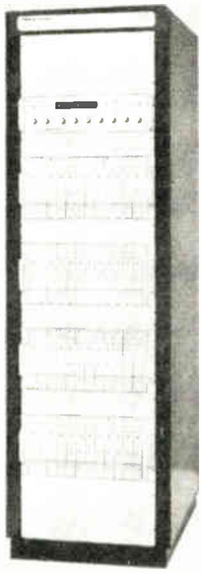
SYSTEM 5



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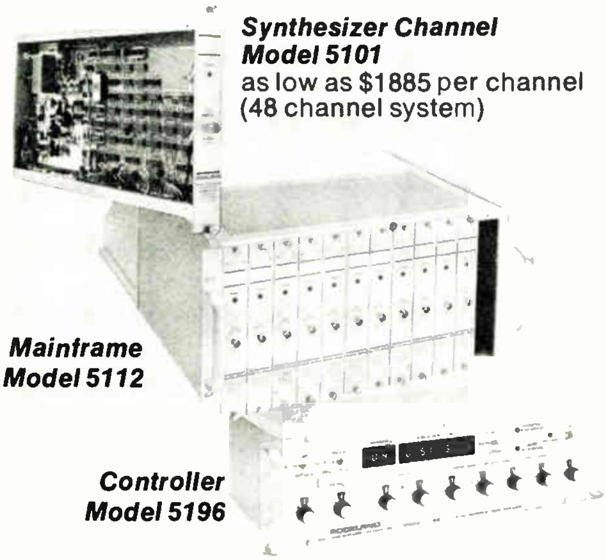

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DC to 2 MHz Range

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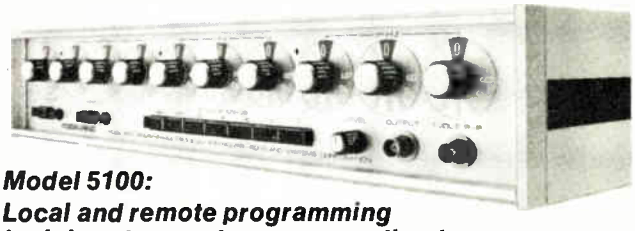

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New literature

from 5 g to 10,000 g, operating dc (steady state) and dynamically. Entran Devices Inc., 145 Paterson Ave., Little Falls, N.J. 07424 [428]

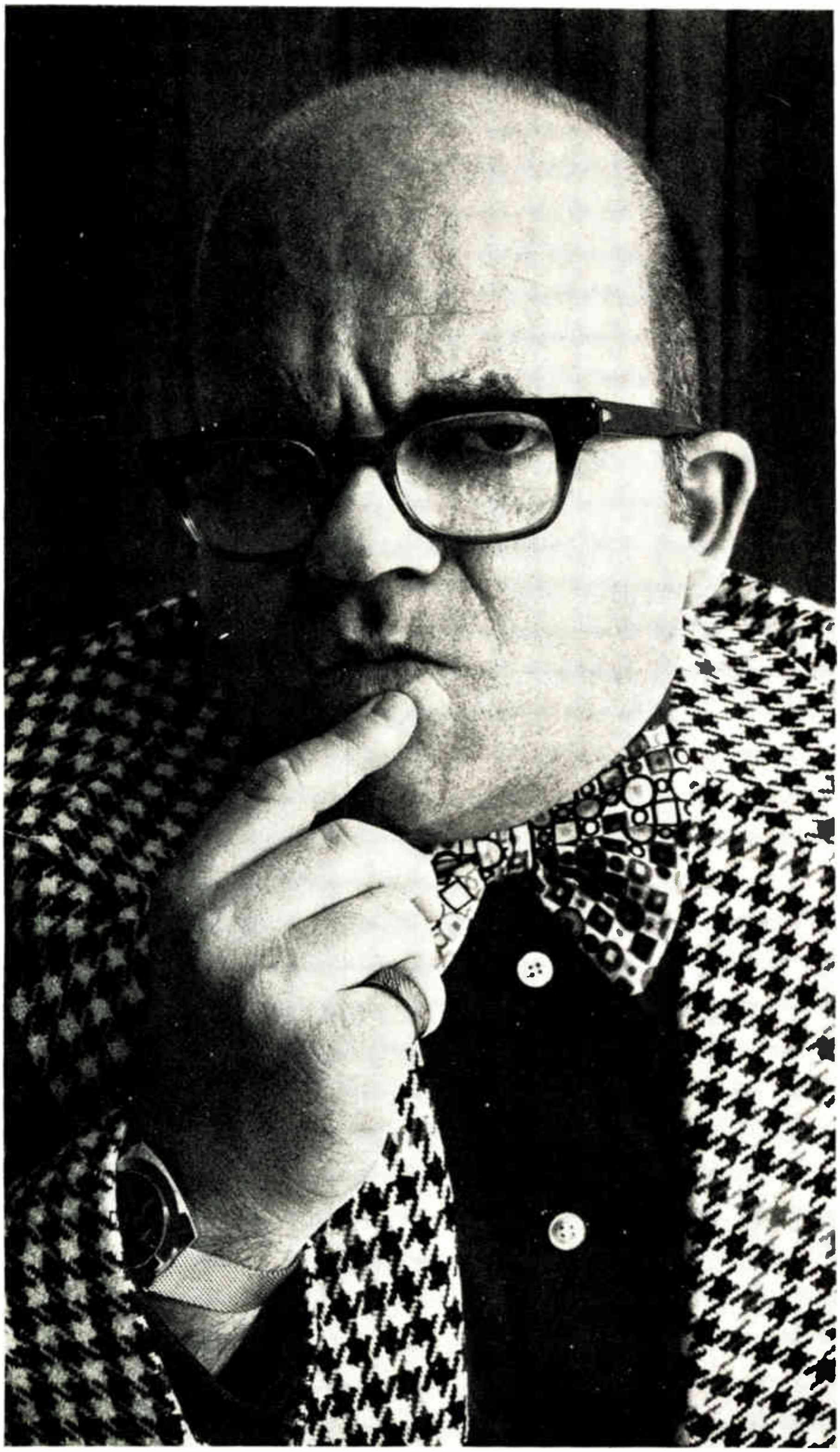
Conductive silvers. A catalog describing conductive silvers for electronics includes information about applications in semiconductor work, thick-film and thin-film hybrid circuits, and capacitor terminations. The 10-page catalog is published by Transene Company Inc., Route One, Rowley, Mass. 01969 [429]

Nonferrous castings. A booklet describes engineering techniques and methods of reducing production costs for casting aluminum and other nonferrous metals for elec-

tronic housings and similar applications. The publication is available from A. L. Johnson Co. 907 South Magnolia Ave., Monrovia, Calif. 91016 [430]

Electronics in India. A 246-page report priced at $35 includes a forecast of India's needs for 74 types of electronic components and 90 types of equipment. The report also contains information on trade practices and regulations and the text of India's 10-year plan for developing its electronics industries. Also, more than 300 electronics manufacturers are listed in the report, which may be ordered from Fred Glynn/

If you're so rich, why aren't you smart?



So you're making a good salary. But you're not saving any of it. Instead, you want to go after the "big deal" that's going to make you a cool million. Maybe.

What happens if your big scheme goes sour? You've still got to get through the future. And, let's face it. Nobody can afford to take tomorrow for granted.

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Graduate Assistantships in Physics can begin during any quarter. Write: Dr. R. Madey, Kent State University, Kent, OH 44242.

New literature

Marketing Research, 2200 Sacramento St., Suite 1206, San Francisco, Calif. 94115 [431]

Zener diodes. Designed for a voltage range from 8.2 volts through 100 v, 2.5-watt molded-diode zeners have a typical thermal impedance of 20°C per watt at a lead length of ⅜ inch. Storage and operating temperature range is from −65°C to 150°C. The zeners are for steady-state applications where reliability at minimum cost is vital. Large junction areas and silver-clad copper leads, combined with conservation power ratings, assure long-term reliability. A dual nail-head configuration provides maximum strength for automatic insertion equipment. A product bulletin on the 2.5-w zeners is available from TRW Capacitors, 301 West O St., Ogallala, Neb. 69153 [432]

Switches. The 16-page M300 switch catalog contains photos, line drawings, and specifications of the complete Molex line of switches. Included for the first time are the dual in-line Boss 3140 models, the 10440 push-button versions, and the new 10400 lighted push-button series. The catalog can be obtained from Molex Inc., 2222 Wellington Ct., Lisle, Ill. 60532 [433]

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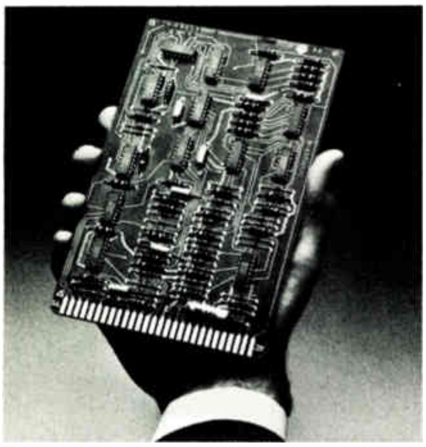
This little part can shut down an entire plant.



But so far, it's had to go through a complex series of separate operations and companies to get it where it's needed: regional warehouses, air freight forwarders, commercial airlines, and trucking firms. And nobody's been very happy with the results.

Now Federal Express has come up with a solution. And like all great ideas, this one is simple.

A WAREHOUSE WITH ITS OWN AIRLINE.

Air Freight Supplement called it "the coup of the year in respect to air freight and physical distribution."

We call it The Federal Express PartsBank.

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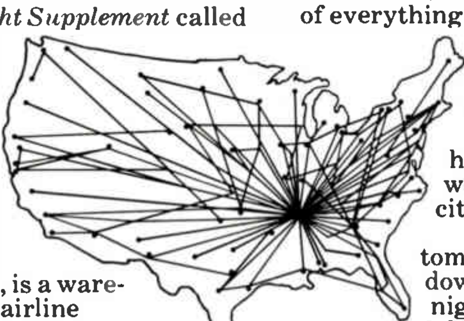

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Automata Theory: An Engineering Approach, Igor Aleksander and F. Keith Hanna, Crane, Russak & Co., 172 pp., $15.50.

Rapid Practical Designs of Active Filters, David E. Johnson and John L. Hilburn, Wiley-Interscience, 264 pp., $16.95.

Introduction to Electron and Electromechanical Devices, Dewey A. Yeager and Robert L. Gourley, Prentice-Hall, 301 pp., $14.95.

Electronic Circuits and Systems, J. D. Ryder and Charles M. Thomson, Prentice-Hall, 445 pp., $16.95.

The Potentiometer Handbook—A Users's Guide to Cost-Effective Applications, Carl David Todd for Bourns Inc., McGraw-Hill, 300 pp., $14.50.

High-Speed Pulse Techniques, J.A. Coekin, Pergamon Press, 219 pp., $8.50 (paper).

Electrical Engineering for Professional Engineers' Examinations, 3rd ed., John D. Considine, McGraw-Hill, 537 pp., $17.

Handbook of Electronic Circuit Designs, John D. Lenk, Prentice-Hall, 307 pp., $15.95.

Digital/Logic Electronics Handbook, William L. Hunter, Tab Books, 308 pp., $9.95; $6.95 (paper).

Aviation Electronics Handbook, Edward L. Safford, Tab Books, 404 pp., $11.95; $8.95 (paper).

MOSFET Circuits Guidebook, Rufus P. Turner, Tab Books, 198 pp., $7.95; $4.95 (paper).

Ion-Implantation Range and Energy Deposition Distributions, Vol. 2: Low Incident Ion Energies, K. Bruce Winterbon, Plenum, 341 pp., $49.50.

Semiconductor Measurements and Instrumentation, W.R. Runyan, McGraw-Hill (Texas Instruments Electronics Series), 280 pp., $19.95.

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January 8, 1976

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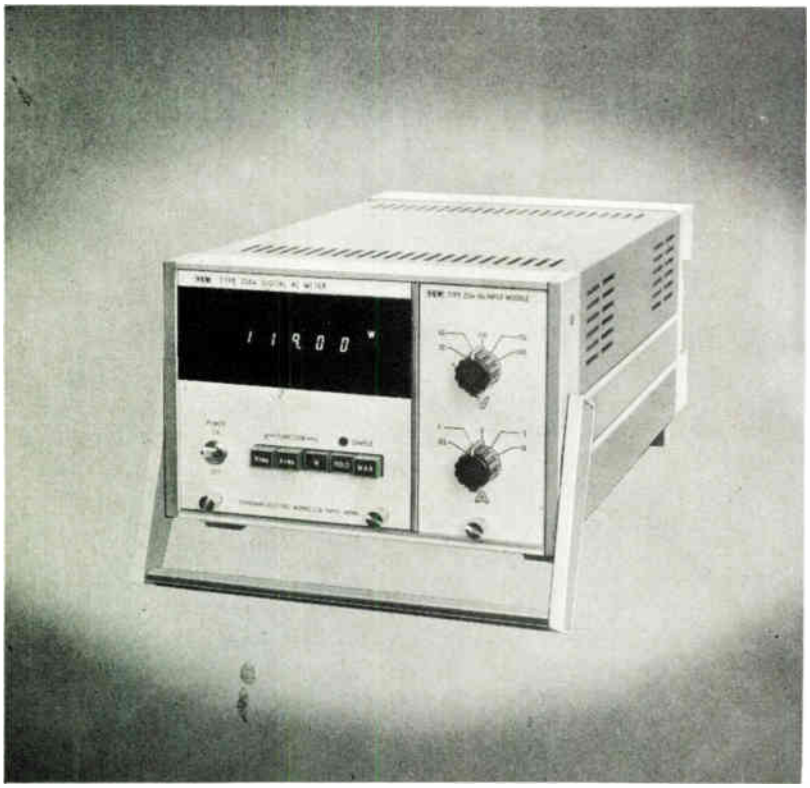

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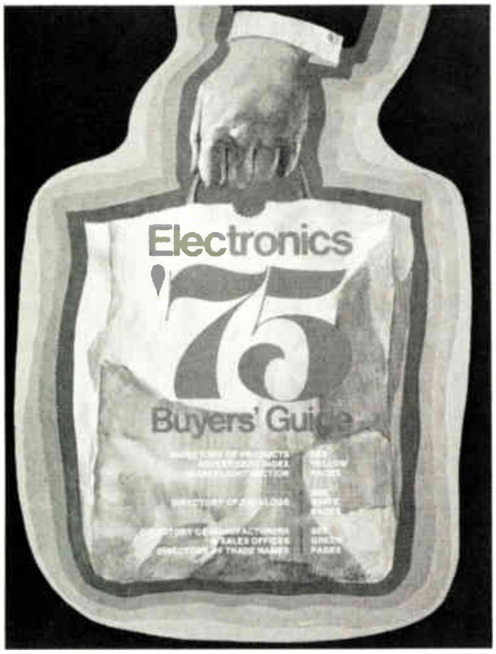

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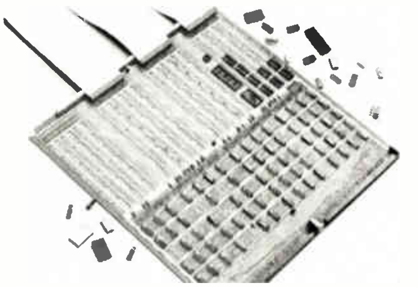

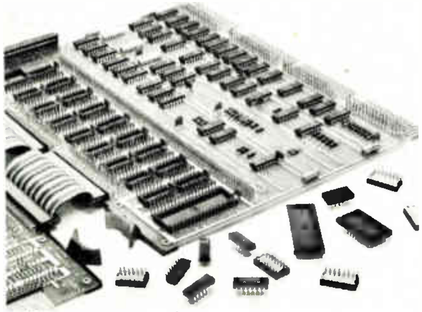

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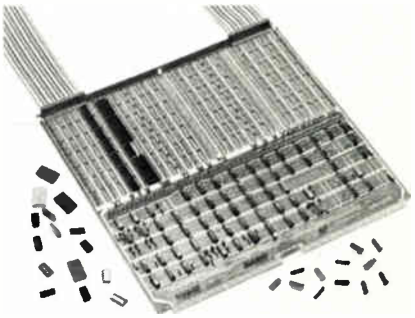

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