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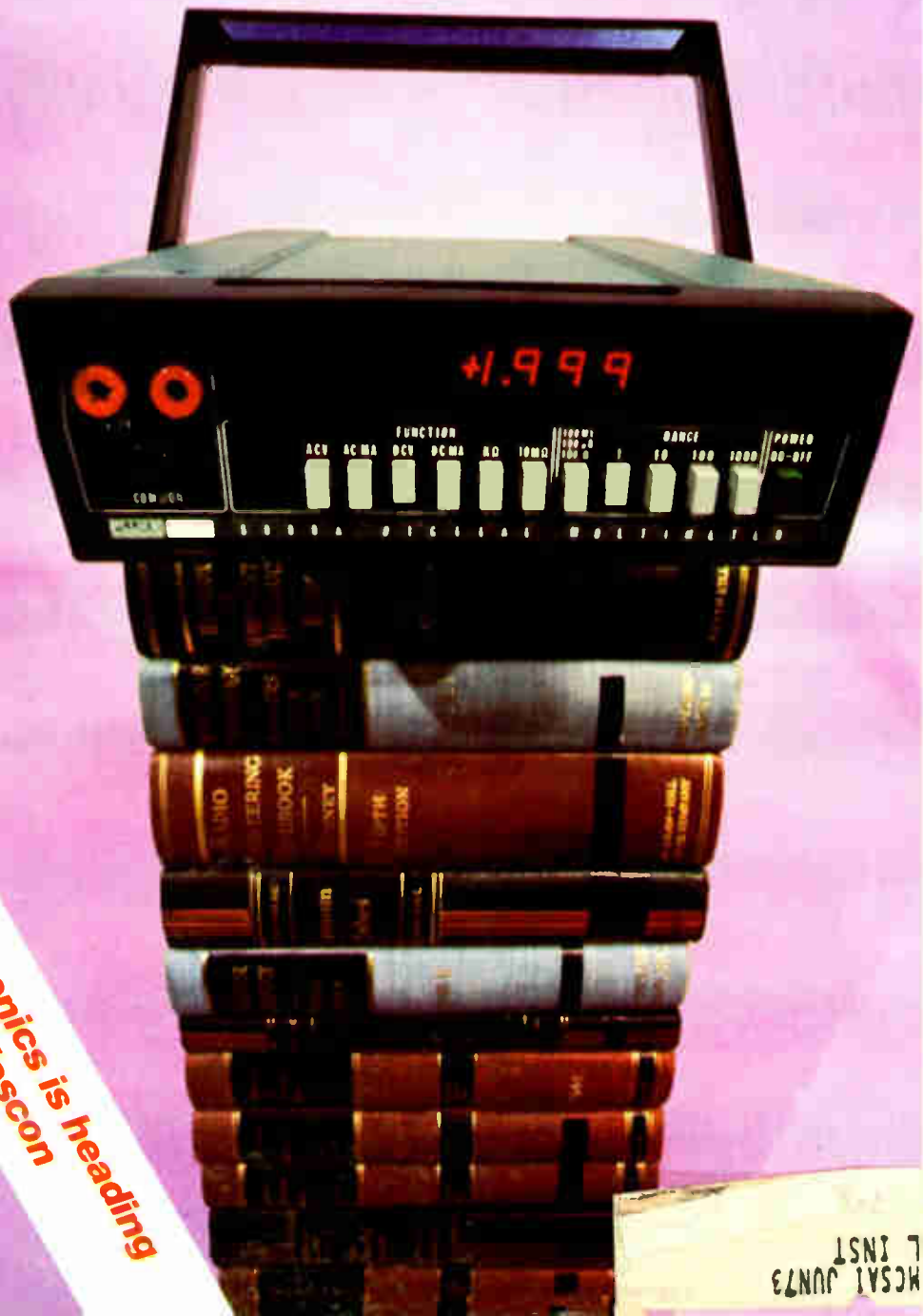
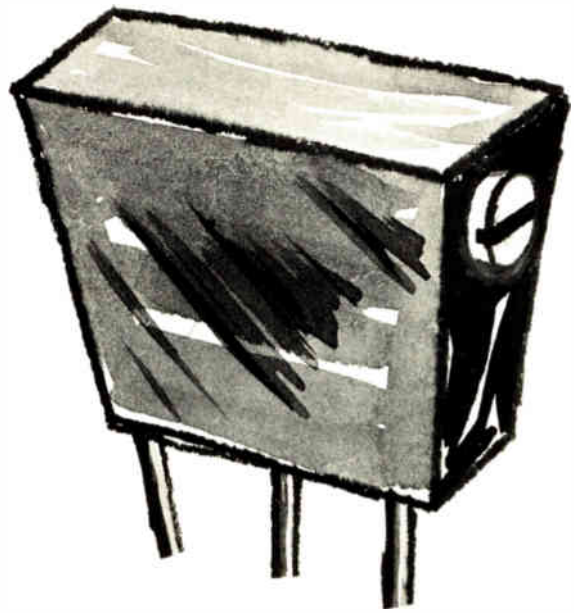
Electronics

LSI spurs revival of old idea in new instrument





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. . . resistance values available **down to 2Ω!**

. . . its dynamic noise is **less than 10Ω ENR!**

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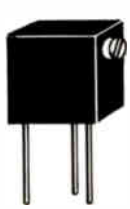
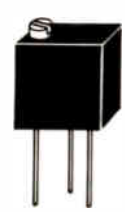


RJR26X

RJR50P



RJR26W

RJR26P

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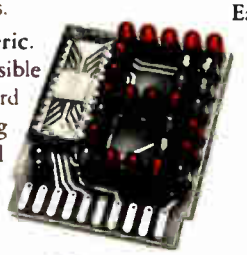
A low-cost LED display. Our numeric and hexadecimal displays have simplified your designs with on-board electronics, standard package configuration, and categorized light outputs. Best of all, the 5082-7300 numeric has a new low price of $8.25 in 1,000 quantities.

A new 1.5" LED numeric. This new LED display, visible from 60 feet, has on-board electronics, wide viewing angle, and is designed for edge mounting in a standard PC board socket. Solid-state reliability makes the 5082-7500 ideal where dependability is important. The price is $23.50 each in 500 quantities.



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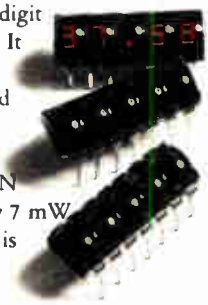

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You can take this lightweight, all solid-state and rugged system out into the field to test cable runs, antennas and the like. Another important and practical advantage for field use: you can operate the detectors up to 200 feet away from the display!

There's economy too: a complete 8755 system with analyzer in an HP 182A large screen scope display, modulation unit and three detectors costs just $3200.

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Circle 2 on reader service card

Electronics

The International Magazine of Electronics Technology

September 11, 1972

Highlights

Airlines switch to EDP for freight, 79
First the passengers—now the parcels are being organized onto and off airplanes by computer. The airlines are going after automation in a big way as air freight is forecast to quadruple over the next eight years.

Reawakening in the west, 89
This year Wescon has two very good things going for it—the twin boom in semiconductor and data processing sales. But the focus has shifted from technology for technology's sake to an applications orientation that users will welcome (see also the Wescon products survey, starting on p.139).

Aerospace computers have all the talents, 112
Today's highly complex aerospace missions make severe demands on airborne computers. But these, thanks to microminiaturization, are proving capable of tasks that only earthbound giants could perform two generations ago.

LSI updates old conversion idea, 102
Voltage-to-frequency conversion using discrete devices were complex and expensive. But LSI transforms the approach, so that it yields a low-cost 3½-digit a-d converter with 0.1% accuracy.

And in the next issue . . .
Coping with the crowded electromagnetic spectrum . . . the third world of silicon-on-sapphire MOS . . . a high-precision 16-bit a-d converter.

The cover
To produce a low-cost a-d converter, Fluke Manufacturing Co. crossed LSI with a technique unearthed from the archives.

Electronics

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Publisher's letter

The Wescon show gets underway Sept. 19 in Los Angeles, and our special report starting on page 89 provides the technical and business background for the show, pointing out trends in western electronics.

Paul Franson, our Los Angeles bureau chief, and Steve Fields, his counterpart in San Francisco, did most of the reporting and writing, with direction and the overview handled by Larry Curran, Managing Editor, News.

We spotlight changes in the report—booming business in semiconductors, aerospace diversification, a search for broadened markets among instrument and data processing equipment manufacturers. But Curran says there's a subtler evolution taking place. He covered the Los Angeles area for us for five years and believes there's a new buoyancy among western firms that have made it through a sobering recession in reasonably good condition.

"I don't see the hand-wringing and open wondering about where to find new business that's been prevalent in recent years," Curran says. "Instead, guys out there are determined they're going to get a piece of whatever business there is that makes sense for them."

We also take a look at the Wescon professional program, focusing on some of the more interesting sessions—those covering technological trends and applications, plus some newer directions reflected in the program. These latter are aimed at management interests and engineering career opportunities in non-traditional electronics fields.

Then, beginning on page 139, we have a roundup of new products that will be shown for the first time at Wescon.

Mexico's electronics industry is growing rapidly. And, while Japanese and European companies are going in, it has largely been U.S. companies that have set up shop both along the border and in heartland Mexico (see Probing the News, p. 65).

It was probably inevitable that the fairly sudden industrialization of once-sleepy towns and villages would spawn its share of urban problems, and it has. In fact, the problems are becoming so acute that the American Embassy in Mexico City has filed a report to the State Department warning of even more problems to come unless the Government starts doing something.

That report has not been made public, but our Washington bureau chief, Ray Connolly, got a copy. Says Connolly: "Particularly important is its expression of Federal concern with the socio-economic impact of a new industry on the life style of a previously underdeveloped and largely rural region, where the only other business besides farming has been tourism."

"With the Federal Government looking at the situation, the U.S. manufacturers involved should concern themselves with those issues, too," says Connolly, "because it seems certain that industry has not heard the last of them."

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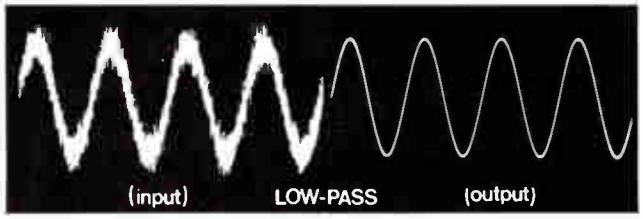
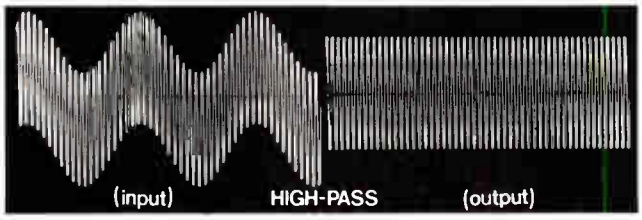
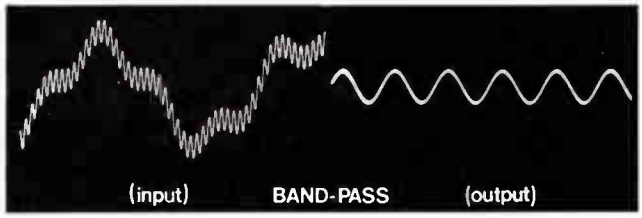
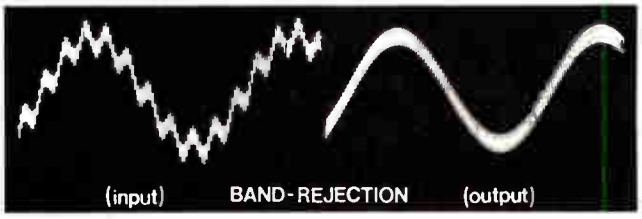
Model 3202 offers two independent low-pass or high-pass channels or single channel band-pass or band-reject from 20 Hz to 2 MHz.









For only $795, Model 3202 provides the flexibility essential for complex frequency or time domain measurements.

FUNCTIONS: Low-pass—direct coupled with low drift. High-pass—upper 3 dB at 10 MHz. Band-pass—continuously variable. Band-rejection—variable broad band or sharp null.

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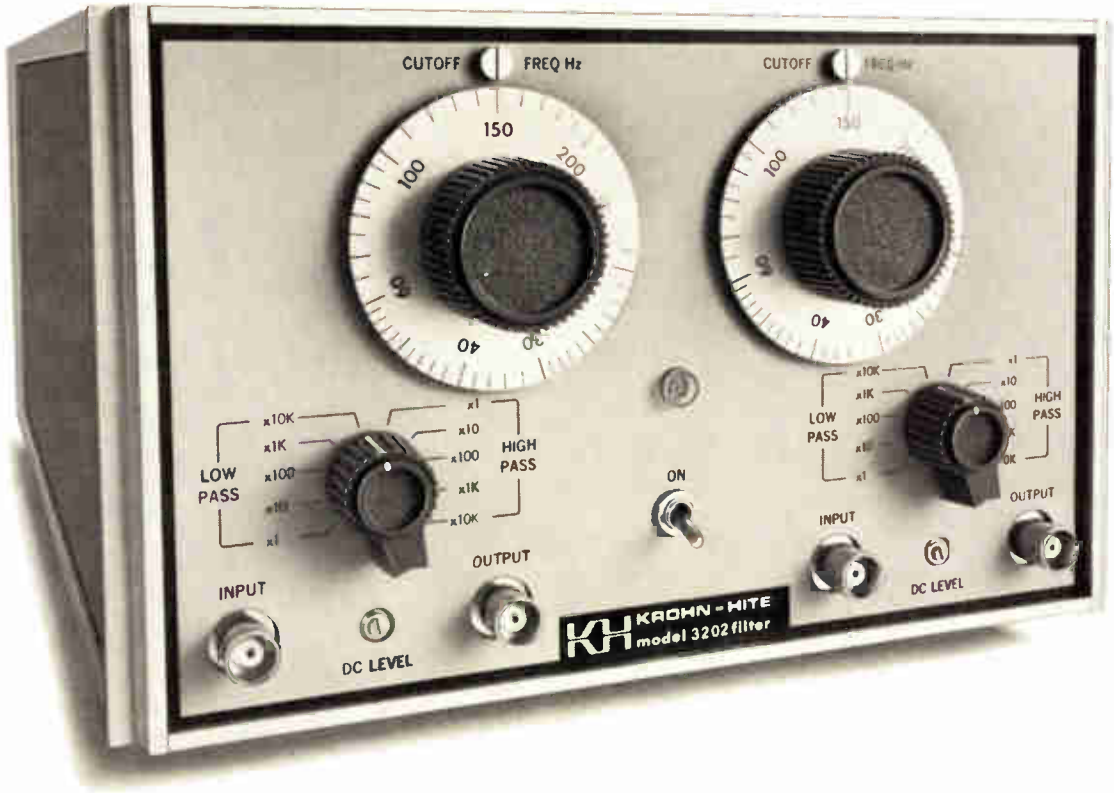

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Readers comment

Digital cassette compatibility

To the Editor: I thoroughly enjoyed Mr. Riley's article on computer peripherals [*Electronics*, July 31, p. 59]. However, I was a little surprised by some of the statements concerning cassette digital tape transports. It is indeed true that "people aren't paying much attention to this (ANSI, ECMA, ISO) de facto standard, especially in the United States."

There are a number of reasons for this—not the least of which is the fact that the standards concern only block recording and have completely ignored the huge key-to-tape data-entry market, where a large majority of cassette digital tape transports find a home.

One reason the ECMA standard is receiving more attention in Europe is that obviously there is a greater exchange of cassettes through the mail because of Europe's poor phone-line communications.

But I certainly agree that cassettes will never be the major medium of data interchange. However, it is a super way to gather data and program load. This makes it imperative that data recorded on a cassette be recovered error-free on any other cassette tape transport of the same variety manufactured by "A."

I agree with J. E. Godbout's comment in the article, "This kind of interchangeability (ECMA) is nice, but I wouldn't sacrifice reliability to achieve it." But he further states, "I'd like to see interchangeability among my own company's machines, *maybe*, but I don't care about anybody else's." That's not an option—it's a requirement.

Another topic I found rather humorous was the discussion about tape guidance. First, we unanimously agree that reliability, low cost, and simplicity are the goals. This eliminates capstans, pinch rollers, solenoids, clutches, belts, and pulleys, leading to reel-to-reel drive mechanisms. Then, what do we do? We pull the tape out of the cassette to guide it externally.

This is not only awkward (since it must be done on a leader, and then, very carefully), it also adds mechanical complexity and loss of reliability. Further, cassettes are available that have better than a ±.004-inch tape registration (how it comes out off the cassette corner rollers), which I'm certain is better than it can be "guided" externally.

Besides, it doesn't matter how you guide it externally, it winds up in the cassette the way the corner rollers want it to. All you can do externally is add skew, edge damage, and tape wear. The trick is to minimize this. I don't think it can be minimized by pulling the tape out of the cassette.

Brent Welling
Computer Access Systems Inc.
Phoenix, Ariz.

Correction

In our special report on semiconductor RAMs, which appeared in the last issue, we inadvertently associated the 6002 memory with American Micro-systems Inc. Of course, the 6002 is a product of Advanced Memory Systems Inc., Sunnyvale, Calif.

NATSEM WOWS WINDY CITY CONFAB

5 Watt Audio Amp Bows, Car Mfg's say 'Socko'

Raves and kudos continue to be heard about NatSem's new LM383K IC audio amp. the only monolithic 5-watt RMS IC audio amp that's fully short circuit and thermally protected and has a preamp and power amp on the same chip.

Cost effective with discrete designs, the new LM383K also offers adjustable voltage gains from 50 to 500.

10-Watt Audio Amp Intros, Hi-Fi Phono Mkt Wowed

National Semiconductor has introduced a 10-watt monolithic power amp designed for use by manufacturers of hi-fi phonographs.

The new LM384 will deliver 10 watts RMS into an 8 ohm load at 28-30V supply voltage. The LM384 is fully short circuit and thermally protected, has both a preamp and power amp on the same chip and is cost effective with discrete designs.

KIDDIE PHONO, PAGING AMP REAL 'LONER'

A new 4-watt IC audio amplifier that requires one external component has been unveiled by National Semiconductor.

Available in a 14-pin DIP package, the new LM380 audio amp was designed specifically for use in kiddie phonographs. paging systems, intercoms and toys which require an amp for their operation.

CERAMIC PHONO CARTRIDGES FIND FRIEND IN NEW DUAL CHANNEL AUDIO AMP

National Semiconductor has added a dual 2-watt audio amplifier to its expanding line of consumer linear integrated circuits. The new LM377 provides up to two watts of continuous RMS power into an 8 ohm load on each of its channels with a high impedance equal to 10 megohms. ideal for the ceramic phono cartridges found in most home stereo sets. Gain is 100 dB and distortion is only 0.5 percent at 1 kilohertz, while power bandwidth is 65 kilohertz.

TV SIGNAL PROCESSOR PACKED WITH POWER

A complete 2-watt TV sound system, utilizing proven circuit techniques, has been incorporated into National's new LM1805. The FM IF portion of the LM1805 uses a three-stage limiting amplifier and a differential peak detector combined with a DC volume control.

Designed for use with a minimum number of external components, the audio power amp section of the new LM1805 may be operated over a wide range of power supply and speaker impedance combinations.

OPEN LOOP GAIN, HIGH INPUT IMPEDANCE MAKE 4-WATT STEREO AMP 'WINNER'

A new dual 4-watts-per-channel stereo amp, the LM378, has been introduced by National Semiconductor.

An internally-compensated IC stereo amp, the new LM378 features a 100 dB open loop gain, typical 10 megohm input impedance. a dual internal power supply regulator and optimum turn-on, turn-off characteristics to eliminate turn-on delay and speaker pop.

Possibilities 'Unending' For New NatSem Quad Amp

National's new LM3900 is the first operational amplifier developed to operate from a single +4 to +36V supply and split supplies as well. It consists of four complete amps on a single monolithic silicon chip and is priced at only 75 cents in quantities of 100.

The new LM3900, which is internally frequency compensated for unity gain and completely short circuit proof, has an open loop gain of 70 dB and a unity gain bandwidth of 2.5 megahertz. Input bias current is only 30 nanoamps.

The combination of four independent amps on a single chip and single power supply operation opens up scores of new applications for op amps in industrial and automotive equipment applications where only one power supply is available.

Intros IC Preamps, Audio Amps

Chicago—One of the bigger coups pulled off at the Spring Conference on Broadcast and Television Receivers was the unveiling of a new line of integrated circuits that perform preamp and audio amp functions within recording, stereo, hi-fi. phono and other entertainment and broadcast-oriented systems.

The new IC preamps and audio amps are being manufactured in volume by National Semiconductor Corporation, a company who's no stranger to the integrated circuit business.

"What we've done," says a NatSem spokesman, "is to take the functions which normally require a combination of discrete transistors, IC's, resistors and put everything on a single chip, with little or no external components required."

In addition to their basic advantages of better systems reliability and lower systems costs. each of NatSem's new IC preamps and audio amps has its own distinct advantages. The LM381, for example, is the lowest noise dual preamp in the business. while the new LM382 is a low noise dual preamp which offers full R.I.A.A. and N.A.B. equalization with a minimum of external components.

Each of NatSem's new consumer IC's, available now at all National Semiconductor distributors, is described in more detail elsewhere on this page.

Kudos for Super Low Noise Preamp

A growing army of former discrete NPN and PNP transistor users are touting the merits of NatSem's new LM381 IC dual preamp. Designed for extremely critical low noise applications. the new LM381 offers a wideband equivalent input noise of 450 nanovolts with 600 ohms source impedance and 10 kilohertz noise bandwidth.

As a result, the new LM381 offers users a single-chip dual amplifier that's as performance effective as a transistor-resistor combo, with much better reliability in the long run.

R.I.A.A., N.A.B. EQUALIZED PREAMP PREEMS, USERS HAIL SIMPLICITY

A cost-conscious low noise IC preamp aimed at the auto tape, tape player, recorder and phonograph market is now available from National Semiconductor.

The new LM382 not only offers the advantage of low noise operation, but requires just three additional external components for full R.I.A.A. or N.A.B. equalization.

40 years ago

From the pages of Electronics, September 1932

There is need to rebuild popular interest in radio. There is want of cooperation with broadcasters. A "National Board of Strategy" for radio could do much to aid manufacturers and broadcasters in reinforcing each other's efforts. Standards of tone quality, sensitivity, and selectivity should be set up; conditions of poor reception should be cleared by a campaign of aid and education.

Meanwhile the spectre of overproduction and disastrous dumping should be laid forever; this can be done by adequate statistics of manufacturing and of stocks-on-hand. Factory costs need to be studied; freight rates to be clarified. Legislation is a recurrent vital problem; so are broadcasting situations growing out of federal regulation and international demands. New models and new tubes need to be controlled; destructive set advertising must be policed. And cooperative promotional efforts should now be pushed forward,—through newspapers, dealers' windows, and the air itself.

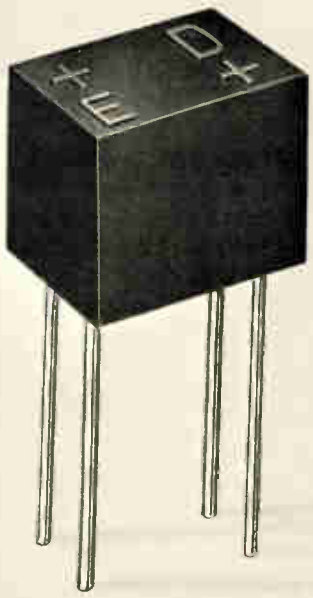
At the Madrid International Radio Conference this month, the question of widening the broadcasting band to include more channels again comes up.

Already it is evident that there is a wide variety of opinion on this subject.

Several different broadcasting proposals were to come before the Madrid meeting, when the international delegates convened September 3 to discuss the allocation of frequencies to various services.

The smokestack of the B. Altman store, Fifth Avenue, New York City, is in the midst of some overhanging apartment buildings, and it is desirable that no smoke offend the occupants. Accordingly a photoelectric relay unit has been put on guard, and if even a slight puff of smoke goes up the chimney, bells are rung in the two firerooms, a sign reading in big red letters "Smoke" lights in front of the desk of Chief Engineer Cummings, and the time and duration of the smoke is recorded on a curve-drawing galvanometer.

4000V ISOLATION!



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*Suggested resale price 1,000 lot quantities

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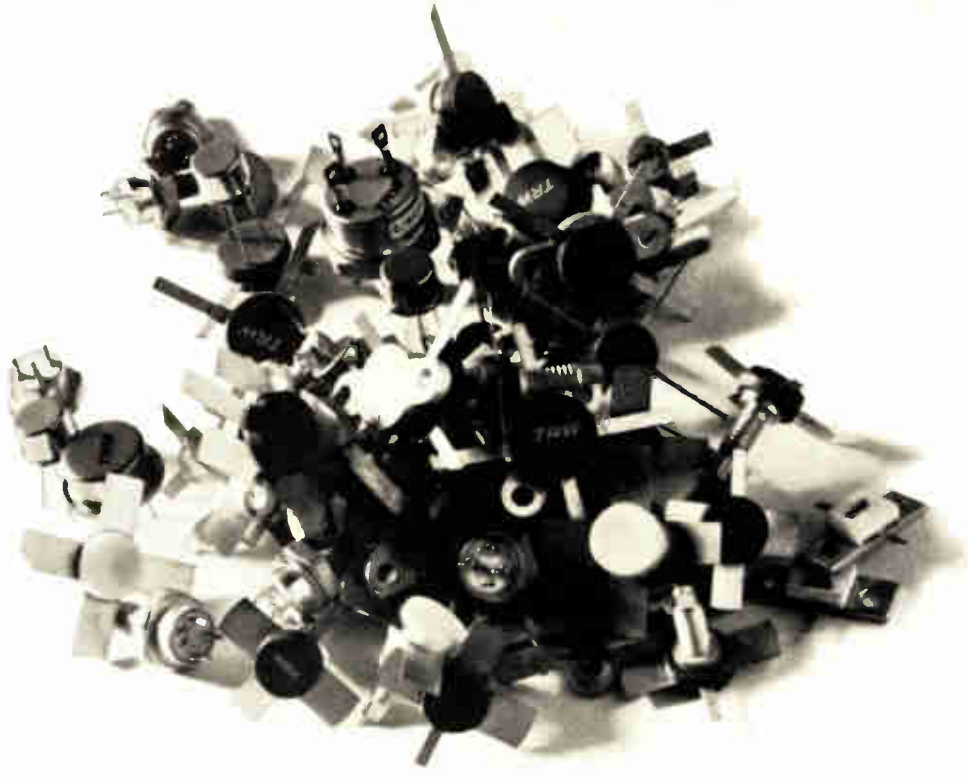

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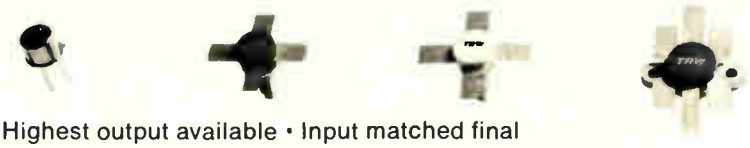
AM Aircraft Radio 108-152MHz	2N3866 → PT5707 → PT6726 → PT5708 → 25W Carrier  Single ended • 5:1 VSWR Circle 189 on the Reader Service Card

If you make	Take advantage of these TRW transistors
Tactical Radio Marine Radio Instrumentation 30-200MHz Broadband	2N3866 → PT4627 → PT6726 → JØ1002 → 120W  Highest output available • Input matched final Circle 190 on the Reader Service Card
Tactical Radio 225-400MHz Broadband	CA820 → PT5749 → JØ2005 → JØ2007 → 50W  Input matched driver & final • Two JØ2007 in parallel will produce 100W broadband Circle 191 on the Reader Service Card
ECM Radio Relay Telemetry 400-600MHz Broadband 600-1000MHz Broadband	2N5764 → PT5749 → JØ2401 → 35W  2N5764 → MRA0610-3 → MRA0610-20 → 20W  Input matched final for ease in broadband design Circle 192 on the Reader Service Card
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Your TRW Distributor has data sheets and application notes on the full line of TRW RF power transistors. For additional information, write TRW Semiconductors, an Operation of TRW Electronic Components, 14520 Aviation Blvd., Lawndale, California 90260. Or call, collect, (213) 679-4561. Ext. 745.

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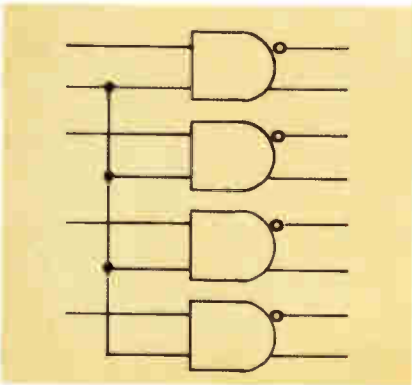
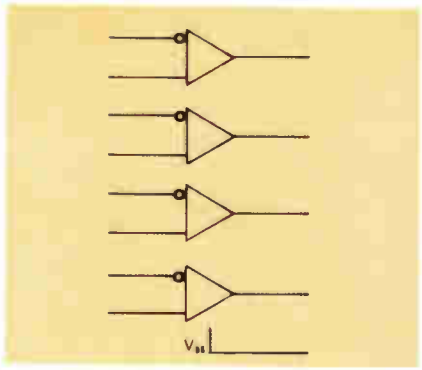
TRANSLATE, MULTIPLEX, INTERFACE, LATCH

Today's designer is faced with the problem of conveying data in the shortest time possible. And this problem is complicated by having to interface low speed TTL sections with high speed ECL systems. Now there is a solution in the form of two new translators that "speak" your language — TTL/MECL or MECL/TTL.



MC10124 MTTL TO MECL TRANSLATOR

A quad translator having TTL compatible inputs and MECL complementary open-emitter outputs that allow use as an inverting/non-inverting translator or as a differential line driver. High fanout capability (can drive 50 ohm lines), and offers a typical propagation delay of 5.0 ns.

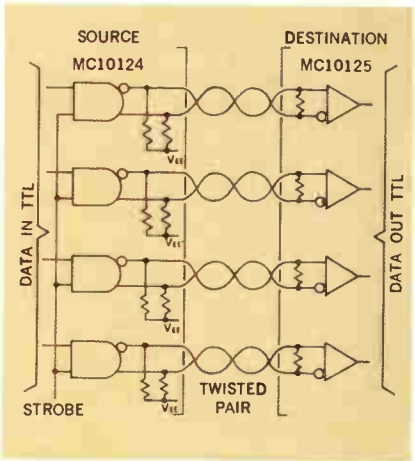


MC10125 MECL TO MTTL TRANSLATOR

A quad translator incorporating differential inputs and Schottky TTL "totem pole" outputs. Differential inputs allow use as an inverting/non-inverting translator or as a differential line receiver. A v_{BB} reference voltage is available for Schmitt trigger applications.

TTL/MECL, MECL/TTL OR TTL/TTL

Although usually used to interface between high speed ECL systems and low speed TTL sections, the translators can improve data transmission between two TTL pieces of equipment. A typical example would be a data line for talking between cabinets and/or remote sections of digital machines. The complementary outputs of the MC10124 can drive a differential twisted pair data line which is received by the differential receiver inputs of the MC10125.



This application provides:

- High speed operation with clock rate typically in excess of 75 MHz.
- Excellent noise rejection. The MC10125 has common mode rejection of ±1 volt specified.
- Quad translators offer minimum package count over conventional duals.
- Strobe capability. The MC10124 has an input common to all four translators to sample input data.

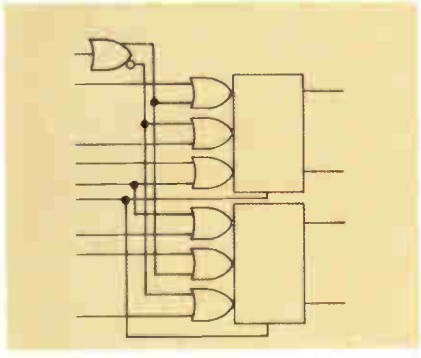
A MECL APPLICATIONS COURSE IS HEADED YOUR WAY

Starting October 16th Motorola will present a series of MECL Applications Courses throughout 15 major cities. Each half-day session will be "how-to-use" oriented and will include system application demonstrations. Discussions will cover transmission lines, system interconnections, PC board techniques, power distribution, thermal considerations, bus interfacing, and typical system applications.

Contact your local Motorola distributor or sales office for further details and location of the course nearest you. Here is your opportunity to learn how MECL can help you move ahead . . . faster!

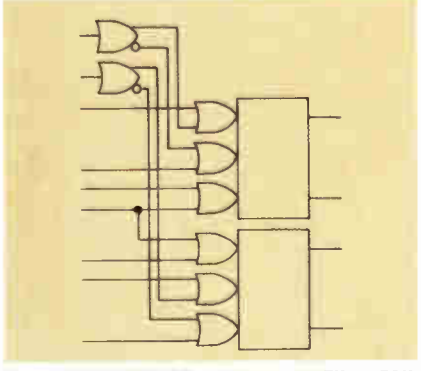
...MECL 10,000 Speaks Your Language

Besides moving data, a designer requires basic storage elements. Two new multiplexer/latches are now available for applications in high speed central processors, accumulators, register files, instrumentation, and high speed digital communication systems.



MC10132 DUAL MULTIPLEXER WITH LATCH AND COMMON RESET

The MC10132 provides a common select input for both latches. Information selected at the inputs is latched on the rising edge of the clock input. A common reset input is provided to reset the latches.

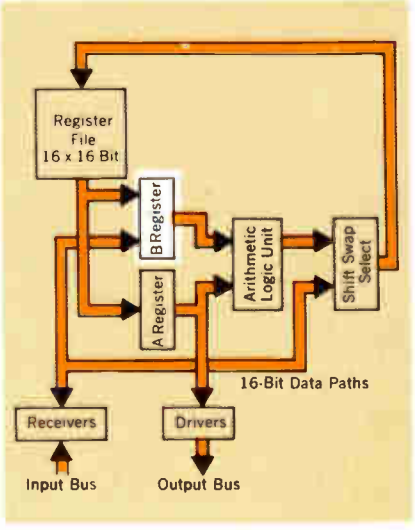


MC10134 DUAL MULTIPLEXER WITH LATCH

The MC10134 offers two latches with separate select inputs for each of the two pairs of data inputs. Each select input determines which information will be provided to the appropriate latch.

MINICOMPUTER STORAGE SIMPLIFIED

One typical application of the MC10134 is temporary



storage in a minicomputer such as the arithmetic section illustrated.

Data may be entered into the "B" register from either the register file or the input bus, requiring a multiplexed input to the register. Eight packages of the dual latch are necessary to construct a 16-bit register. And reset capability is available from the MC10132 if required.

MECL 10,000 APPLICATIONS ASSISTANCE

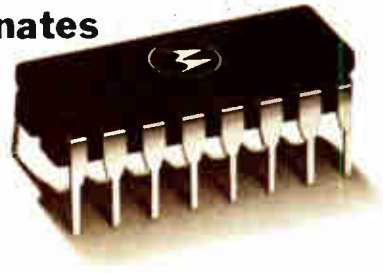
Three new application notes are now available to assist you in applying MECL 10,000. Briefly, these are:

- AN-556: Interconnection Techniques. Describes some of the characteristics of high speed digital signal lines and provides wiring rules for MECL 10,000.
- AN-565: Using Shift Registers As Pulse Delay Networks. The note develops a circuit useful for timing basic computer decisions or for use as an adjustable digital delay line for pulses.
- AN-566: High Speed Binary Multiplication Using The MC10181. With a 4-bit arithmetic unit you can reduce both package count and interconnections in a ripple multiplier and achieve very fast multiplier times.

For complete specifications on these new products and applications information write to Motorola Semiconductor Products Inc., P. O. Box 20912, Phoenix, AZ 85036. And for immediate evaluation call your local Motorola Distributor.

MECL 10,000 is the industry's #1 fastest growing high-speed logic family. Whether your need be applications assistance, system speed, increased performance, or cost reduction — *MECL 10,000 speaks your language.*

MECL 10,000 eliminates the alternatives. Evaluate and compare!



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People

Kershner, popular pragmatist, gets a new post at APL

At the Johns Hopkins Applied Physics Laboratory outside Baltimore, it is common knowledge that Richard Kershner's definition of a successful experiment is one that provides a learning experience. And this probably best explains why the pioneer space researcher could smile, amid a sea of depressed Navy faces, when in 1960 APL's Satellite IB failed to achieve orbit and fell into the sea off Ireland.

"It was at that point that I recognized what people mean when they call him a pragmatic optimist," recalls an associate in the experience with that launch. (It was the precursor to the Navy's successful Transit satellite signal navigation system.) "He was smiling because he knew we had been able to measure the satellite's doppler signals and trajectory so we could make the necessary corrections. He was convinced we had learned a lot."

As it turned out, Kershner was right—a fact the Navy subsequently recognized when it presented him with the Navy Distinguished Service Award, its highest civilian honor, for his leadership of the Transit program as head of APL's Space department. It is an honor he had won twice before for leadership in developing the Terrier antiaircraft defense missile and for major contributions to the Polaris Fleet Ballistic Missile Systems—all developed at the Johns Hopkins Laboratory, where he has worked for 28 years.

Now 59, Kershner has achieved recognition again with his appointment as assistant director. Though he will continue to function as chief of APL's space operations, Kershner's new assignment will give him a key role in managing the big $50 million lab and making decisions on its role, policy, and programs along with director Alexander Kossiakoff and his deputy Frank T. McClure.

Under Kershner's guidance, APL first made use of nuclear power in space, first employed gravity gradient stabilization to passively fix the face of a satellite toward earth, and pioneered the use of satellites for geodesy.

Apart from his many and varied professional honors, however, perhaps the best testimony to Kershner's leadership at Johns Hopkins is the observation of one associate that, in the 13 years since he assumed responsibility for establishing APL's space program, he still "has basically the same crew he began with. He's a firm guy, but he is also very popular."

A native of Crestline, Ohio, Kershner grew up in Baltimore and received his Ph.D. in mathematics from Johns Hopkins at the age of 23. After a brief pre-World War II excursion into teaching, he returned to Johns Hopkins only to leave after Pearl Harbor to serve on the staffs—again briefly—of the Carnegie Institution of Washington and the Allegheny Ballistics Laboratory at Cumberland, Md. Then he returned to APL in 1944.

Keyes tightens WDL along systems lines

The past few months have seen Philco-Ford's Western Development Laboratories going through some changes that, according to John C. Keyes, "are aimed at making a profitable division even more

Surgeon. WDL's Keyes has merged two operations.

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People

profitable." Keyes, who recently was named general manager of the division and elected a vice president of the corporation, is trying to reorganize WDL to do better what it does best—build and sell satellite communications systems.

"We've merged two separate operations," says Keyes. "The space systems operation, which manufactures our satellites, and our ground terminal operation have been combined to form the space/ground communication systems operation. This gives us a single group that sells complete communications links, instead of two operations separately marketing the space and ground segments of a satcom system." Keyes feels that the revamping will help WDL be more a total systems company—the business he is really interested in. "The only products that we get into are those that support our total systems objectives."

The WDL division is a major supplier of communications, meteorological and scientific satellites, ground equipment for satellite communications and control, and engineering services in support of military satellite programs and NASA manned space missions. Included in the division is the Houston, Texas, Philco operation which built and helps maintain NASA's Mission Control Center.

Keyes himself is a graduate of UCLA, from which he got his bachelor's in chemistry and master's in engineering. He has been involved with systems at Philco but at one time also got into the components business. Before becoming general manager, he was director of WDL's special programs operations—an area that covers security; surveillance; and military command, control, and display systems mainly for classified Government programs. Keyes first joined Philco-Ford in 1958, as director of WDL's systems engineering lab and manager of the Discoverer program.

He left to start a company of his own and then in 1966 rejoined Philco-Ford as director of the western operation of the defunct Microelectronics division.

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The new system consists of the Model 5200A AC Calibrator and the Model 5205A Precision Power Amplifier.

Covering a frequency range of 10 Hz. to 1.2 MHz, the Model 5200A output is from 100 microvolts to 120 volts at current levels up to 50 milliamperes. Mid-band accuracy is ±0.02 percent. Short term amplitude stability is ±10 ppm. Six month stability, ±0.01 percent. Working with the 5200A, the Model 5205A provides output voltages from 100 volts to 1200 volts at current levels up to 200 milliamperes. Combined 5200A/5205A amplitude accuracy is ±0.03 percent.

The 5205A can also be used as a stand-alone amplifier providing programmable gains of X10 and X100 for frequencies from dc to 120 kHz. Output amplitudes from 1 millivolt to 1700 volts peak are offered for a wide variety of waveforms including pulses, sawtooths and triangles. All functions are remotely programmable with standard TTL logic levels. Uniquely, the 5205A can be programmed by both the 5200A and another control source so that it can be time-shared in an automatic system to perform a multitude of functions.

Price of the Model 5200A AC Calibrator is $3,995. The Model 5205A sells for $2,495.

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Meetings

Western Electronic Show & Convention (Wescon): WEMA, Convention Center, Los Angeles, Sept. 19-22.

Engineering in Medicine and Biology: IEEE, Americana, Bal Harbour, Fla., Oct. 1-5.

International Symposium on Remote Sensing of Environment: U. of Michigan, Willow Run Labs, Ann Arbor, Oct. 2-6.

Electronic Packaging and Production Conf. (Nepcon Central): Kiver Pub., Arlington Park Towers, Arlington Heights, Ill., Oct. 3-5.

U.S.A. & Japan Computer Conf.: AFIPS, IPSJ, Tokyo, Oct. 3-5.

Ultrasonics Symposium: IEEE, Statler Hilton, Boston, Oct. 4-6.

National Electronics Conf.: NEC, Regency Hyatt O'Hare, Chicago, Oct. 9-11.

International Conference on Cybernetics and Society: IEEE, Sheraton, Washington, D.C., Oct. 9-12.

Conference on Display Devices: IEEE, United Engineering Center, New York, Oct. 11-12.

Eascon: IEEE, Marriott Twin Bridges, Washington, Oct. 16-18.

Fifth Annual Connector Symposium: Electronic Connector Study Group, Cherry Hill Inn, Cherry Hill, N.J., Oct. 18-19.

International Conference on Computer Communications: IEEE, ACM, Hilton, Washington, D.C., Oct. 24-26.

Nerem: IEEE, John B. Hynes Civic Auditorium, Boston, Nov. 1-3.

International Conference on Magnetism and Magnetic Materials: AIP, IEEE, et al., Hilton, Denver, Nov. 28-Dec. 1.

International Electron Devices Meeting: IEEE, Washington Hilton, Washington, D.C., Dec. 4-6.

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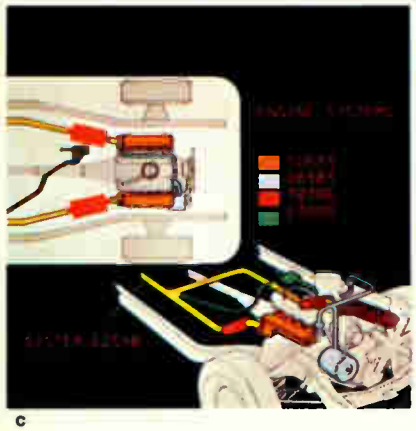

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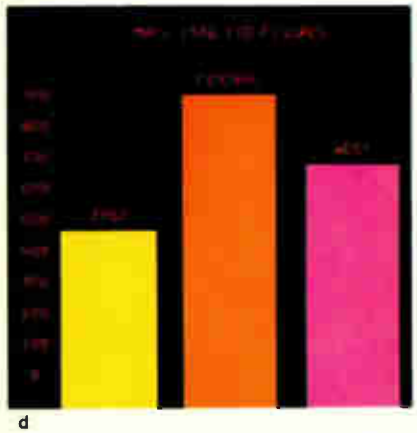

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Communicate. That's the watchword for the Seventies. And that's just what Digivue® Display/Memory units do—with impact, immediacy and memorability.

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Communication with Digivue units begins at a data processing center like the one pictured on the opposite page, where computer-generated information is directly addressed to Digivue units at various locations.

a/*A Digivue unit in a shipping department relays the day's orders by catalog number, type, quantity and method of shipment. Digivue's inherent memory allows instant retrieval of this information without refresh requirements at any time.*

b/*A Digivue unit on the desk of a financial vice president transmits a twelve-month cost projection. Terminal manufacturers note: Digivue's slim panel depth allows for high-styled consoles and attractive, unobtrusive placement in an almost limitless variety of situations and locations.*

c/*Digivue units help a sales training class with assembly techniques for a new product line. Because Digivue panels are transparent, rear-projected graphics in every color of the rainbow deliver high-impact visuals no CRT system can even come close to.*

d/*With the help of a Digivue unit, a busy executive secretary prepares information for an important meeting—utilizing a combination of rear-projected graphics and computer-generated alphanumerics.*

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Owens-Illinois

Circle 23 on reader service card

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BUNKER RAMO AMPHENOL

Circle 24 on reader service card

Texas Instruments breaks with EIA . . .

Texas Instruments has quit the Electronic Industries Association after 17 years because of **"questions as to the effectiveness of EIA as an industry service institution and rising costs of participation."** V.J. Adduci, EIA's salaried president in Washington, reluctantly confirmed the report that TI had resigned its corporate and five divisional memberships by letter dated Aug. 24, but retroactive to the end of EIA's fiscal year, July 31.

Beyond attributing TI's action to "some differences in philosophy," Adduci declines comment, except to cite his own internal staff announcement that noted, "Every effort was made to avoid it."

The big Dallas systems and components producer responded more specifically, however, **challenging EIA's "questionable credibility with many areas of Government"** because of its long-standing "inability to take a total association position on a vital matter, such as international trade." EIA's directors, of which TI president Mark Shepherd Jr. is a leading member, divided, and thus failed to act, on trade policy at a closed board meeting in Los Angeles last year. The division was along classic lines, **with EIA's Components group members taking a generally protectionist view and effectively neutralizing the so-called free trade position of consumer products manufacturers** with large offshore manufacturing interests, or multinational companies like TI. "The failure of EIA's interface with U.S. Government bodies," TI declared, "has permitted gross distortions of the vital role of multinational corporations to our national economic well-being" and "can lead to damage to the international position of the U.S."

. . . but return, like Zenith's, held likely

"They will be back sooner or later." That private observation by one senior industry executive on TI's resignation from the Electronic Industries Association effectively summarized the views of a sampling of industry officials commenting on the impact of the action on the manufacturers' organization.

"Don't forget that Joe Wright took Zenith out in a huff a few years back, but now Zenith is back in. **I believe it will be the same with TI," said another source.** Most expressed shock and disappointment when advised of the action, particularly in view of the two terms of TI's Mark Shepherd Jr. as EIA's president, plus his 1971 selection for the group's top honor, the EIA Medal of Honor—an award made in 1967 to his predecessor at TI, Patrick E. Haggerty.

A different kind of speculation came from another industry source and former EIA director, however, who said he believes **Shepherd's first break with other board members "took shape about a year and a half ago" with the controversial and short-lived hiring of George Butler as EIA's first salaried president.** "Mark wanted George to run EIA like a business and that, frankly, caused a lot of trouble before Butler left. You just can't run an association like a business," he observed, noting that it is more analogous to "running a political party," where more compromises are struck than orders given. "Ever since that showdown," he concluded, "there seemed to be increasing disagreements between Mark and others on the board."

Donn Williams, president of North American Rockwell's Electronics group, agrees there's splintering within the EIA. Williams, an EIA

board member, says, "I'd like to see TI in the EIA, but a stronger EIA. We, as a company, plan to work within to strengthen EIA."

Instrument makers turn to distributors

Look for an acceleration in the trend toward nontraditional instrument marketing techniques as increasing numbers of manufacturers try to break into low-priced markets. **Switches from reps to distributors are a possibility** for at least two reasons. As J. E. Niebuhr, marketing manager for Systron-Donner's Instrument group, points out, "In-person sales calls cost too much to make for a $300 instrument, and secondly, the buyer of a $200 or $300 instrument doesn't want to wait 60 to 90 days for delivery—he wants it now."

Fred L. Katzmann, president of Ballantine Laboratories, agrees, and further speculates that **the future may see a trend toward much shorter warranty periods for low-cost instruments.** "This would not represent a reduction in quality," Katzmann says, "but rather a separation of the costs of manufacture from the costs of service."

DuPont maps push for its Corfon fiber-optic material

The selling might of E.I. DuPont is being mustered to help develop a market for DuPont's plastic fiber-optic material called Corfon. Although the material has many uses, from remote sensing and illumination to data communications, **DuPont is most interested in the automotive market**—at a time when car makers are looking hard for a way to carry myriad multiplexed computer-controlled signals to perform all automotive functions over a single, small, rugged fiber.

The material uses an acrylic core and a proprietary outer cladding but contains no styrene, which degrades rapidly and can cause problems when in the gaseous environment of automobiles. While DuPont freely admits there's also a place for glass fibers, it feels **the lower fabrication costs and ruggedness of the plastic material make it better suited for use in automobiles.**

Postal Service plans $2.4 billion for electronics, EDP

The U.S. Postal Service may rival the Defense Department as a big buyer of electronics equipment. Over the next six years the service plans to spend about $2.4 billion in electronics-related or computer-directed equipment to automate 177 preferential mail centers (see also p. 30). **Already 15 companies are interested in one of the first planned buys—18 new Advanced Mail Code Systems** that will encode personal mail at the Cincinnati post office operational test-bed. Once top management has approved it, **the purchase would lead to procurement of several thousand units.**

Addenda

The first commercial millimeter-waveguide system is scheduled to open in 1978 between New York and Philadelphia, according to an AT&T Long Lines spokesman. **The 100-mile link will be capable of carrying 230,000 two-way voice conversations.** Cost per channel will be $1, says the spokesman, compared to $3.74 for existing coaxial systems. . . . IBM has agreed to pay $250,000 to Energy Conversion Devices Inc., Troy, Mich., for a limited license covering recording, storing, and erasing of so-called ovonic amorphous semiconductor materials by an automatically directed energy beam. **IBM says its interest is purely experimental.**

the nutcracker

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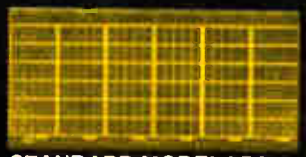

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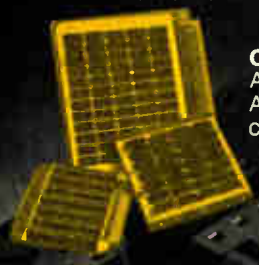

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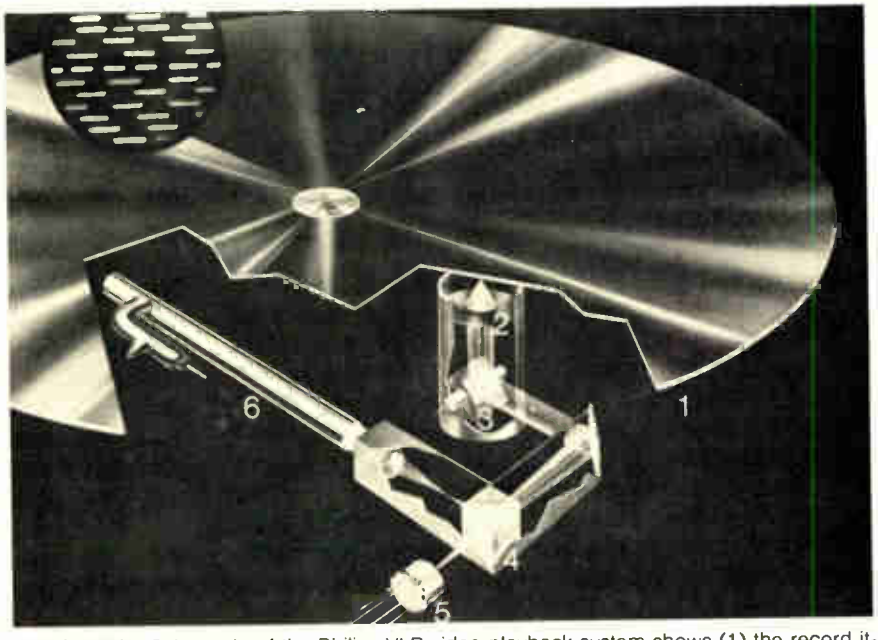
Philips TV disk, read by light beam, could shape market

Company says its VLP could carry 45 minutes of color or up to 45,000 frames on a record; plays 25 images/s



Play it again. Schematic of the Philips VLP video-playback system shows (1) the record itself, with the pattern of pits in the inset; (2) spring-suspended lens with automatic focus of the light beam; (3) hinged mirror for following track; (4) beam-splitting prism; (5) photodiode detector; (6) light source. The disk is the size of audio long-playing records and offers the advantage, with its light-beam readout feature, of not wearing out like grooved types.

Anyone planning to bet on who will dominate the upcoming consumer video-playback market now has to sit down and refigure the odds.

Philips Gloeilampenfabrieken, already a strong contender with its video cassette, has come in with a late entry that could well become the front runner within a few years. The Dutch company unveiled last week a long-playing video disk that it says should be on the market within a few years.

To be sure, AEG-Telefunken and Decca showed their jointly developed black-and-white video disk equipment two years ago [*Electronics*, Aug. 3, 1970]. But because Teldec disks have grooves and mechanical tracking, there are two inherent problems—short playing time and high record wear.

No wear. Philips' disk, the company says, can pack in 30 to 45 minutes of color program. It's paired with a player that feeds the program into an ordinary color TV set through the antenna terminals. The video records can be played back at regular 25-image-per-second speeds, in slow motion, or as "stills." Philips points out that the record could be used as a "color-photo album" with up to 45,000 frames on the disk. There's no problem about record wear, since the records are read out by a light beam.

The records are the same size as audio long-playing records and are made from much the same material as LPs. But instead of grooves, the VLPs, as Philips calls them, have pits of submicron size molded into a spiral-shaped track.

The record spins at 25 revolutions per second, and each turn of the track has all the information needed for one image. This matches all the pits for depth and width. Their length and the spacing between them store the video information—such as synchronization, luminance, and chrominance—and the accompanying sound signals.

Patterns in the pits are read out by a laser-generated light spot. Light bounced off the pits is reflected onto a photodiode through a pair of mirrors and a beam-splitting prism. The diode output then is processed to get a composite TV signal that a regular set can play. Tracking is wholly optical: one of the mirrors moves the spot from track-to-track under control of a precise position system that Philips won't talk about at the moment.

Low noise. The laser is necessary to keep noise levels acceptably low. To keep the cost of the playback hardware low, too, Philips has developed a small helium-neon laser that can be mass-produced.

Philips also plans to keep prices of the records themselves low. Its record-making subsidiary, Polygram, is at work adapting pressing techniques to the submicron precision that is needed for the pits them-

selves. The VLP records, after pressing, get a reflecting metallic layer atop the plastic. □

Optoelectronics

Glass guide loss is cut to 4 dB/km

A major milestone on the long road to practical fiber-optic communications systems has been passed. Researchers at Corning Glass Works have reduced attenuation losses in glass-fiber waveguides to 4 decibels per kilometer from the previously reported 16 – 20 dB/km.

The immediate significance, says Robert D. Maurer, manager of applied physics research at the Corning, N.Y., laboratories, is economic, since with the lower-loss fiber "the expensive repeater stations in laser communications systems can now be placed four or five times farther apart." Corning is now aiming at a 2-dB loss per kilometer.

A 550-meter length of the new fiber—solid glass with a core material of higher refractive index—was tested at wavelengths between 600 and 1,100 nanometers. Maurer identifies the more significant wavelength region in the 800-to-900-nm range, where gallium-arsenide lasers operate. Of particular interest is the fact that the amount of aluminum added to the GaAs laser controls the operating wavelength, so the laser can be matched to a minimum attenuation frequency of the fiber over a 100-nm range centered approximately at 850 nm.

Another attenuation minimum occurs at about 1,060 nm. This is the region where the neodymium-doped yttrium-aluminum-garnet laser operates.

The entire achievement resulted from "improved multimode fiber preparation techniques" to be discussed by Maurer at the European Electro-Optics Markets and Technology Conference in Geneva, Sept. 13-15, and at the Northeast Regional Electronics Meeting in Boston, Nov. 1-3. □

Government electronics

Postal Service tests address reader

Even though large-volume mailers, such as insurance or telephone companies, use standardized envelopes, processing their mail still takes many steps. In an attempt to speed one of those steps, the U.S. Postal Service is starting tests of POMP (for prototype precoded originating mail processor), built by E-Systems Inc., Dallas, Texas. The Postal Service plans to have 90% of such mail machine-processed over the next several years.

The solid-state POMP will read a strip of binary-coded vertical bars below the address area, reformat the coded strip onto a standardized location on the lower right front of an envelope, verify both codes, and sort the letter toward one of 30 destinations—at the rate of six per second, according to E.E. (Ewald) Lang, advanced postal systems manager of the Garland division of E-Systems Inc. A production model would process eight a second, he says.

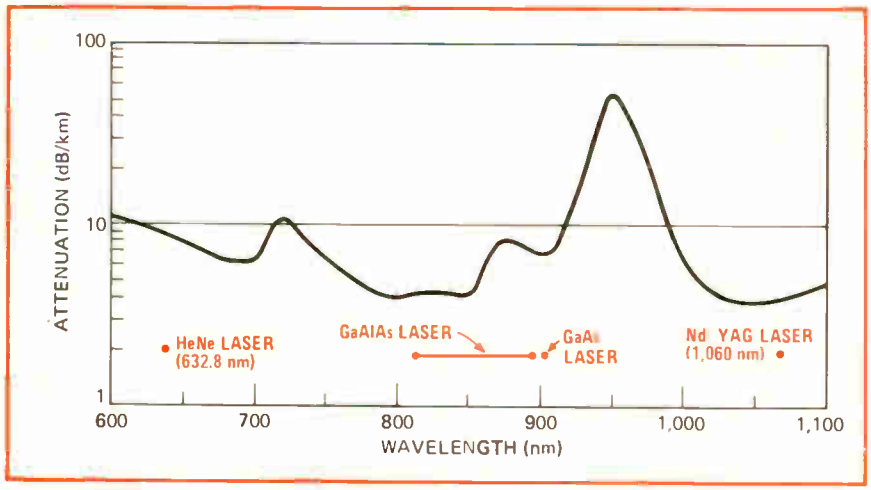
Short float. Units like POMP are important to big mailers because faster coding and sorting means that bills get to their customers faster and—they hope—the companies get money back sooner. This would cut the "float" and reduce short-term borrowing costs.

For E-Systems, the test of POMP at the Cincinnati Post Office, the postal service's operational test-bed [*Electronics*, Sept. 14, 1970, p. 125] could mean a good business, says Lang. The one POMP unit was developed in a short 17 weeks under a $300,000 contract, with options for nine more at additional cost. Should the Postal Service, as expected, buy 200 or more units for its planned 177 preferential mail centers, E-Systems feels it has an inside track under competitive bidding. The company also is eyeing a possible commercial market among mailers.

To use POMP, an operator takes a sample letter from the long row of mail placed ready on a rack in the leg of the L-shaped unit. He puts the sample on a sloped positioning counter, and moves an indicator over the precoded binary strip below the address to position the bar code reader. In operation, the letters zip past the reader, past a flying jet inker that prints the new codes. Then they are verified by another reader and sorted.

Format. In printing a new binary-coded strip, the unit rearranges it into a two-section format, essentially zip code and street address. The machine then is able to sort by zip code, says Lang. An electronic self-test unit is included, and Texas

Reducing losses. Corning's new glass fiber-optic waveguide material cuts attenuation loss to 4 decibels per kilometer. Most significant region is 800 to 900 nanometers, says Corning.



Instruments devices are used throughout, he adds. A solid-state control unit deciphers, checks errors, and sorts in collaboration with a system directory lodged in a central post office computer. □

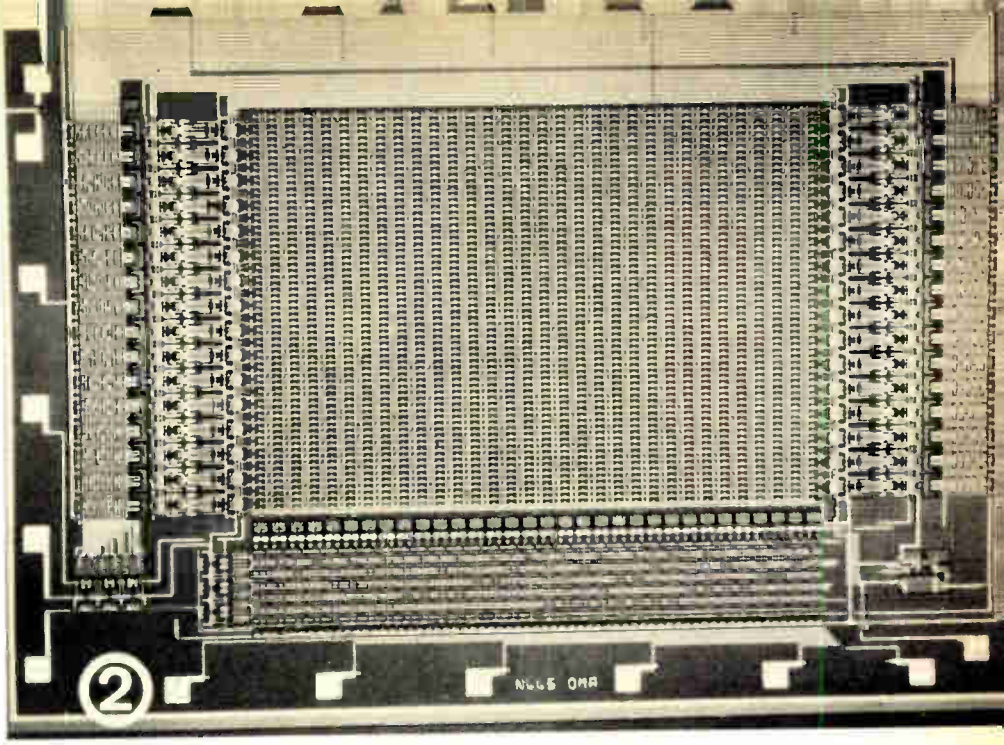
Memories

Philips' 4-kilobit RAM uses p-channel

Just as many semiconductor people were becoming convinced that n-channel MOS fabrication was the best way to get high bit densities in random-access memories, Philips Gloeilampenfabrieken in the Netherlands has built a p-channel 4,096-bit RAM.

Philips turned the RAM density trick by combining its oxide-isolation technique with reliable metal-gate p-MOS structures. This isolation rivals the bipolar oxide-isolation methods getting so much attention these days. Here's proof: of the several developmental 4,096-bit RAMs Philips has already built, all have access times of about 300 nanoseconds and cycle times of 400 ns, which means that it's possible to access through 4 kilobits of memory in the time it takes the old p-channel memories to access through 1,024 bits. What's more, in one version of the Philips RAM—an 18-pin device to be sampled early next year—all clocks are on the chip, greatly simplifying memory systems. A 22-pin version in which one external clock generates all clock signals is expected by year's end.

The Philips oxide-isolation technique, called Locos for local oxidation of silicon, both shrinks memory cells and puts them closer together. Cell sizes are about 1.5 mil², compared to 6 mil² for conventional p-channel RAMs and 2 mil² for other manufacturers' projected 4,096-bit n-channel RAMs. The Locos method is also being adapted to n-channel, with the implication of still higher densities. And most important, unlike today's MOS RAMs, Philips devices are TTL-compatible (in inputs and outputs but not in clocks), eliminating the buffers required to boost bipolar logic signals.



By the thousand. Philips has built this 4,096-bit p-channel RAM by combining its oxide-isolation technique with metal-gate p-MOS structures. Part accesses in 300 ns, cycles in 400 ns.

Another key feature of the new Philips RAMs is the use of a single-transistor cell. Although tried before, the one-transistor cell was never successful because it produces low logic swings into high bus capacitance. Philips solved the problem by developing a super-sensitive sense amplifier to sense logic. □

Commercial electronics

Calculator industry's growing pains intensify, but everyone's optimistic

It can be said that the electronic calculator industry has yet to reach maturity, but no one can deny that it's starting to have adolescent growing pains. Look at just two developments of recent days: some manufacturers and suppliers grudgingly admitting there's a parts shortage, and companies announcing firsts, all at the same time.

The parts shortage seems to be a concomitant of success. Roger Johnson, vice president for production and program management at Singer Business Machines Co. of San Leandro, Calif., says he has put his suppliers "under pressure." Also, he notes that the problem is a happy one because it indicates that sales are exceeding expectations. But at Eldorado Electrodata Corp. in Concord, Calif., Gary Hasenfus, calculator program manager, says: "We have no problems keeping up with our orders. I have little sympathy with less fortunate companies—possibly they're having problems [getting parts] because they were late getting aboard."

Bowmar/ALI, Acton, Mass., which turns out 1,500 units a day, says it's experiencing no trouble with Texas Instruments—which designed the circuits—or its other sources.

Prosperity. A circuit supplier, Warren Wheeler, president of the Micro-products division of American Micro-systems Inc., says the whole MOS industry is enjoying a boom, so deliveries are starting to stretch—say, from 30 days to 60 days.

Typical of the confusion is a claim by Computer Design Corp. of Santa Monica, Calif., which makes ma-

chines for Monroe Calculator Corp. It said that 4,000 partly built $4,000 calculators were waiting for LSI memories promised for January 1972 delivery. Wheeler of AMI, one of Computer Design's three suppliers, says that deliveries were late—but that they had been promised for June, not January.

Another supplier to calculator makers, Texas Instruments, has stopped taking orders for 1972 deliveries. TI won't comment, but a competitor says: "I imagine a lot of their production is being diverted to their own calculators." At Mostek Corp. in Dallas, where the first single-chip circuit for hand-held calculators was made, James Wilson, operations vice president, says: "We have consciously not overbooked."

Vertical. Adding spice to the bubbling calculator broth is the advent of the first low-priced printing calculators with vertical tapes. Unicom Systems Inc. of Cupertino, Calif., has unveiled two desktop models—the 1000P and 1010P—that use drum printers and start at $295. Both use two Hitachi chips. Major features beyond the usual four arithmetic functions are grand total memory register, automatic decimals, constants, chain calculations, credit balance, two-color printing, repeat add-subtract, automatic retention of last item, and buffered keyboard. Unicom says its machines will be available in December.

A $275 hand-held battery operated machine with a printed readout—the Phoenix P—has been announced by a small company, Ian Jones International of Bayside, N.Y. It uses a fixed-head thermal printer developed by Displaytek. □

Finding his place. Engineer tunes in simplified Transit satellite signal receiver (Transim) at Johns Hopkins Applied Physics Lab. At right is the standard electronic desk calculator.

Low-cost Loran, Transit developed

Over the last few years, Johns Hopkins University Applied Physics Laboratory developed a computerized Loran-C navigation system for the Coast Guard and a sophisticated shipboard system for the Navy that uses the timing signals from the Transit navigational satellite. These systems are fine for the two services, which can afford to build them, but would be way out of reach for civilian vessels.

Now, APL has designed a low-cost version of each, for use by small patrol boats, cutters, commercial fishermen, and pleasure craft. The Loran set is to cost $2,000 in 1,000-unit production quantities and will plug into the $2,000 Loran receivers now under prototype production by Litcom and Teledyne. The Transit set, called Transim, is pegged for under $10,000, including receiver, antenna, and electronic desk calculator.

Integration is key. The key to the Loran unit's lower-cost is MOS LSI. The logic replaces a processor and the Hewlett-Packard desk calculator, printer, and plotter of the Coast Guard set, explains Robert C. Hester, senior program engineer. The unit's Intel NCS-4 logic system is "a complete central processing unit on one integrated circuit," says Robert C. Moore, senior design engineer, and includes MOS read-only and random-access memories. Overall, the prototype unit consists of a few printed-circuit boards, displays, digital switches for dialing in numbers, receiver interface logic, and a low-cost receiver, and weighs under 30 pounds with backup battery supply.

Of course, with the lower cost, the user doesn't get all the fancy options. The new unit will give a navigator only the range to his destination in kiloyards and his bearing relative to his course. It will not tell him relative position, plot, and speed. But $4,000 will still buy the pilot what he needs—an accurate navigation system.

To use it, a navigator "dials in his destination in Loran (time-difference) coordinates, and the set computes in real time the time to his destination," Moore explains. The pilot sets his compass on the bearing indicated, and the distance indicator gives the diminishing distance to the destination. APL also is working on a simple autopilot for the unit consisting of a "pair of relay contact closures to drive simple bang-bang servos on the rudder," Moore adds. If the boat were off course, the unit would create an error signal to slew the rudder the right way, he says.

As for the Transim sets, they are low-cost versions of the Navy's AN/SRN-9 navigation units that process 400 megahertz signals, time- and location-coded from Transit satellites to give Navy ships more accurate fixes.

Hester says that the Transim sets will have the same capability as the more sophisticated Navy sets in giving navigation fixes anywhere, anytime in the world to a one-mile ac-

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Model 2208 Magnetic Core Memory—8,192 byte, 8-bit module (up to 8 modules per computer). $1,800

Utility Interfaces

Model 2510 Byte I/O Controller—provides independent input and output controllere each with 8-bit data transfers. $800

Model 2511 Full Word I/O Interface—provides 32 input lines and 32 output lines with data transfers under program control. $700

Model 2512 Priority Interrupt Board—provides 8 levels of priority interrupt with individual arm/disarm. $550

Model 2513 Selector Channel—operates by way of direct memory access, accommodates up to four I/O devices. $850

Communications Interfaces

Model 2601 Synchronous Modem interface—has auto call/answer unit, accommodates standard rates up to 9600 baud. $1,200

Model 2610 Asynchronous Communications Controller—single channel, full duplex, programmable baud rates to 9600 baud. $500

Model 2612 Asynchronous Communications Controller—provides simultaneous operation of 8 full duplex asynchronous channels. $1,600

Model 2613 Asynchronous Modem interface—provides simultaneous operation of 8 full duplex 103 and 202 type data sets. $2,000

Model 2620 Modem/Communications Control—provides 16 discrete inputs and 16 discrete outputs. $800

Model 2630 Automatic Call Unit Controller—provides control function for four Bell Model 801 automatic call units. $950

Peripheral Systems

Model 2710 Paper Tape System—300 cps fanfold 8-channel reader, 75 cps fanfold 8-channel punch. $3,955

Model 2720 Card Reader—300 cpm, 80 column cards. $3,750

Model 2731 Line Printer—80 column, 64 character set, 356 lpm. $9,750

Model 2732 Line Printer—132 column, 64 character set, 245 lpm. $12,500

Model 2810 Magnetic Tape System—with one 7", 9 track, 800 bpi, 10,000 bytes/second transport and controller for up to four transports. $4,630

Model 2811 Magnetic Tape System—with one 7", 9 track, 800 bpi, 20,000 bytes/second transport and controller for up to four transports. $4,760

Model 2820 Magnetic Tape Transport—7" reel, 12.5 ips, 9 track, 800 bpi. $2,830

Model 2821 Magnetic Tape Transport—7" reel, 25 ips, 9 track, 800 bpi. $2,960

Model 2822 Magnetic Tape Transport—8½" reel, 12.5 ips, 9 track, 800 bpi. $2,890

Model 2823 Magnetic Tape Transport—8½" reel, 25 ips, 9 track, 800 bpi. $3,020

Model 2851 Disc System—includes disc drive with moving head removable cartridge, 2.4 million bytes, 75 ms random access, 200 kb transfer rate. $11,730

Model 2852 Disc System—includes disc drive with moving head (one fixed and one removable), 4.9 million bytes, 95 ms random access, 200 kb transfer rate. $12,750

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curacy. The transit system is based on doppler shift.

Three elements make up the prototype transit sets: the APL-designed receiver and antenna and a Wang Industries 700B electronic calculator. The set is self-contained and needs no added printers because the calculator has a keyboard for entering course and speed data and has a built-in magnetic tape cassette drive for program tapes. □

Communications

Laser satellite system due in '75

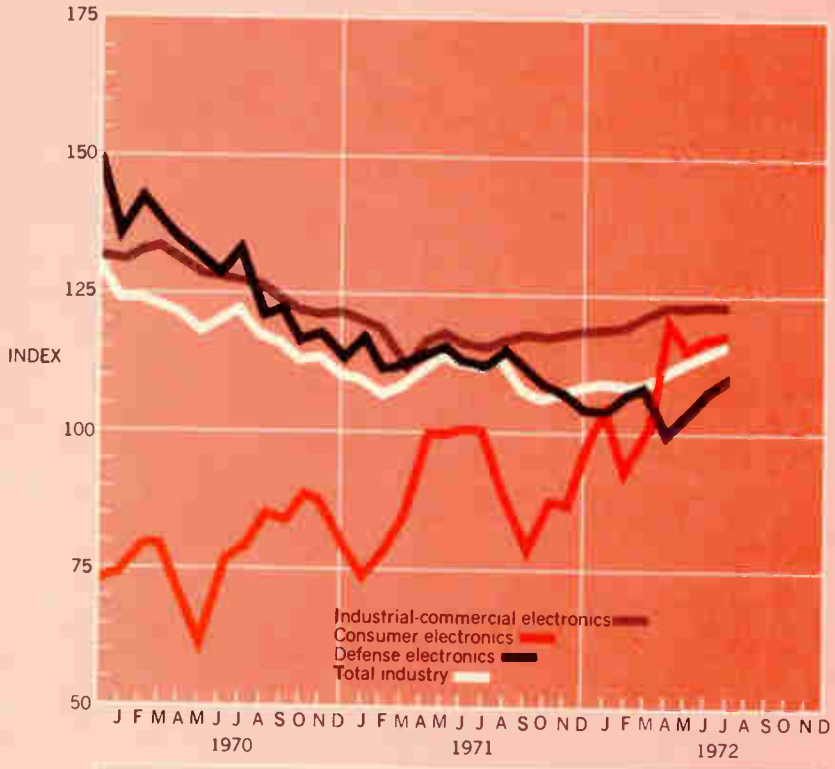
Laser communication with satellites—the subject of much hopeful discussion in the past—is due to become a reality in 1975. A contract for more than $5 million has been awarded to ITT Gilfillan by NASA to develop an experimental, two-way laser communications system for the ATS-G applications technology satellite.

The first such equipment on a satellite, it would be used primarily for studies of laser propagation through the atmosphere, with interest also in extending the system to allow the synchronous satellite to communicate with lower satellites and spacecraft like the space shuttle.

Lasers are especially attractive for communicating from space because of the very high data rates, spectrum saving, and security they offer. The initial experiment will be at 30 megabits per second, a safe low rate since the experiment isn't designed to test data rates, says Robert Graham, Jr., engineering section manager at Gilfillan in San Fernando, Calif. Operational systems could be expected to carry much higher rates.

The spectrum savings and security are the result of a narrow beam. Even after traveling 22,000 miles from synchronous orbit, the beam illuminates a spot only 1,000 feet in diameter. Thus, many different systems could operate on the same frequency simultaneously if the beams were pointed in slightly different directions. Likewise, no one outside the small spot can intercept the signal, an obvious advantage for confidential data. The antenna (telescope) is also very small compared to that of the conventional microwave system, only 5 inches in diameter.

Off the shelf. Though this experiment is a first, it is a low-cost effort and will use available equipment. The red helium-neon laser in the satellite will be the first such laser used in space, but has already undergone extensive qualification. The green ground-based argon laser is a standard product. Both lasers will be modulated with electro-optic



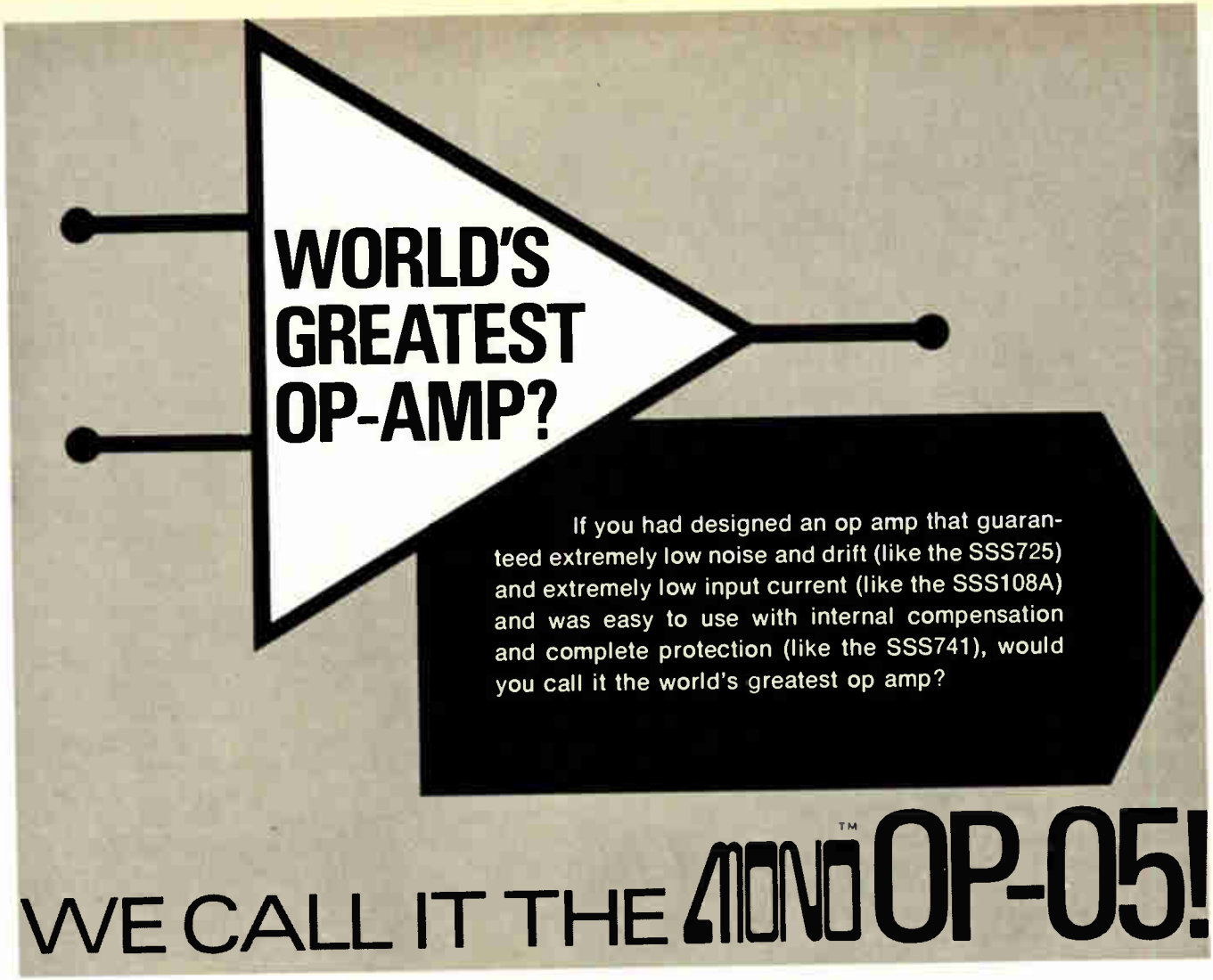
Electronics Index of Activity

Sept. 11, 1972

July's preliminary data indicates that the index is maintaining the mild upward trend begun in the spring. Defense electronics, with orders still rising, was the biggest July gainer—up 2.5%, leaving it 0.8% ahead of its July 1971 level and continuing to wipe out the losses of late 1971 and early 1972. Consumer electronics posted a 0.5% monthly gain. And while industrial-commercial activity was off slightly, that area still stands 5.4% ahead of its year-ago figure.

Segment of Industry	July '72	June '72*	July '71
Consumer electronics	118.4	117.8	102.4
Defense electronics	111.0	108.3	110.1
Industrial-commercial electronics	123.9	124.1	117.6
Total industry	116.3	114.8	111.1

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



Here are the facts on the new monoOP-05 Instrumentation Operational Amplifier:

	monoOP-05	monoOP-05EJ	monoOP-05CJ
V_{os} Max (mv)	0.5	0.5	1.3
I_B Max (nA)	3.0	4.0	7.0
R_{in} Min (MΩ)	20.0	15.0	8.0
Noise Voltage Max (μVp-p)	0.6	0.6	0.65
TCV_{os} Max (μV/°C)	1.0	0.6	1.5
CMRR Min (db)	114	110	100
Slew Rate (V/μsec)	0.25	0.25	0.25
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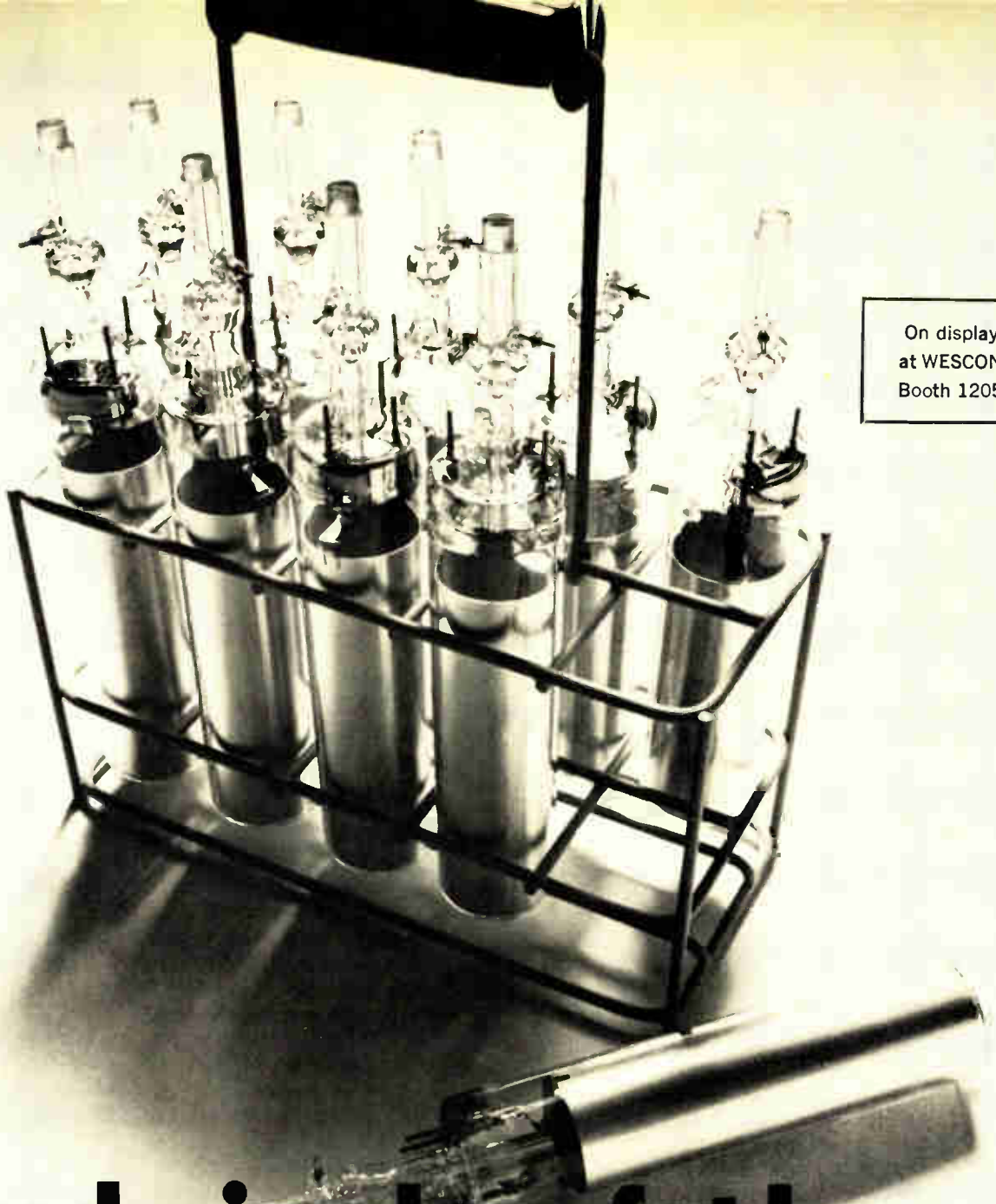

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switches. The detectors will be standard image dissectors, and the communications detectors standard photomultiplier tubes. Ground locations will be an observatory on an 8,500-foot Arizona mountaintop, below sea level in Death Valley, Calif., and Huntsville, Ala.

Though tracking might seem a problem due to the narrow bandwidth, Graham says available techniques now make it possible. In fact, Gilfillan, which absorbed ITT Aerospace's electro-optics group early this year, is now engaged in experiments with similar equipment in a WB-57 reconaissance-type aircraft flying at 60,000 ft, or above 95% of the earth's atmosphere.

The experiments, conducted by NASA's Marshall Space Flight Center, also use a helium-neon laser aloft and an argon laser on the ground. Data transmitted is either 30 Mbit random word streams or telemetry signals of the aircraft's performance.

"The experiment already has had significant payoffs," says Joseph L. Randall, chief of the applied physics branch at Marshall's astrionics lab. For example, it has shown that on-off beaming is better than polarization techniques. □

Medical Electronics

Computer ousted as heart monitor

One way to monitor the condition of a heart quickly and accurately is by video fluoroscopy—with a computer to calculate the pumping of the left ventricle, a sign of a heart's efficiency. Now, a group at the National Institutes of Health has found an even quicker way, which doesn't need a computer at all.

The new method is based on the raster scan technique because only a portion of each raster scan line actually images the ventricle. Through a series of integrator circuits, the voltages proportional to the lengths of those portions are totaled. Then, explains William H. Schuette, electronics engineer with NIH's division of research services in Bethesda, Md., when the sum of the lines is totaled 60 times a second at the end of each television field, the result is proportional to the volume pumped by the ventricles.

Two checks can be made to insure that the video-fluoroscopic unit is picking up only the ventricle picture, Schuette says. With a radio-opaque dye flowing through the ventricle, a threshold level can be set on a detection circuit so that only the dyed ventricle image shows up. Should the dye's illumination overlay the spine or part of the rest of the heart, however, an image from a second camera can be superimposed and an electronically generated silhouette can be derived by mixing the results of the two cameras.

Cylinder. The concept assumes that the ventricle is a cylinder whose volume, made up of the individual scanned lines, is equivalent to the pumping volume of the ventricle. The cylinder is formed with a cross-hatched grid. During each scan, a voltage pulse of constant amplitude is generated when the density exceeds the threshold level. An integrator circuit sums the pulse length and is reset when the scan reaches the right border of the ventricle cavity and the pulse disappears. A second integrator circuit integrates the output and, just before it is reset, transfers its output to a sample-and-hold circuit. That circuit provides a continuous analog voltage proportional to the ventricular volume. The information is fed to a chart recorder also displaying electrocardiogram and blood pressure information.

"Before, you had to get the length and width of the image and then go to a computer to cough up the volume," Schuette says. "This way you can integrate the lines as you go." The real-time function is important medically, he adds. The results also can be videotaped for later analysis.

Parts. The beauty of the system is that almost any well-equipped medical center already should have the equipment to build a unit, Schuette says. His division produced the unit with the National Heart and Lung

Institute for about $2,000. Another advantage is that the same idea can be used with video-microscopy to measure cell bodies. □

Wheelchair takes voice commands

Engineers at Texas A&M University are developing a voice-controlled wheelchair for the nation's some 60,000 quadriplegics whose spinal cord injuries make them totally or partially dependent on others for daily maintenance. And unlike earlier tongue-switch models, or the NASA-developed sight-switch-controlled models, the Texas chair's solid-state control system appears to present minimum interference with such activities as eating.

Voice control. Electric wheelchair is controlled by hums picked up by the throat microphone.

What's more, its price is reasonable—perhaps as low as $150 plus chair in production quantities, estimates Paul H. Newell Jr., associate dean of engineering and the system's architect. The control system is now being evaluated on two electric wheelchairs by the Veterans Administration Prosthetics Center in New York City.

Basically, the user hums a tone into a dynamic throat microphone to control the direction of the wheelchair. As long as he sustains the tone, the chair will move in a direction determined by the frequency of the tone. "We found out right away that perfect pitch is rare," says Newell, "so we put an inexpensive frequency meter on the side of the chair." Patients, however, generally need the meter only the first 10 minutes of the day to learn the pitches, he says.

The meter displays frequency bandwidths of about 25 hertz for forward, reverse, right, and left, as well as overlaps to allow commands like forward and right, and forward and left. The circuitry protects the user from accidently activating the wheelchair's motors during normal speech—it takes 0.75 second of sustained humming to initiate action, although changes in the pitch and therefore the chair's direction, will register within 0.25 s. The control logic also will disable the decoding circuits if the input signal is stopped for more than 0.02 s.

The output of the microphone is coupled to a bandpass amplifier and Schmitt trigger combination that feeds to a digital counter and comparator circuit. The counting period is controlled by an oscillator that allows an 0.25-s count. The oscillator frequency is externally controllable, so that the range of control frequencies can be altered. □

Computers

LSI keeps rent low for Four-Phase

When Four-Phase Systems Inc. announced its LSI computer system IV/70 about two years ago. many industry observers speculated that the idea of employing large, complex MOS circuits to put a lot of computing power in a small package would soon be copied. But while this may yet come true, so far only one other system like it has arrived on the market—and that's the Cupertino, Calif. firm's new IV/70 model 7002.

Out front. Like its predecessor, the 7002 is a clustered-cathode-ray-tube intelligent-terminal system that employs some of the most advanced MOS LSI circuits in the industry. The first new system was installed in June for use in Western Union's nationwide information services computer system for telegram entry, editing, and transmission. Four-Phase has orders for 80 more.

Commenting on the new system, Lee Boysel, Four-Phase president, says: "The production economies which we have achieved through extensive use of LSI circuitry make it possible for us to lease typical disk-based CRT systems complete with CPU, high-speed line printer, and remote bi-sync communications for less than the monthly rental of an IBM 270 display system alone."

The basic system combines a cluster of up to 32 12-inch, 1,152-character CRTs with keyboards and a general-purpose computer that can have up to 98,000 bytes of directly addressable semiconductor memory. (The older system can handle a maximum of 16 terminals). The all-LSI CPU contains new high-speed commands for decimal arithmetic and data string manipulation that reduce byte processing time by 80% from the older system.

Eleven chips. The 7002 CPU consists of II LSI chips on a single-printed-circuit board. All of the LSI circuits, including the memory, are made with conventional high-threshold p-channel metal-gate MOS. The CPU is made up of three 18,000-word read-only memories that contain the instruction set, three logic chips, three arithmetic chips serving as storage and address registers, an arithmetic logic chip that sets up data for the decimal math chip, and the decimal math chip itself.

This last chip, the largest of the 11, measures about 280 by 250 mils

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(70,000 square mils) and contains over 7,000 active elements. It is so big that the patterns could not be put on a single mask and had to be split into quadrants. Thus, for each mask, the wafer had to be exposed four times and the patterns exactly matched. The memory is made up of 2,048-bit chips, mounted 48 to a card. Eight cards make up the maximum memory configuration.

New family. With the basic system, the company introduced new software and a new family of peripherals. The latter includes a 50-million-byte disk file (similar to a double-density 2314), a 600-card-per-minute reader, and a buffered synchronous communications controller.

The new software for the model 7002 includes a disk operating system. Cobol compiler, plug-compatible simulators for IBM's 3270 and 2260 display systems, and an enhanced multiterminal source data entry package with magnetic tape, binary synchronous communications, and IBM channel output options. All Four-Phase software is provided without charge, and programs written for the older model 7001 processor are compatible with the new system.

In on-line operation with the 2260 simulator program, one 7002 can serve as a replacement for up to four local or remote IBM 2260/2848 display systems with typical monthly savings from 40% to 60% on a similar one-year lease. For shared processor data entry with magnetic tape output, the system can be configured with all editing and validation features for less than $100 per terminal per month with a one-year lease. All lease prices include maintenance, systems engineering support, and systems education service.

Monthly rental for a typical system with a 72,000-byte CPU, 50-million byte disk file, high-speed line printer, bi-sync communications, and four 1,920-character CRTs with dual intensity and audible alarm is under $2,000 for three years. □

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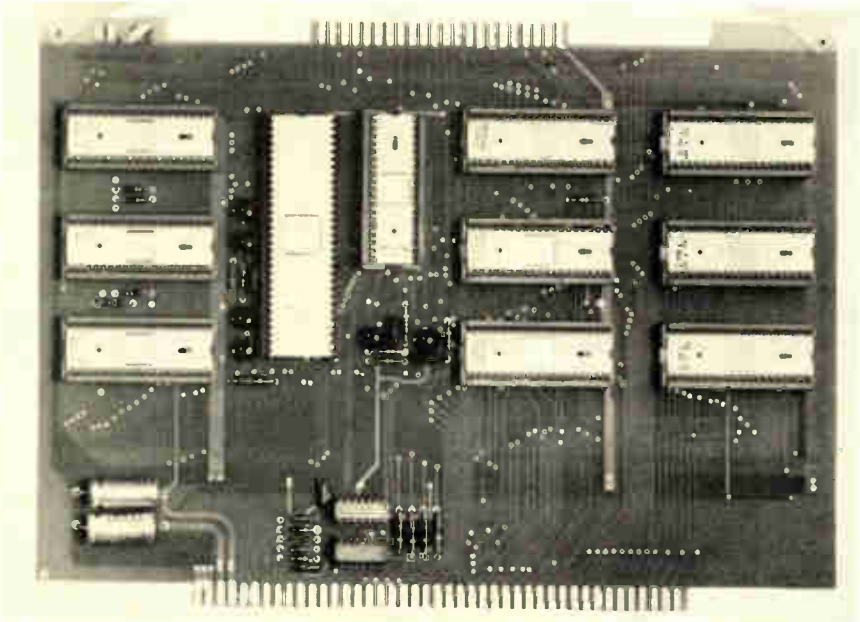
Integrated. Four-Phase Systems' new 7002 central processor features 11 chips on this board. Decimal math chip is largest of all and had to be made with four matched masks.



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Electronics review

alone would be dramatic—and that's the goal of Alan C. Kay of the Xerox Corp.'s Research Center in Palo Alto, Calif. Kay has an idea for such a computer-aided-instruction system that he calls Dynabook, and he believes it could be a commercial reality in the next few years.

The notebook-sized Dynabook would outwardly consist of a keyboard and a liquid crystal display capable of showing at least 4,000 printing quality characters. It would be about 9 by 12 inches, weigh 4 pounds at most, include a one-chip LSI processor for stand-alone computation, and 8,192 words of solid-state random-access memory. Large files would be stored in cassettes.

Price of a TV. Counting on the price declines characteristic of the semiconductor industry and the potentially widespread use of the device, Kay estimates that the Dynabook could soon be produced for about the price of a color TV set—about $300 for electronics and another $200 for packaging, cassette drive, and input-output devices like the keyboard and display.

The Dynabook's probability of success depends on the truth of the theory behind it—that in educating one's computer, one will educate oneself. In order to program a computer to do a task or play a game, the user has to understand the concepts underlying the task or game. And so even the toughest kid on the block, if he wants to play space war with the other kids. has to learn Newton's laws, mathematics, and other subjects, some with the aid of a teacher and much by himself.

Kay envisions Dynabooks also plugging into library computers and so extending the reach of today's libraries. A 500-page book could be stored in a cassette within a few minutes, he says, and meanwhile the Dynabook's umbilical cord would be recharging batteries.

Booksellers might offer access to new titles through a slot machine approach, so Kay does not feel that the concept would endanger the publishing industry. Instead, it might make scarce titles easier for the reader to find, because booksellers would only have to reserve memory space instead of carrying large physical inventories.

Beyond childhood, the Dynabook could: couple into corporate information systems and inventory control data bases; emulate dictating machines for executives; act as personal notebooks; and in general do almost everything that a pencil and paper would do today.

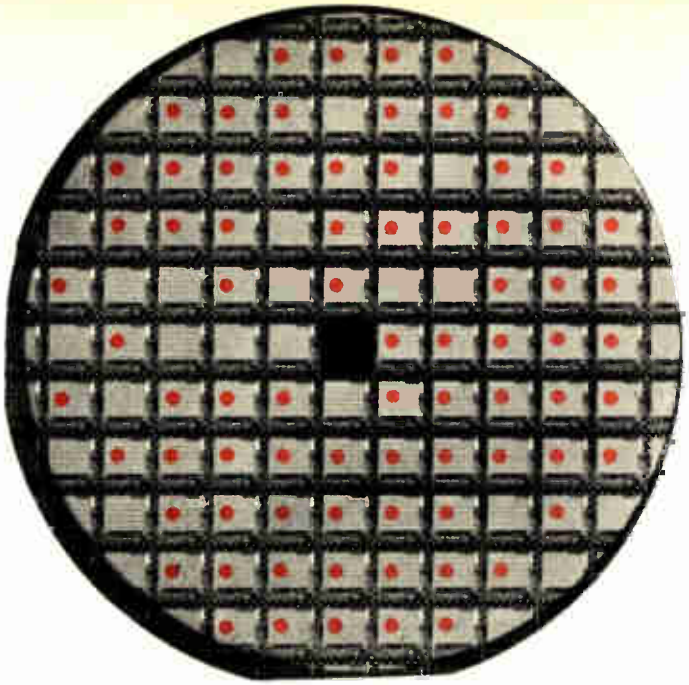
Is this blue sky? Not to Kay: "The software knowledge, the computer language design philosophy and user interface ideas are at least five years old," he says. "Power, packaging, and weight considerations all are drawn from existing technology. And the interactive computer teaching approach is undeniably good. The only hangups are the size of the liquid crystal display, the price estimates, and my own guesses about how much can be done on an 8,000-word machine like the Dynabook. But in view of the Dynabook's market potential and educational value, I say, let's build it." □

Industrial electronics

Holographic test unit can be rolled around

The first portable holographic camera won't exactly fit in a pocket, but it should make nondestructive holographic testing possible for users who aren't laser experts. The new system, made by the Korad department of Union Carbide Corp., includes a tripod-mounted camera head, a power-supply cabinet and water-cooling system. It can be rolled around easily for use in production areas, as well as in laboratories. On the other hand, present techniques for making holograms require granite vibration isolators and critical arrangements of laser and optical components.

Stuart H. Zuck, marketing manager of the Santa Monica, Calif., facility, says that the camera will open new doors to holography: "In the early days, lasers were used by people who were experts in their use. Now they're getting into areas



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where users don't care whether they're using lasers or sledge hammers: they just want to do a job. The camera is ideal for them because you simply point it at an object, take two exposures, and you have a hologram."

Zuck foresees applications in both reflective and transmissive holography. The reflective technique, which he predicts will find wider use, can be used to detect flaws in structures, composite panels, honeycomb materials, pressure vessels, tires—and microcircuits. Transmissive holography provides three-dimensional records for applications that include flow visualization, plasma diagnostics, electrochemicals, and ballistics, where the laser's 20-nanosecond exposure time can freeze moving projectiles on permanent holograms.

Zuck attributes the practicality of the system to the use of a high-power ruby laser as a light source, rather than the conventional helium-neon laser. A HeNe laser, with perhaps 50 milliwatts output, requires an exposure time as long as a few seconds, necessitating exceptionally rigid mounting.

The pulsed-ruby laser in the Korad system can have an output as high as 100 megawatts; hence, the 20-ns exposure. The camera head is designed to accommodate different lasers for different requirements. With a standard single-pulsed model, the camera will holograph fringe-free depths of up to 2 meters. Laser outputs up to 10 joules are available, with interpulse separations from 20 ns to 10 ns. The mounting bed contains provision for numerous optical variations.

HeNe option. The system also can reproduce holograms by means of an optional helium-neon laser mounted beneath the camera. It can even be used to reconstruct the images during recording, a feature for which Korad is seeking a patent. The camera with laser is priced at $20,000 to $40,000, depending on capability and options. □

For the record

Optel, Solitron in C-MOS deal
Optel Corp. is deepening its commitment to digital watchmaking [*Electronics*, May 22, p. 59]. The Princeton, N.J., optoelectronics company has contracted to purchase $1,350,000 worth of C-MOS circuits from Solitron Devices Inc., Tappan, N.Y., beginning in December.

DEC cuts more prices
The decision to make core memory and new peripheral equipment in-house has allowed the Digital Equipment Corp., Maynard, Mass., to drop prices on nearly every computer system it makes—including, now, the DECsystem-10 line. DEC's largest mainframe series, the 10 lines have been cut in price from 15% to 35%.

Also, a new price slot has been filled with the DECsystem 1040. With its price dropping from $531,000 to $387,000, it now fills a gap between DEC's larger PDP-11/45 medium-scale computer installations and the 10 series. The 1040 includes as unusual standard equipment both disk and tape stores, a 300-card-per-minute reader, a 425-line per-minute printer, a real-time clock, and communications equipment for 16 local lines.

MIT gets Trident guidance
The Navy's proposed long-range Trident ballistic missile for use in new submarines of the same name will get its guidance system from MIT's Draper Laboratory, developer of virtually all U.S. ICBM guidance packages. MIT has been funded with $21.3 million in two cost-plus-fee awards.

Computer network
The National Science Foundation is moving ahead with plans for a computer network to link engineers, scientists, and educators in industry, Government, and universities. Planned are $2 million in fiscal 1973 awards to examine problems of such a network.

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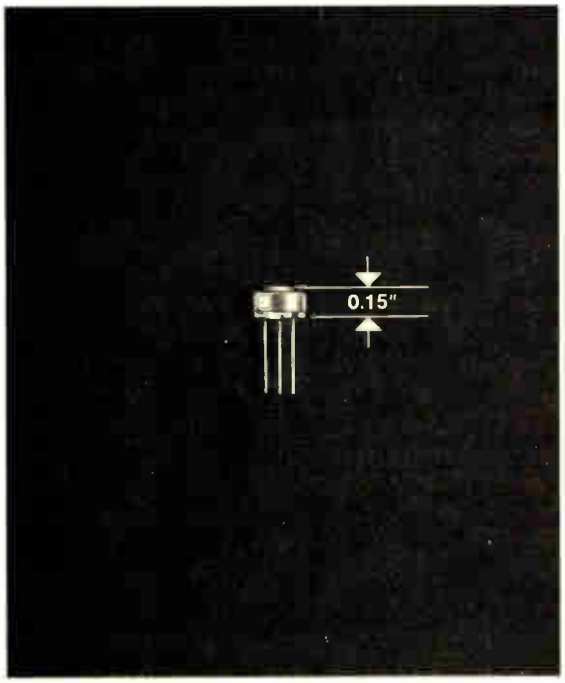

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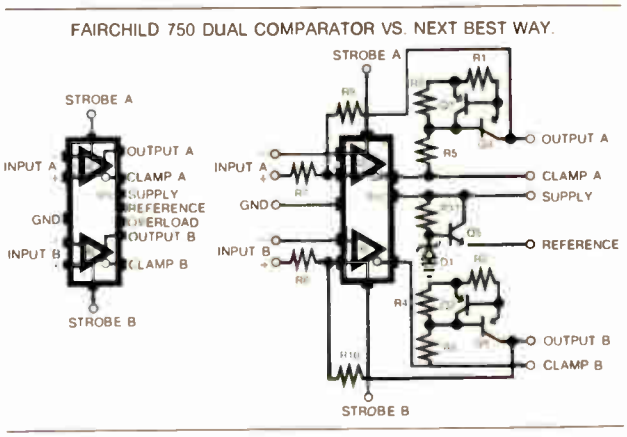

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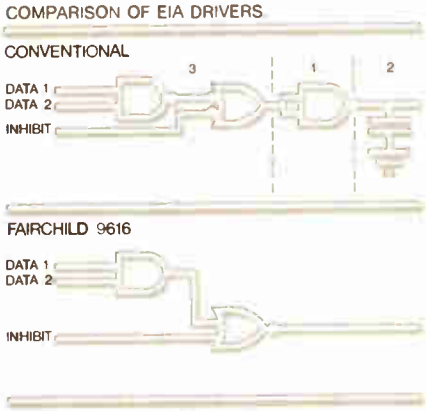

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Model 7110 is priced from $1,695 including 100 mV full scale and ratio ranges. Ask your local Scientific Devices office for technical data or contact: Concord Instruments Division, 888 Galindo St., Concord, CA 94520. Phone (415) 682-6161.

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Washington newsletter

DOD takes more steps toward automated hospital

The Defense Department is moving ahead with development of a **state-of-the-art automated hospital, which could have a "mind-boggling" electronic content,** says one knowledgeable industry source. DOD soon will authorize the Navy to formulate engineering selection procedures, says a DOD official, and the Air Force recently awarded contracts to study the hospital size to Westinghouse Electric Corp.'s Health Systems Division and Benham, Blair and Affiliates, an architect-engineering firm. The studies, due Nov. 1, will form the basis for design competition early next year and for concurrent **development of the computer-based medical and management systems** to be used.

The hospital, which will be built at Travis Air Force Base in California, will be "an excellent test-bed for the entire health industry," says the industry source. Depending on size, **it could run to $60 million, with development of the computerized information system alone "a big chunk" of the add-on costs,** he says. The two-year construction is due to begin in early 1974, says DOD [*Electronics*, June 21, 1971, p. 32].

Igloo White flop spurs new Air Force effort

The Air Force is privately **unhappy with performance of its Igloo White air-dropped vehicle-detection sensors** in Southeast Asia [*Electronics*, March 15, 1971, p. 114]. Since the transfer of the system's operation from Laos to the demilitarized zone separating north and south Vietnam, it **failed altogether to detect tanks and trucks rolling across that border during the last major north Vietnam assault** earlier this year.

Now an embarrassed Air Force is quietly **anticipating mid-September responses from industry "for development and evaluation of a new concept** for location and identification of wheeled and tracked vehicles." Rome Air Development Center is directing the effort.

Navy, Air Force seek radar, EDP R&D sources

New research and development source lists are being compiled by: the Air Force Electronic Systems division, Hanscom Field, Mass., for **a large over-the-horizon (OTH) backscatter radar in the 3-30-GHz range** to be ordered next July for the 414L continental U.S. OTH program; the Naval Electronic Systems division for a study to determine **optimum computer communications for future Marine Corps command and control systems;** the Naval Ship Systems Command for design, development, manufacture, test and support of **a major new antisubmarine warfare communications system** called Ships Acoustic Modem and Controller (Samac).

Addenda

Westinghouse Electric's Aerospace division, Baltimore, is getting new Naval Air Systems Command money for engineering systems analysis, design and development of a breadboard advanced Visual Target Acquisitions Systems for pilots employing a helmet-mounted sight. In the past, Honeywell has been sole supplier of such systems, by which an on-board computer automatically directs aircraft missiles in the direction that the pilot is looking . . . **Competitive prototypes of the Army's UTTAS helicopter** (for Utility Tactical Transport Aircraft System) **will be built by Boeing's Vertol division and United Aircraft's Sikorsky operation.** Their awards of $91.3 million and $61.9 million, respectively, nosed out Textron's Bell helicopter.

Washington commentary

Electronics and politics in Mexico

Long before that dour cleric John Calvin came along some 400 years ago and equated work with virtue, thus siring the Protestant Work Ethic that made labor the freeman's pride, the ancient Greeks had a different view of work, something they reserved primarily for slaves. The Greek word for "work" was the same word they used for "sorrow," which conveys quite well how they felt about it.

The distinction is worth noting because now it appears that the continuing expansion of American-owned electronics manufacturing operations in Mexico, intended to enhance the concept of Calvin by creating jobs where there were none before, has as much potential for sorrow as it has for pride within the working community there. At least that is what American Embassy at Mexico City has reported to the Department of State (see p. 65).

A delicate relationship

By creating more jobs in cities just south of the border that runs from California to Texas, the electronics companies appear to have unintentionally contributed to the beginnings of a socio-economic upheaval in the area. President Luis Echeverria's criticisms of what his government regards as America's studied ignorance of Mexico as a poor relation are well known in Washington—he delivered them personally to President Nixon and again to Congress on a state visit earlier this year.

Thus the American Embassy at Mexico City is presumably nervous about exacerbating an already delicate relationship, and is urging State to generate some professional research on the social problems that seem to follow the establishment of new American electronics plants in the Mexican cities: an increase in prostitution and illegitimate births, deterioration of traditionally strong family relationships, and similar tensions generated by the overcrowding resulting from "heavier-than-normal migration to the border zone combined with unfulfilled job expectations."

Whose responsibility?

The fact that there has been no adequate investigation of the impact of industry on the society and economies of the border cities is something the embassy report calls "most distressing." But there is at least one Government source in Washington who questions whether the cumbersome Federal machinery—particularly that of the Department of Health, Education, and Welfare—can gear up quickly enough to perform the required social research, even though the U.S. itself is familiar with similar social ills within some of its own cities. "Look at what's happened to the Puerto Ricans who flocked to New York. The problems in northern Mexico are not that much different," he holds. "They just are not as severe—yet."

If the governments on two sides of the border cannot mount a sufficient effort quickly enough to cope with the developing problems, then who can? The suggestion of the Federal official: "Why can't the manufacturers help? It is certainly in their interest." Actually, many manufacturers are likely to challenge that view. One of their men in Washington—who also requests anonymity on the ground that "I'm not even supposed to be talking about this"—argues that "social welfare studies and things like that are, I thought, what we pay taxes for." That kind of truism, of course, is the kind of thing that makes social scientists cringe.

And it also fails to consider that U.S. electronics operations are relatively high-profit despite the unrelieved competitive pressures on U.S. components prices. Indeed, the State Department's analysis of Mexican electronics assembly operations—first generated by the low tariff advantage offered under Section 807.00 of the U.S. tariff schedule—indicates that U.S. manufacturers' margins are so high that some 50 of them "do not capitalize on these value-added duty schedules at all," while "others use them for only part of their production."

Weighing the options

Thus it is documentable that there are clear advantages for manufacturers locating electronics plants in Mexico. And there are others besides Americans who have made and are making that discovery. The question then becomes: what, if any, responsibilities do those manufacturers have to the communities in which they set up shop?

That there is no pat answer goes without saying. What needs to be said, however, is that American manufacturers operating in Mexico would do well to consider what options they have while they still have them. For there are Mexicans who can recall the plea of one of Luis Echeverria's predecessors, Porfirio Diáz, who sighed: "Poor Mexico! So far from God and so close to the United States." And it may be that one of them will one day confront industry as the technological workingman's equivalent of that California food growers phenomenon, Cesar Chavez.

—Ray Connolly

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Antenna designed to broadcast to car and portable radios

While broadcasting authorities in Europe are debating the question of frequency allocation for a Continent-wide traffic-radio network, engineers at Rohde & Schwarz have developed a new type of transmitting antenna that the company hopes will become standard, no matter what the outcome of the frequency talks.

The new antenna, designed for operation in the vhf fm radio range, can radiate horizontally, vertically, circularly, or elliptically polarized waves. Thus, it meshes better with the reception characteristics of car radios and of portable receivers.

Normal fm transmitting antennas propagate electromagnetic waves mainly in horizontally polarized form, which works best for stationary antennas, especially in hilly areas. But antennas used for car radios or portable receivers are generally vertical types because they are easier and less expensive to fabricate. These antennas, however, can pick up only a fraction of the energy contained in the incoming horizontal waves.

Interaction. That's where the new Rohde & Schwarz transmitting antenna with its multi-polarization properties comes in. Designed for operation in the 87.5–108-megahertz range, the company's first prototype version is made up of two orthogonal groups of dipole radiators resembling one H on top of another. The radiators are mounted on a 3-by-4.5-foot reflector plate to form a directional array on top of a 15-foot pole.

One dipole group, the sides of each H, consists of four vertically arranged elements; the other, the bars of each H, of two horizontal ones. Opposite and parallel dipole radiators in the array are separated by one-half of a wavelength. Their distance from the reflector plate is one-quarter of a wavelength. The array's two dipole groups have separate power feeds and are decoupled by more than 30 decibels.

With the antenna switched to its "mono" operation mode, one of the dipole groups is selected for signal propagation, producing either a horizontally or a vertically polarized wave. In "simultaneous" antenna operation, both dipole groups radiate at the same time, generating either circularly or elliptically polarized waves, depending on the relative power and phase difference.

A circular wave is obtained if the energy from each dipole group is the same and at a 90° phase difference. Elliptical polarization results when, at a 90° phase difference, the power of each group is not the same or, when at the same levels, the phase difference is other than 90°. In most cases an R&S engineer says, a circularly polarized wave would be used because that radiation mode provides better reception with vertical car antennas. □

France

Japanese seek to lower blocks to trade in France

Sony Corp. and other Japanese consumer electronics companies are gearing up for the opening this month of crucial negotiations to open the tightly controlled French market. The talks are aimed at renewing—and the Japanese hope, liberalizing—the "voluntary agreement" under which Japan agrees to hold down its electronics imports into France. Japanese businessmen in Paris say privately that the term "voluntary" is a euphemism for "bitterly disputed."

As if anticipating long and tough talks, the negotiators will begin a full six months before the expiration next March of the current three-year quota agreement. The pact was the first between the electronics industries of the two countries.

Not fair. The Japanese are disturbed by French import controls because no other major European country limits their sales so strictly. Only Italy has a similar "voluntary" agreement, but customs controls are so lax that hundreds of thousands of dollars worth of Japanese hi-fi equipment, TV sets and tape recorders move at cut-rate prices on the Italian "grey market" every year.

France keeps a tight grip on the Japanese, however, limiting TV sets to 38,000 units—of which Sony is allowed to bring in only 10,000—and limiting tape recorder imports to 85,000. Sony is permitted only 9,000.

What else? Yet Sony and other Japanese companies prefer the voluntary agreement between the French electronics industry federation and Japanese industrial trade associations to the alternative—government-to-government agreements. The latter would almost certainly be even stricter.

Paul-Roger Sallebert, the head of the French electronics federation, sees the voluntary quota agreement as a legitimate tool that avoids "wrecking the French market." "We try to be flexible," he says, "adjusting the quotas upward from year to year. It seems the best way to avoid disorder in the market place." □

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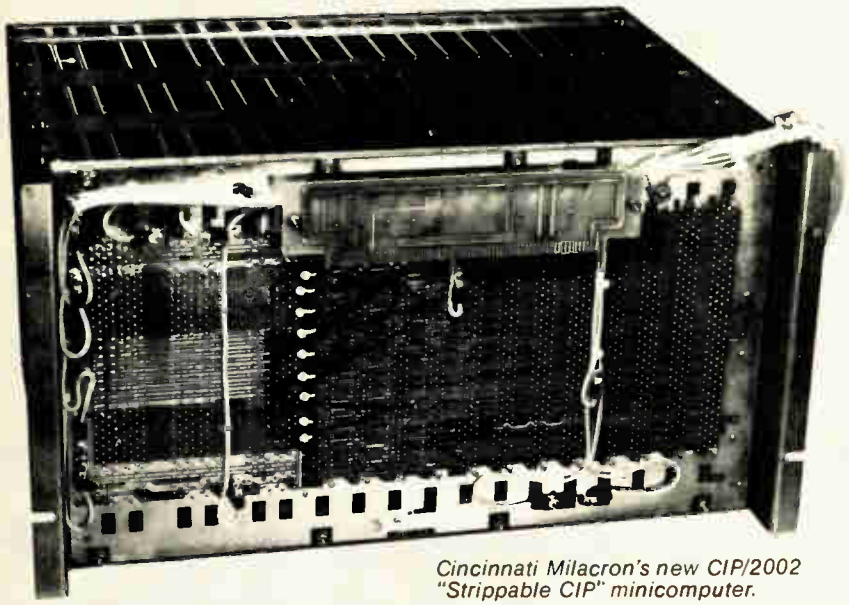

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Little fallout for electronics at Hawaii summit

The U.S. electronics industries are unlikely to benefit from the reportedly limited trade concessions made by Japanese Prime Minister Kakuei Tanaka to President Richard Nixon in their recently concluded Hawaii meeting. This is the judgment of Government insiders familiar with the talks—specifics of which were largely worked out before the two leaders met. **American entry into the Japanese computer market in particular proved a stumbling block despite increasing and generally effective U.S. pressures on Japan to curtail its consumer electronics exports to America.**

One Federal economist familiar with the preliminary discussions says the adamant Japanese have offered to buy a package of U.S. goods, largely raw materials, over a period of years but with "much of the money pre-paid this year." This "will make the President look good for re-election and offset somewhat our tremendous deficit" with Japan. But the source notes that inflation, however gradual, will "boost our costs on these products in future years" when the U.S. has agreed to deliver on 1972 terms. **Japan reportedly will provide its own avionics for the wide-bodied jet transports and helicopters expected to be part of the deal.**

Japan's broadcasters look to U.S. for satellite launching

American rockets may launch Japan's initial broadcasting and communications satellites. Nippon Hoso Kyokai (NHK), Japan's public service broadcaster, and the Nippon Telegraph and Telephone Public Corp. have submitted plans to the Ministry of Posts and Telcommunications to ask the U.S. to launch satellites weighing 250 to 350 kilograms in 1976 **because they are tired of waiting for domestically produced satellites to be orbited for their use.** Reportedly the telecommunication minister is against the idea.

Meanwhile, the National Space Development Agency has disclosed that contracts will soon be concluded with Mitsubishi Heavy Industries and Ishikawajima-Harima Heavy Industries for the manufacture of the body and engine of the first stage of the planned N rocket, which is to be used to launch Japan's first domestically produced utility satellite in 1975.

British plan test of data-packet switching network

The British Post Office plans to open an experimental high-speed data network in about two years. The system will operate at 48,000 bits per second, using packet-switching data-handling techniques. The network will work by breaking messages up into packets, each having a maximum length of 256 8-bit bytes, plus 10-byte header and two-byte error check. **Each packet is dispatched as it's completed, and consecutive packets take the best route to the destination at the time of dispatch.** Thus, different packets may go by different routes. On arrival, packets are reassembled into the right order. The National Physical Laboratory, which developed packet switching, maintains the method is more efficient for carrying computer data than are dedicated-link methods, because the packets marry more easily with the byte grouping modes in which computers generally work. **Furthermore, link failures are less of a problem, because packets can go by any route.**

Initial trials will link London, Manchester, and Glasgow in a

triangle. Users will be able to use either their own computers to build up, dispatch, and receive packets via post office packet-switching exchanges or a special format on a teletypewriter to punch in their messages to the computers at the packet-switching exchanges. Post office men emphasize that the experiment is to test packet-switching methods, and doesn't imply permanent commitment to them. Thus, users will be charged very low fees at least for the first year of operation.

Liquid-crystal line bows in France

The French display firm Orega-Sifte has decided to launch a line of liquid crystal products on the European market this fall, **starting with a four-digit display designed for electronic instruments.** Samples already are being examined by some potential customers, and larger quantities of samples will be available in October or November. Orega-Sifte expects to begin full production in January, with new versions of its display developing rapidly as customers make known their needs. The firm says it has conducted an extensive market study in Europe and **foresees a 1973 market of about 150,000-200,000 digits.** "But the big fight will come in 1974-75," says a company commercial man," when the Americans come in and other Europeans join the fray."

Japanese company makes planar light-emitting diodes

Using a planar process, the Sanken Electric Co. has started making gallium arsenide phosphide light-emitting diodes **at reduced production costs and with increased light-emitting efficiency.** Their process starts with the usual n-type epitaxial layer on an n-type gallium arsenide phosphide substrate. Silicon dioxide is deposited by chemical vapor deposition and then etched to remove oxide where p regions are required. This is followed by deposition of a porous oxide layer and then a porous oxide layer doped with zinc. Subsequent heating causes the zinc in the doped oxide to diffuse into the epitaxial layer and form pn junctions. **The oxide layers prevent loss of the volatile phosphorus and arsenic.**

With a current of 20 milliamperes, typical chips **have a brightness of 700 foot lamberts,** compared with 200 to 500 foot lamberts for diodes available on the market. The company expects to reach a monthly production capacity of 50,000 to 60,000 units by year end, and estimates price at that time in quantity will be about 16 cents a unit. Later it plans to offer seven-segment displays.

Network to monitor ocean pollution proposed in Sweden

A Swedish royal commission on oceanic resources has proposed that **Sweden develop a system of automatic oceanographic and meteorological stations at a cost of between $1 million and $2 million. The commission proposed locating 10 stations in the Baltic Sea and the Kattegat, the narrows that lead to the Atlantic Ocean.** The stations would transmit data by telemetry to a central computer on land, operated by the state meteorological service. The commission proposed that the stations be designed so that they could be used to gather data connected with pollution, and that funding for research and development of automatic stations be increased. Such R&D is now being done by the Meteorological and Hydrological Institute, on a budget of only $60,000 annually. The commission wants that amount tripled.

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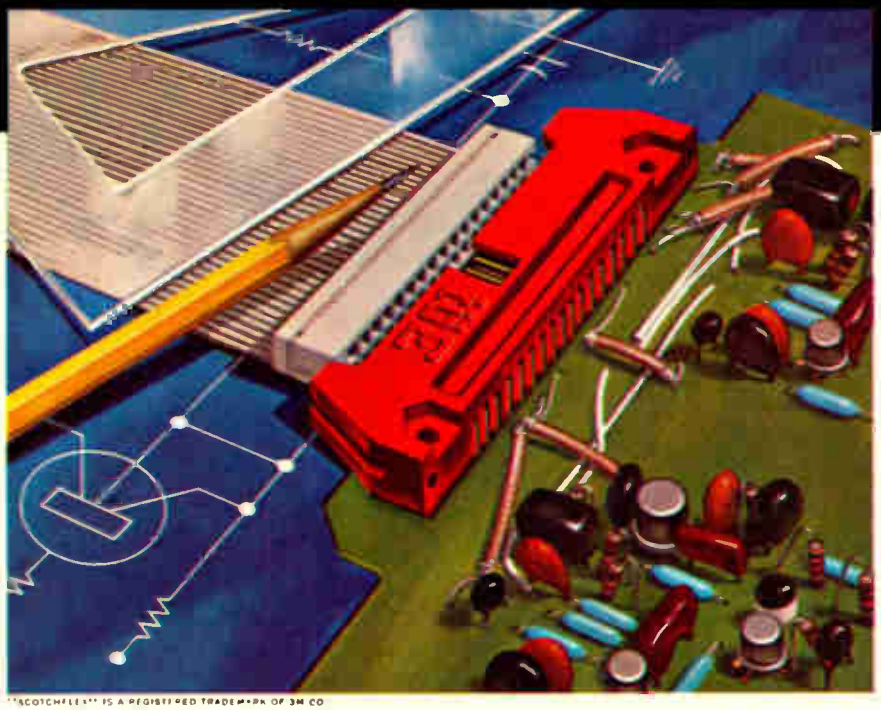

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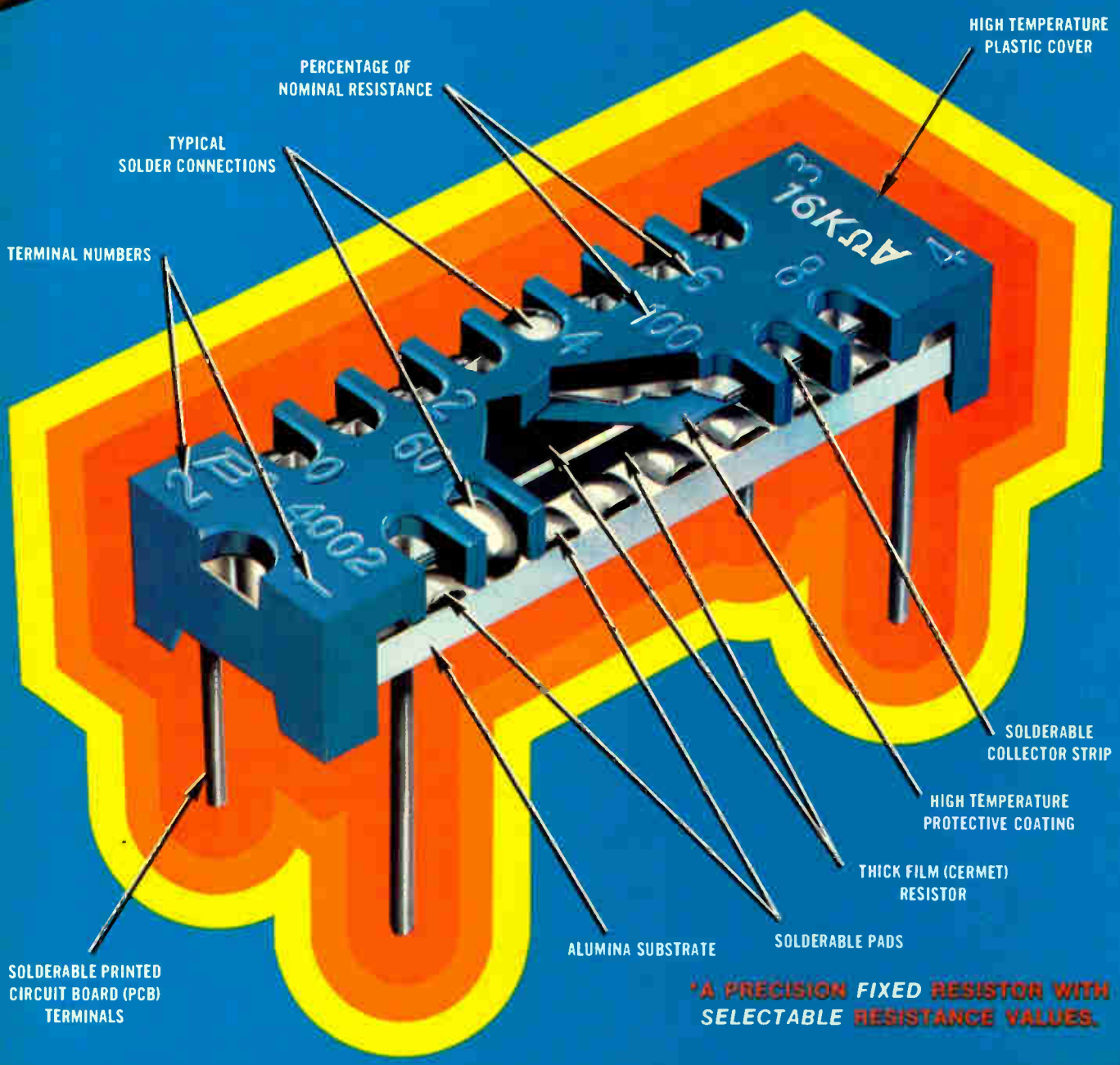

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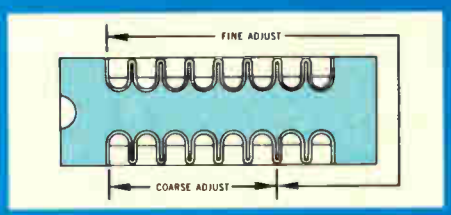

Figure 1


Figure 2


Figure 3

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7401	.26	.25	.23	.22	.21	.20
7402	.26	.25	.23	.22	.21	.20
7403	.26	.25	.23	.22	.21	.20
7404	.28	.27	.25	.24	.22	.21
7405	.28	.27	.25	.24	.22	.21
7406	.52	.50	.47	.44	.42	.39
7407	.52	.50	.47	.44	.42	.39
7408	.32	.30	.29	.27	.26	.24
7409	.32	.30	.29	.27	.26	.24
7410	.26	.25	.23	.22	.21	.20
7411	.28	.27	.25	.24	.22	.21
7413	.58	.55	.52	.49	.46	.44
7416	.52	.50	.47	.44	.42	.39
7417	.52	.50	.47	.44	.42	.39
7420	.26	.25	.23	.22	.21	.20
7421	.26	.25	.23	.22	.21	.20
7423	.80	.76	.72	.68	.64	.60
7425	.50	.48	.45	.43	.40	.38
7426	.34	.32	.31	.29	.27	.26
7430	.26	.25	.23	.22	.21	.20
7437	.56	.53	.50	.48	.45	.42
7438	.56	.53	.50	.48	.45	.42
7440	.26	.25	.23	.22	.21	.20
7441	1.73	1.64	.155	1.46	1.37	1.27
7442	1.27	1.21	1.14	1.07	1.01	.94
7443	1.27	1.21	1.14	1.07	1.01	.94
7444	1.27	1.21	1.14	1.07	1.01	.94
7445	1.71	1.62	1.53	1.44	1.35	1.26
7446	1.24	1.17	1.11	1.04	.98	.91
7447	1.16	1.10	1.04	.98	.92	.85
7448	1.44	1.37	1.29	1.22	1.14	1.06
7450	.26	.25	.23	.22	.21	.20
7451	.26	.25	.23	.22	.21	.20
7453	.26	.25	.23	.22	.21	.20
7454	.26	.25	.23	.22	.21	.20
7460	.26	.25	.23	.22	.21	.20
7470	.42	.40	.38	.36	.34	.32
7472	.38	.36	.34	.32	.30	.29
7473	.50	.48	.45	.43	.40	.38
7474	.50	.48	.45	.43	.40	.38
7475	.80	.76	.72	.68	.64	.60
7476	.56	.53	.50	.48	.45	.42
7480	.76	.72	.68	.65	.61	.57
7482	.99	.94	.88	.83	.78	.73
7483	1.63	1.55	1.46	1.38	1.29	1.20
7485	1.43	1.35	1.28	1.20	1.13	1.05
7486	.58	.55	.52	.49	.46	.44
7490	.80	.76	.72	.68	.64	.60
7491	1.43	1.35	1.28	1.20	1.13	1.05
7492	.80	.76	.72	.68	.64	.60
7493	.80	.76	.72	.68	.64	.60
7494	1.18	1.12	1.05	.99	.93	.87
7495	1.18	1.12	1.05	.99	.93	.87
7496	1.18	1.12	1.05	.99	.93	.87
74100	1.52	1.44	1.36	1.28	1.20	1.12

CATALOG NUMBER	ANY QUANTITY PER ITEM			MULTIPLES OF 10 PER ITEM		
	1-99 MIX	100-999 MIX	1000-UP MIX	100-990 MIX	1000-9990 MIX	10,000-UP MIX
74107	.52	.49	.47	.44	.42	.39
74121	.56	.53	.50	.48	.45	.42
74122	.70	.67	.63	.60	.56	.53
74123	1.21	1.06	1.00	.94	.89	.83
74141	1.63	1.55	1.46	1.38	1.29	1.20
74145	1.41	1.33	1.26	1.18	1.11	1.04
74150	1.63	1.55	1.46	1.38	1.29	1.20
74151	1.20	1.13	1.07	1.01	.95	.88
74153	1.63	1.55	1.46	1.38	1.29	1.20
74154	2.43	2.30	2.16	2.03	1.89	1.76
74155	1.46	1.39	1.31	1.23	1.16	1.08
74156	1.46	1.39	1.31	1.23	1.16	1.08
74157	1.56	1.48	1.39	1.31	1.23	1.15
74158	1.56	1.48	1.39	1.31	1.23	1.15
74160	1.89	1.79	1.68	1.58	1.47	1.37
74164	1.89	1.79	1.68	1.58	1.47	1.37
74166	1.98	1.87	1.76	1.65	1.54	1.43
74176	1.62	1.53	1.45	1.36	1.28	1.19
74177	1.62	1.53	1.45	1.36	1.28	1.19
74180	1.20	1.13	1.07	1.01	.95	.88
74181	5.20	4.90	4.59	4.28	3.98	3.67
74182	1.20	1.13	1.07	1.01	.95	.88
74192	1.98	1.87	1.76	1.65	1.54	1.43
74193	1.98	1.87	1.76	1.65	1.54	1.43
74196	1.98	1.87	1.76	1.65	1.54	1.43
74197	1.98	1.87	1.76	1.65	1.54	1.43
74198	2.81	2.65	2.50	2.34	2.18	2.03
74199	2.81	2.65	2.50	2.34	2.18	2.03
NE501	2.99	2.82	2.66	2.49	2.32	2.16
NE526	3.59	3.38	3.17	2.95	2.74	2.53
NE531	3.81	3.58	3.36	3.14	2.91	2.69
NE533	3.81	3.58	3.36	3.14	2.91	2.69
NE536	7.31	6.88	6.45	6.02	5.59	5.16
NE537	7.53	7.09	6.65	6.20	5.76	5.32
NE540	2.16	2.04	1.92	1.80	1.68	1.56
NE555	.98	.93	.88	.83	.78	.73
NE560	3.57	3.36	3.15	2.94	2.73	2.52
NE561	3.57	3.36	3.15	2.94	2.73	2.52
NE562	3.57	3.36	3.15	2.94	2.73	2.52
NE565	3.57	3.36	3.15	2.94	2.73	2.52
NE566	3.57	3.36	3.15	2.94	2.73	2.52
NE567	3.57	3.36	3.15	2.94	2.73	2.52
N5111	.90	.86	.81	.77	.72	.68
N5556	1.87	1.77	1.66	1.56	1.46	1.35
N5558	.80	.76	.72	.68	.64	.60
N5595	3.40	3.20	3.00	2.80	2.60	2.40
N5596	1.87	1.77	1.66	1.56	1.46	1.35
709	.42	.40	.38	.36	.34	.32
710	.42	.40	.38	.36	.34	.32
711	.44	.42	.40	.37	.35	.33
723	1.00	.95	.90	.85	.80	.75
733	1.90	1.80	1.70	1.60	1.50	1.40
741	.44	.42	.40	.37	.35	.33
747	1.05	.99	.94	.88	.83	.77
748	.48	.46	.43	.41	.38	.36

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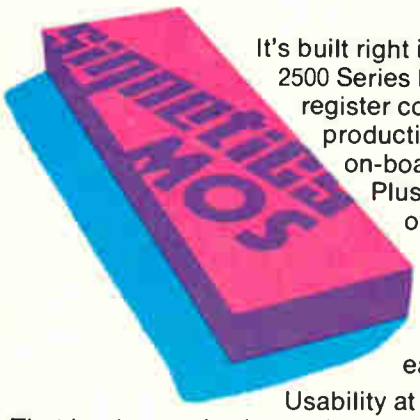

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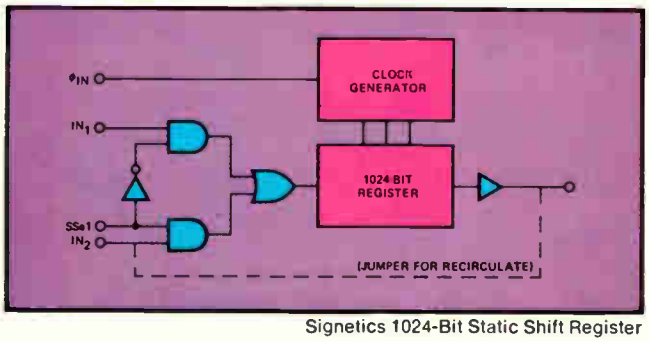

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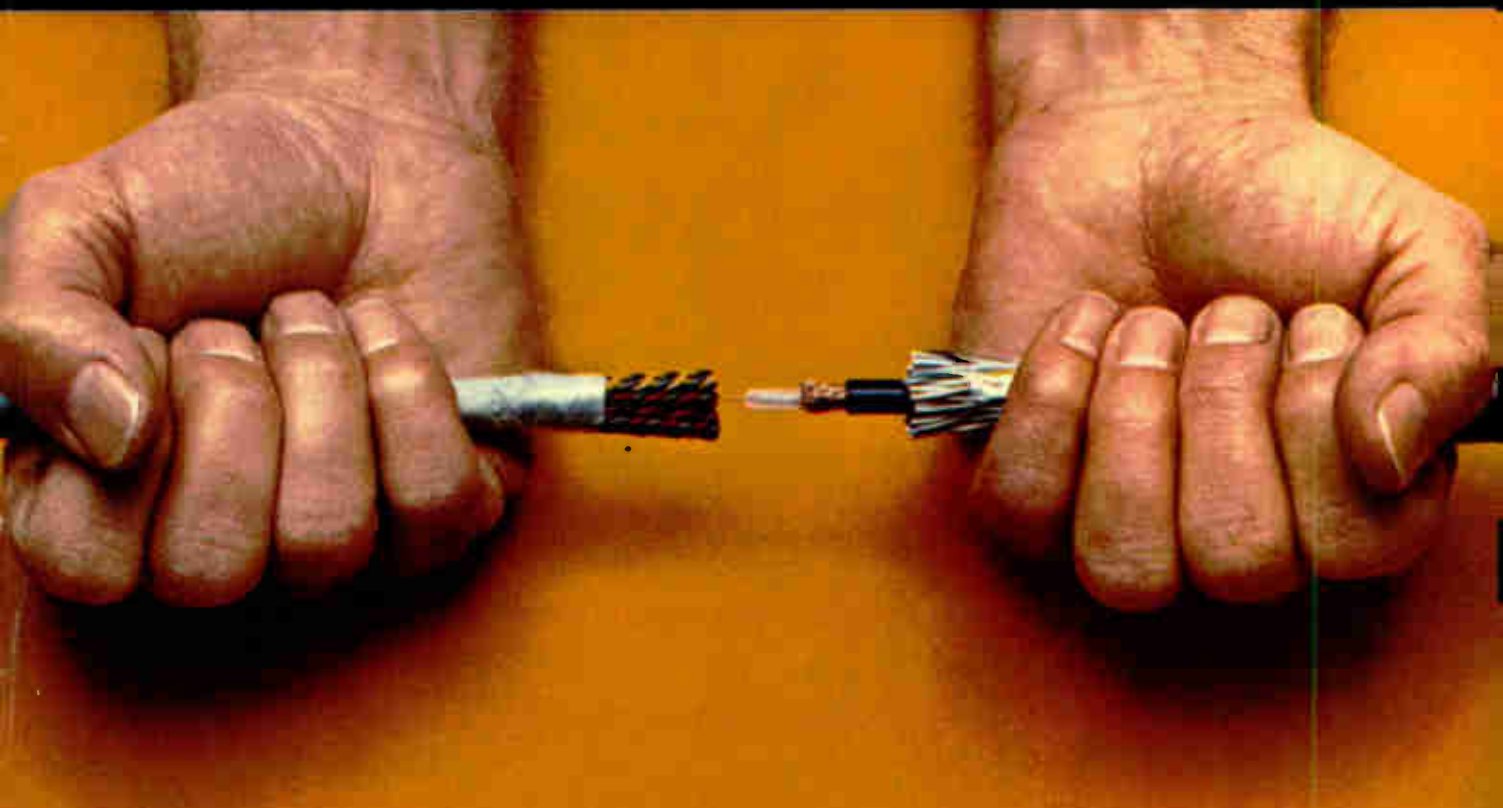

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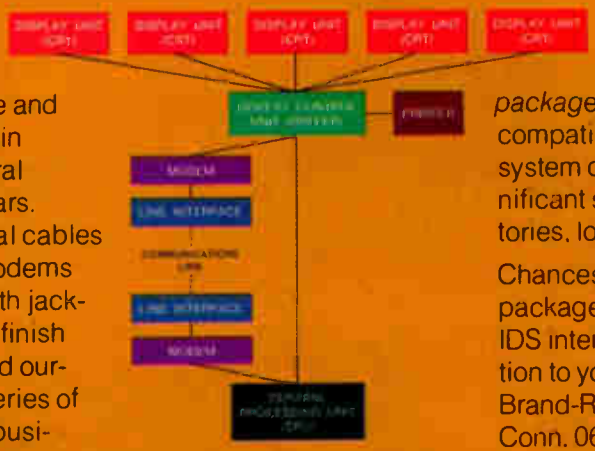

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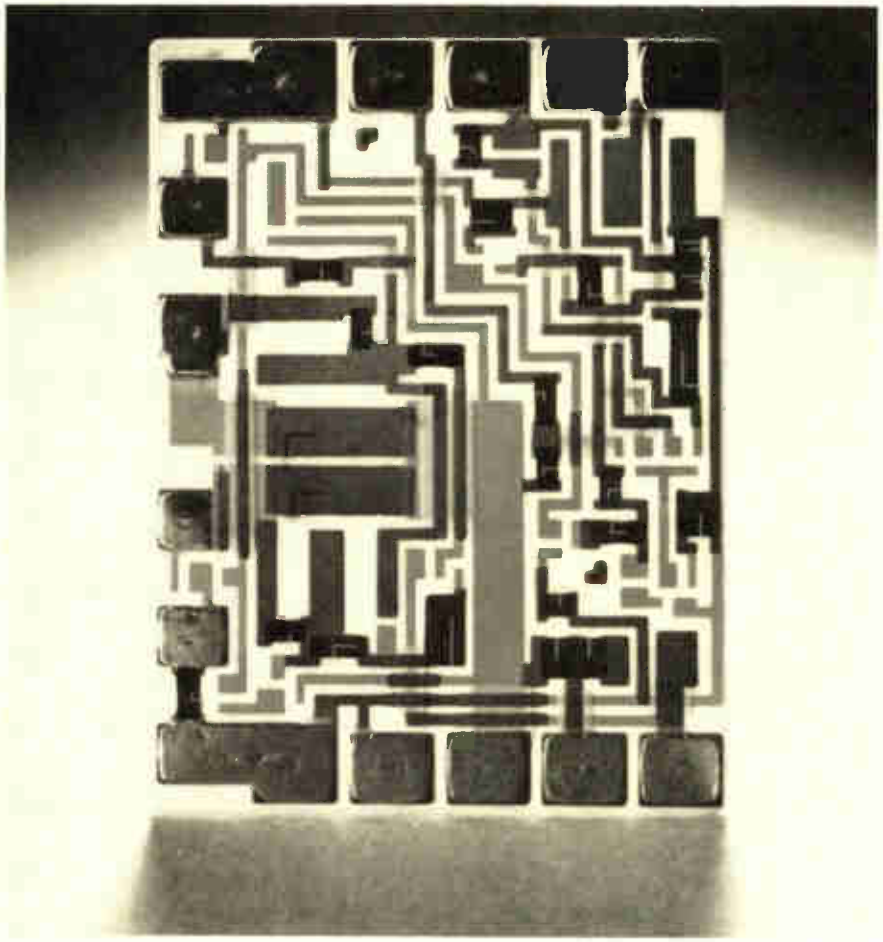

The circuit: a linear amplifier produced by RCA's Solid State Division, Mountaintop, Pa. 11 resistors are double-cut, 11 are L-cut. All trims are to 1% of nominal value or ratio. Throughput: better than 700 an hour. System datalogs before and after resistance values and deviations from nominal

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TERADYNE

Competition gets hot in Mexico

Industry growth of 29% in the year till June was led by the U.S.,
but Japanese and European entries in border cities drive some firms south

by Ray Connolly, Washington bureau manager

Mexico's electronics industries, heavily dominated by American companies, continue to expand. A hundred and fifty-two operations were reported at the end of June—an increase of nearly 29% over the 118 companies operating there last year, according to a report to the State Department by the U.S. Embassy in Mexico City. With this growth, there has been a corresponding decrease in the number of textile operations in Mexico. The Government report gives two reasons for the correlation: electronic components are not subject to demand variations, and they can be shipped by air at a relatively low cost.

Signs are that electronics in Mexico will grow even more rapidly as Japanese producers move in, as European companies explore the territory, and as more U.S. manufacturers find operations encouraged by Mexico's Border Industry Program. Indeed, electronics growth "almost necessitates the entry of competitors in order to equalize cost factors", concludes the unreleased 46-page Embassy assessment. While most companies are just south of the border, manufacturers of discrete semiconductors, integrated circuits, passive components, cathode-ray tubes, TV receivers, tuners, calculators and a variety of other labor-intensive products are beginning to expand into the Mexican heartland.

Some of them find it just too crowded in those development areas most popular since the Border Industry Program really began to boom in 1968. Tijuana, just south of San Diego, for example, contains 41 distinct electronics operations. On the east coast, just south of Brownsville, Texas, Matamoros houses 19 companies. Nogales, less than 100 miles south of Tucson, Ariz., has 18 more, while Ciudad Juarez across from El Paso, Texas, counts 13 companies, according to the State Department figures.

The biggest moves thus far have been to Guadalajara on the Pacific Coast, almost due west of Mexico City. There, Semiconductores Motorola employs 1,000 workers making transistors, circuits and relays for its parent in Phoenix, Ariz., while Burroughs de Mexico, with a force of about 600, turns out similar lines for Burroughs Corp., Detroit. Industrias Motorola at Nogales employs another 1,000 making transistors and integrated circuits, according to U.S. Embassy figures, making it the largest American operator in terms of total employment (see table).

Since late 1971, Omron de Baja California has been assembling calculator parts for its Japanese-owned parent in the U.S., Omron R&D of Mountain View, Calif., while Sony Mex de Mexico is about to begin TV receiver assembly for its new U.S. plant outside San Diego at Rancho Bernardo, Calif. "Mitsubishi is also establishing a large manufacturing operation in Rancho Bernardo and is expected to enter the border program soon," states the Embassy study, which adds that "almost all other major Japanese electronic firms and some European firms have recently visited the area to investigate assembly possibilities."

Beyond the obvious problems of crowding, excess demand for services and the relatively higher wages in the border region, however, there are more recondite rea-

Boom-town problems

Short-term, the additional jobs in Mexico may be all to the good. But, says the U.S. Embassy's latest assessment of Mexico's Border Industry Program, "we have no real idea of what the long-term effect of the program may be" for Mexican border cities. To gather such data, the State Department and U.S. Information Agency are urged to "bring this matter to the attention of appropriate institutions and social scientists," possibly for study under a Health Education and Welfare graduate research grant.

Taking an intentionally negative position, the report identifies six "peripheral effects":

- Increasing prostitution and delinquency as a result of heavier-than-normal migration to the border zone with unfulfilled job expectations.
- Rapid changes in the traditional relationship between parent and adult daughter and an increase in illegitimate births.
- Changing traditional male-female family roles with male frustration leading to greater delinquency.
- Inability of the border cities to meet demands for housing, sewage, medical care and other services.
- Limitation in the ability of some border cities to provide for inhabitants, particularly adequate water.
- Increased social tensions because of these problems, rather than a decrease through higher employment.

sons why U.S. operators are seeking out other relatively undeveloped sections farther south in Mexico for expansion. One of them is the opportunity to export to third markets.

First drawn to the Border Industry Program by the appeal of the so-called "value-added" sections of the U.S. Tariff Code—806.30 and 807.00 under which U.S. components shipped to Mexico for low-cost assembly and re-importation with duty paid only on the value added—American companies find low Mexican costs also enable them to export to third markets where they were previously unable to compete.

Thus American manufacturers seem to be doing more with their Mexican operations than simply capitalizing on tariff savings on assemblies. "Since the duty for most electronic items in only 5% to 8%, the duty savings through use of these sections (approximately 3% to 5% in added value) is often insignificant compared to the savings in labor costs." says the report, adding that "the Embassy suspects that a large majority of existing firms would not alter their present oper-

MEXICO'S TOP ELECTRONIC FIRMS

The following companies are responsible for approximately half of the total employment and probably account for much more than half of total border industry electronics production. Numbers in parentheses after cities indicate total number of electronics plants in the area.

Mexican Company	Employment	Product	U.S. Affiliations
MATAMOROS (10)			
Electronic Control Corp. de Mexico	650	Switches, controls	Electronic Control Corp., Euless, Tex.
Leece Neville	450	Fractional HP motors	Leece Neville Co., Brownsville, Tex.
NUEVO LAREDO (8)			
Transitron Mexicana	1,600	Semiconductors, diodes, harnesses	Transitron Electronics Wakefield, Mass.
Sarkes Tarzian Mexicana	750	Transistors, TV tuners	Sarkes Tarzian, Inc., Bloomington, Ill.
PIEDRAS NEGRAS (3)			
Sarkes Tarzian Mexicana	800	UHF & VHF TV tuners	Sarkes Tarzian, Inc., Bloomington, Ill.
CIUDAD ACUNA (2)			
Standard Components	800	TV tuners	Standard Kollsman, Inc., Melrose Park, Ill.
CIUDAD JUAREZ (13)			
RCA Victor Mexicana	1,200	Deflection yokes	RCA TV Components, Indianapolis, Ind.
Sylvania Componentes Electronicos	400	TV receiving tubes	GTE Sylvania, Seneca Falls, N.Y.
NOGALES (18)			
General Instruments	1,200	Components	General Instruments, Newark, N.J.
Industrias Motorola	1,000	Transistors, ics	Motorola, Inc. Phoenix, Ariz.
Cfa. Electronica Mexicana	450	TV components	Griffith Electric, Linden, N.J.
Mem Mex	400	Cores, components	Memorex, Santa Clara, Calif.
MEXICALI (10)			
Autonetica	600	Integrated circuits	North American Rockwell, Anaheim, Calif.
TIJUANA (41)			
Electronica de Baja California	1,600	TV receivers	Warwick Electronics, Hilsa, Ill.
Industrias Beta	650	Magnetic tapes	Audio Magnetic Corp., Gardena, Calif.
Industrias Mega	500	Printed circuits	Control Data Corp., San Ysidro, Calif.
IMEC	450	Electronics	Republic Corp., San Diego, Calif.
GUADALAJARA (2)			
Semiconductores Motorola	1,000	Transistors, circuits, relays, etc.	Motorola, Inc. Phoenix, Ariz.
Burroughs de Mexico	600	Circuits, relays	Burroughs Corp., Detroit, Mich.

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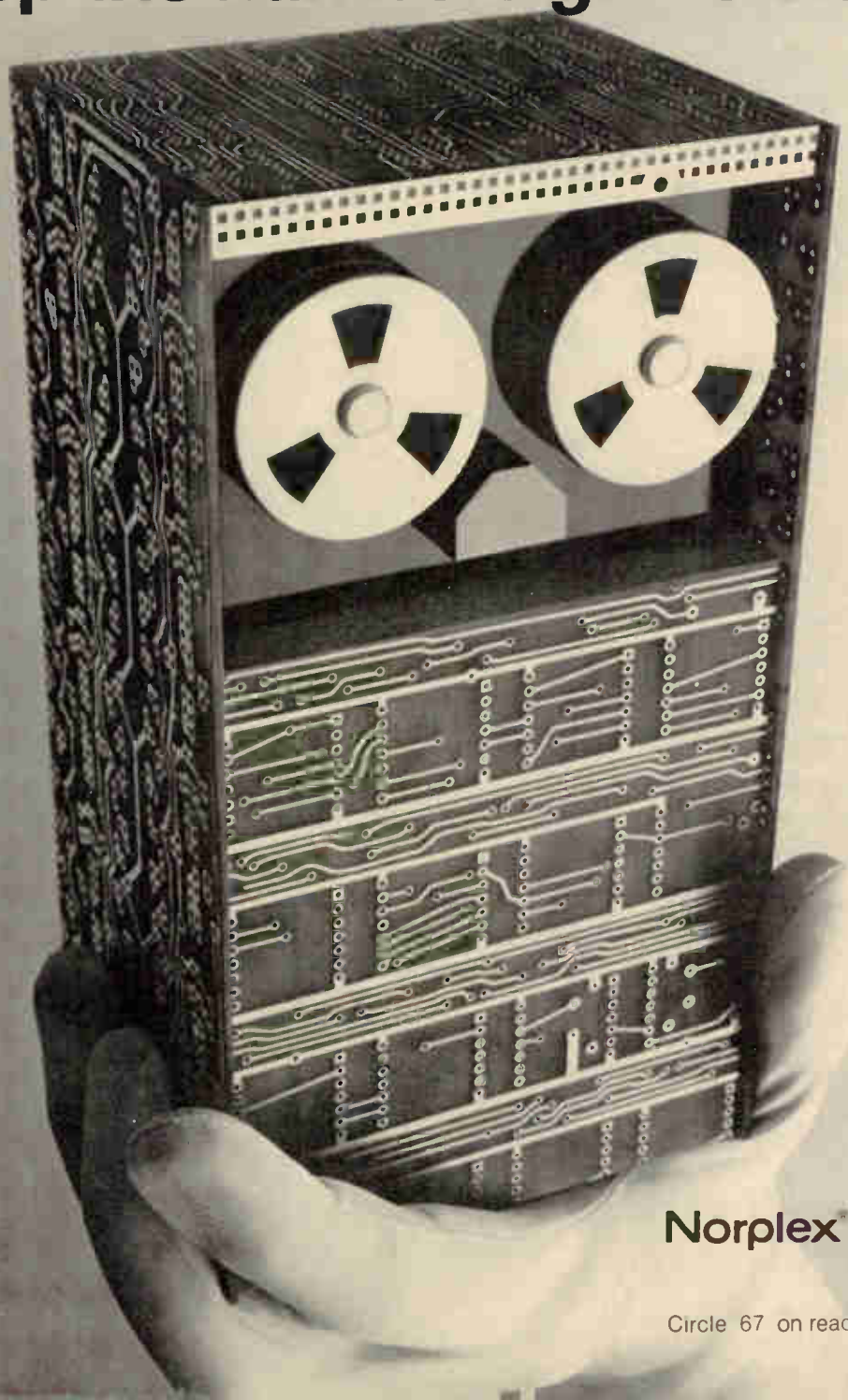

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Circle 67 on reader service card

ations were sections 806.30 and 807.00 to be abolished."

Advantages. Two relatively recent actions—one official and one not—appear to have increased the appeal of Mexico to American and other electronics manufacturers serving American markets. First was the March 1971 decree by President Echeverria clarifying the rules for establishing and operating a border industry assembly plant and expanding the program to all Mexican coasts. Second has been the upsurge in development of industrial parks so familiar to U.S. manufacturers.

"In the earlier days of the program," recalls the Embassy study, most companies found it necessary to research every aspect of opening an assembly plant, find (or arrange to construct) a suitable location, and obtain all permits and complete all paperwork entirely on their own." With the coming of the industrial parks near the border, however, "a firm may obtain almost immediate production from a subcontractor, take time as necessary to evaluate costs and quality with no investment risk, and upon deciding to proceed receive a large complement of trained workers with no break in production."

While Nogales, Ciudad Juarez and Matamoros "appear to be significantly in front" in industrial park development, according to the report, others are in the works in cities farther south—areas which have also aroused Japanese expressions of interest. On the Gulf of California, for example, parks are planned for Guaymas and Empalme, and "several Japanese firms have indicated interest in establishing electronics and metal-working operations at Mazatlan, Sinaloa."

On the Yucatan peninsula on the Gulf of Mexico, another park is scheduled for completion early next year at Merida. Even though the region is outside the specified 20-kilomoter strip for the Border Industry Program, special approval has been granted, and the State Department study indicates that several U.S. and Japanese companies have expressed interest in the area. □

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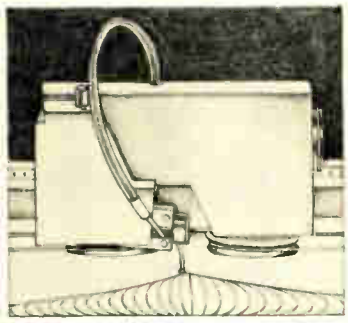

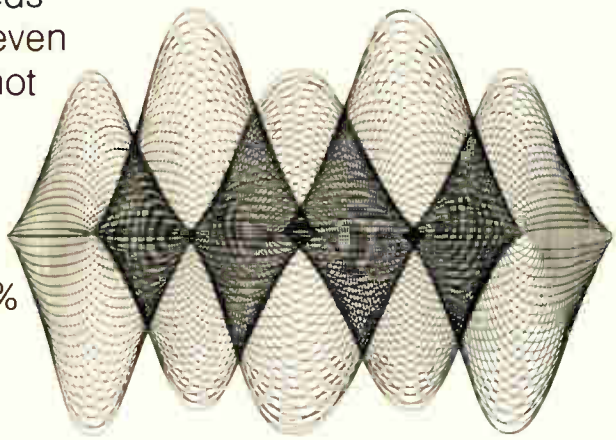

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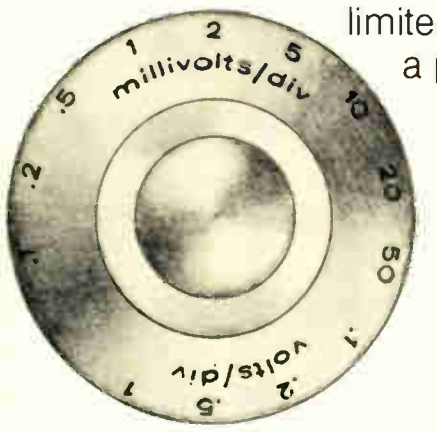

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What looks good to venture capital

The groups that put up the seed money for new ventures feel that success no longer lies at the leading edge of technology, but in applications

by Larry Armstrong, Dallas bureau manager

If the venture capitalists are right, the big growth spurts based on new electronics technology are over for a while. The time for applications, particularly in the medical field, communications, and business systems, is about to begin.

"Technology is less of a governing factor in the 1970s," says Jack Brooks, president of Boothe Computer Investment Co., San Francisco. This decade, he says, will be "more of a marketing and business era."

Albert Kelley, dean of Boston College's School of Management, sees the 1970s as the decade of communications. Venture capitalists, he says, are moving into modems, microwaves, and cable television.

"We're now entering the pervasiveness phase of electronics," says Richard Petritz, one of the founders of New Business Resources, Dallas, the partnership that midwifed Mostek Corp., Carrollton, Texas. "So we're looking at new-applications companies, not new-technology companies." He admits that he doesn't know what the next technological wave will be. "You could argue for charge-coupled devices or bubble memories, but I can't spot anything really major. I'm pessimistic, and I'm waiting four or five more years." The most recent venture at NBR is Linolex Systems Inc., a Bedford, Mass., business-computer maker.

The leaders. Leading the list of market areas expected to offer the "greatest potential reward" during the next three to five years is the medical/scientific field, followed by communications, computers and peripheral equipment, information services, and a decidedly non-electronic newcomer, leisure time. This ranking shows up in a survey of the changing nature of venture-capital investments by New York's Diebold Venture Capital Corp.

Those preferences are in sharp contrast to the pet investment area during the past three years, electronic devices and components. George Pratt, president of Diebold Venture Capital Corp., says, "So many were burned so badly with their experience in that industry that there's a great reluctance to get back in." And Petritz seconds that dissatisfaction: "With 32 MOS companies, it's a little late," he says.

In addition, investment people are not too happy about the sharply dropping prices for electronic calculators—one of the big application areas for such things as MOS devices. The same fear applies to the watch industry, Pratt says. "We don't know if there will be enough lead time to get our investment back as the prices come down."

In the medical/scientific field, Pratt expects increased automation of the chemical processing functions now performed by relatively high-priced hospital-laboratory technicians, and he predicts a new emphasis on low-cost patient-monitoring systems. Frank Chambers, of Continental Capital Corp., San Francisco, cites optics and electronic heat sensors as potentially profitable investments in the biomedical area.

Illustrating this potential is the experience of New York lawyer Frederick R. Adler, a venture capitalist who backed Data General Corp., Southboro, Mass., and Intersil, Cupertino, Calif. He chose to invest in medical electronics in 1969. "Because of the impending reces-

The big companies venture out

"If strategic planning really takes hold so that operations are developed early, big companies will be big competition to venture-capital firms in the future," contends Dick Petritz of NBR. He cites Texas Instruments as one of the few companies that do strategic planning and says General Electric and Westinghouse are beginning to move in that direction.

Other electronics firms are approaching the problem by creating internal or external venture-capital groups. Emerson Electric Co., St. Louis, funded and founded Techno-Venture Inc.; General Electric Co., New York City, established Business Development Services Inc., and Textron Inc., Providence, R.I. bought American Research and Development Corp.

Recently, Motorola Inc., Franklin Park, Ill., created a new post in Phoenix—vice president for new ventures. Internally, Motorola solicits ideas and tests their technical and market feasibility. "If the idea stands up to thorough screening and has good possibilities as a venture, we set up a separate profit center—almost as an independent company, but obviously subject to certain restraints to make them adhere to basic Motorola policies," says its new-ventures man Steven Levy. "They're not necessarily put under a Motorola division, but under an entrepreneur—probably the one who thought up the idea—and remain under my guidance up until the time we decide they should go into another division."

sion, one would think we couldn't have picked a worse time," he says. But he adds that the company, Vertek Inc., a Burlington, Vt., manufacturer of computers for diagnosing pulmonary and respiratory functions, was profitably sold to Hewlett-Packard five months ago.

At Capital Management Services Inc., in Los Angeles, president Don Valentine looks for areas that exhibit a high price/earnings ratio, as the semiconductor and data processing industries have in the past, and at the worldwide market for the product. "The company's business should be commercial—preferably consumer, end-user oriented—and the market should be from $50 to $100 million at the time of investment." In electronics, that includes computer-output microfilm systems, data and microwave communication systems, point-of-sale equipment, CATV, selected peripheral equipment, and educational systems and equipment, he says.

Success seeker. Richard L. Geiger, of the New York venture capital firm, Geiger and Fialkov, has some interesting statistics on the success of companies backed by venture capitalists. Of 20 ventures, he expects two big winners—that is, they will pay off at 10 to 1 or better. Six or seven will go bankrupt and the rest may have a payoff of 2 or 3 to 1. "So the net results of capital investment are better than the stock market," Geiger says.

But to get that payoff, the venture firm has got to get out. "If we pay $5 to get in, we want $25 out in three years," says Valentine, "and we have to ask 'how are we going to get it?' " The two best possibilities, he says, are either "the high probability of acquisition or going public."

And venture capitalists are still looking for the public market to make their deals work, according to the Diebold survey. Some 65% indicated that they might reject a venture situation if it required more than $1–3 million before realizing a positive cash flow. More than 83% of the venture capitalists surveyed look for a visible but open-ended market, while none wants a new and unknown market. That suggests,

says the Diebold preliminary report, that venture capitalists "may not be as 'venture-some' as their name implies."

Money markets. The public willingness to support capitalism-in-electronics is changing, and the money markets are beginning to open up. "Venture capital companies as a group did quite a disservice during the money crunch in 1969," says NBR's Petritz. Venture firms put all their money in at the beginning and depended on either the public or industry for second-round financing. "When that was not forthcoming, a number of small companies went under." But Petritz now foresees the public's beginning to "buy stories"—to take stock-market gambles on a company's potential. The attitude should filter down to the traditionally private money used to start up new electronics firms. "People have shied away from start-ups to more comfortable situations where they can see what's going on," says Boston College's Kelley. "I think more people will be willing to take on start-ups as business improves."

When dealing with a start-up, says Robert S. Ames, president of American Research and Development Corp., in Boston, venture pioneer, "you usually start with what you believe is a narrow base, but it can turn out to be much broader, like DEC." And Digital Equipment Corp., Maynard, Mass. is the star in ARD's firmament—its investment of $61,000 when the company was new was worth about $265 million at the time it was divested. Partnerships like Geiger and Fialkov and NBR were set up to fund initial start-ups, where they could shape the resulting company. "It's the most venturesome part of it, and the returns are greater," says Geiger.

When companies don't succeed, Geiger says, the reason is more likely to be faulty management, than that the technology is no good. With the economic slowdown of 1969 and 1970, financial control exercised by the venture capitalists on the enterprises became much tighter than it used to be. "Where we are the principals, we want to have all kinds of financial control," Geiger says. "You've got to mind the store." □

Transportation

A test ride for people movers

Computer-controlled cars reaching Morgantown, W. Va., this month are a tryout of both a transit concept and the transfer of aerospace technology to other jobs

by Stephen Wm. Fields, San Francisco bureau manager

Rather than moving astronauts at thousands of miles per hour, vehicles built by Boeing will be moving people in Morgantown, W. Va., along a guideway at 30 mph. In a Department of Transportation trial that begins in October, the Seattle company has applied its aerospace technology and the Bendix Corp., Ann Arbor, Mich., has developed electronic controls to move people in driverless, computer-controlled cars. And the passengers can punch in their destinations as simply as pressing a floor-number button on an elevator.

This month, Morgantown will recieve the first five vehicles for the $37 million test system that DOT Secretary John A. Volpe says will set the pace in transportation facilities for communities throughout the nation. The personal rapid-transit (PRT) system in DOT's demonstration project will serve some 23,000 students and faculty members at two of the University of West Virginia's three campuses, as well as 30,000 Morgantown residents. The completed system, with a capacity of 70 cars, six stations, and 3.5 miles of guideway, is slated to begin operation in late 1973.

Computer control. The first five cars, linked to a central computer will operate initially along 2.25 miles of the mostly elevated guideway. Operating personnel in the main control room will handle any emergencies that may be encountered. This control and communications system (CCS) was developed by the Bendix Corp. aerospace system division, Ann Arbor, Mich. The CCS is designed to:

- dispatch vehicles as scheduled or as requested,
- provide communications between the control center, the stations, and the cars,
- maintain the system, and
- ensure fail-safe operation.

Keith S. McMullan, project engineer in Bendix's transportation and urban applications operations, says the CCS uses a central supervisory computer (a PDP 11/20 with 20,000 16-bit words), specially designed computers at each station, guideway communications loops, controls and communication equipment on each car, and a collision-avoidance system.

McMullan points out that the central computer automatically manages the system—receiving and responding to destination service requests from the stations. Asynchronous 1,800-bit-per-second data lines provide duplex communications with the stations. The computer interfaces with the data lines by modems at both the central control and the stations.

The station computer receives inputs from passengers via the destination-selection buttons and gives passenger instructions on passenger-advisory displays. The station computer manages vehicle movements and receives status information via the data-handling unit.

Loops. Speed, stop, steering and calibration signals are all transmitted from the computer to the vehicles via inductive communications loops in the guideway. Four sets of

En route. The first of five "people movers" for the Morgantown, W. Va., rapid transit system are being shipped this month.

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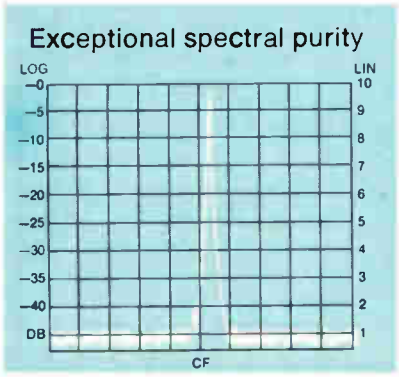

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New looks in ground transport

While the Morgantown, W. Va., people mover system is the first of its type to begin operation, similar guideway systems are being built by LTV Aerospace Corp., Dallas, Texas, for the new Dallas-Fort Worth Airport; Wabco Monorail division of American Standard Co., New York City, for the Houston International Airport; and Westinghouse Electric Corp., Pittsburgh, Pa., for the Tampa International Airport.

LTV's Airtrans system is controlled by four separate computer systems—one each for wayside communications, station activities, central surveillance and on-board control. These controls are augmented by sensing and television systems at passenger terminals. Wabco's cars straddle an inverted T-shaped guidebeam and use individual servomechanisms to equate a car's performance with computer-directed inputs. Each Westinghouse car carries a "subminicomputer" to insure precise braking.

LTV also has a Mini-Mover system, which is propelled by linear induction motors buried in the guideway. Although the system has not yet been sold Mini-Mover is aimed at high-density, low-speed applications, such as hotel-office-shopping complexes, resorts or airports.

Four more experimental systems were displayed in June at Transpo 72, the Department of Transportation's exhibition in Washington, D.C. The Bendix Corp., Ford Motor Co., and Transportation Technology Inc., an affiliate of the Otis Elevator Co., presented guideway vehicles. Ford's automatically controlled transportation and Bendix's Dashaveyor use rubber-tired vehicles, which pick up power and direction signals from the sides of the guideways, whereas Transportation Technology's electric-powered cars ride on an air cushion. A fourth system, Rohr Industries' Monocab, employs cars suspended from a monorail.

Down the road, larger and speedier cars using tracks and air cushions are being built for DOT testing by Rohr and LTV. Both electric-powered cars will carry passengers at 150 mph.

loops in the guideway provide a safe tone, station area control, speed control, and calibration.

"In most of these operations," says McMullan, "the computer acts as a monitor and the actual control of the vehicle remains with the vehicle itself." Thus each car is an independent control system, checking its own position and speed to make sure that it is not encroaching on the "territory" of another vehicle.

The safe tone is part of the collision-avoidance system. If for any reason the tone disappears, the car automatically stops. The tone is controlled by a set of magnetometers along the side of the guideway. As a car passes one, it "kills" a section of guideway behind it by turning off the safe tone. The computer is programed not to instruct a car to enter the dead area. When the car passes the next magnetometer, it turns on the dead section and kills the intermediate section.

In the station areas, there is another set of loops controlling speed and stopping. This loop, a figure eight, is controlled by the station computer. When a car enters the loop, it gets a "slow" command and then at the center—the cross in the "eight"— the car stops. Since there are several stop loops in each station—to accommodate several cars—the controller stops the car at the most forward location in the station.

Odometers. The speed loop carries frequency-shift-keyed messages from the central computer. These include half, three-quarter, and full speed (30 mph). The car follows the speed command as best it can, using an on-board odometer.

If the car unit calculates that the speed is 3 feet per second or more over the computer's instructions, the car is stopped and the operator notified. If speed is 4 feet or more per second slower than the instruction, the car keeps on going and the operator is alerted. If the speed tone is lost completely, the car slows and at 4 feet per second a warning goes out to the operator.

The fourth loop, spotted every 1,000 feet along the guideway, is used to calibrate the odometer. When a car enters a loop, the odometer calculation is compared with the loop length, and the vehicle checks tire wear and line-voltage variations. □

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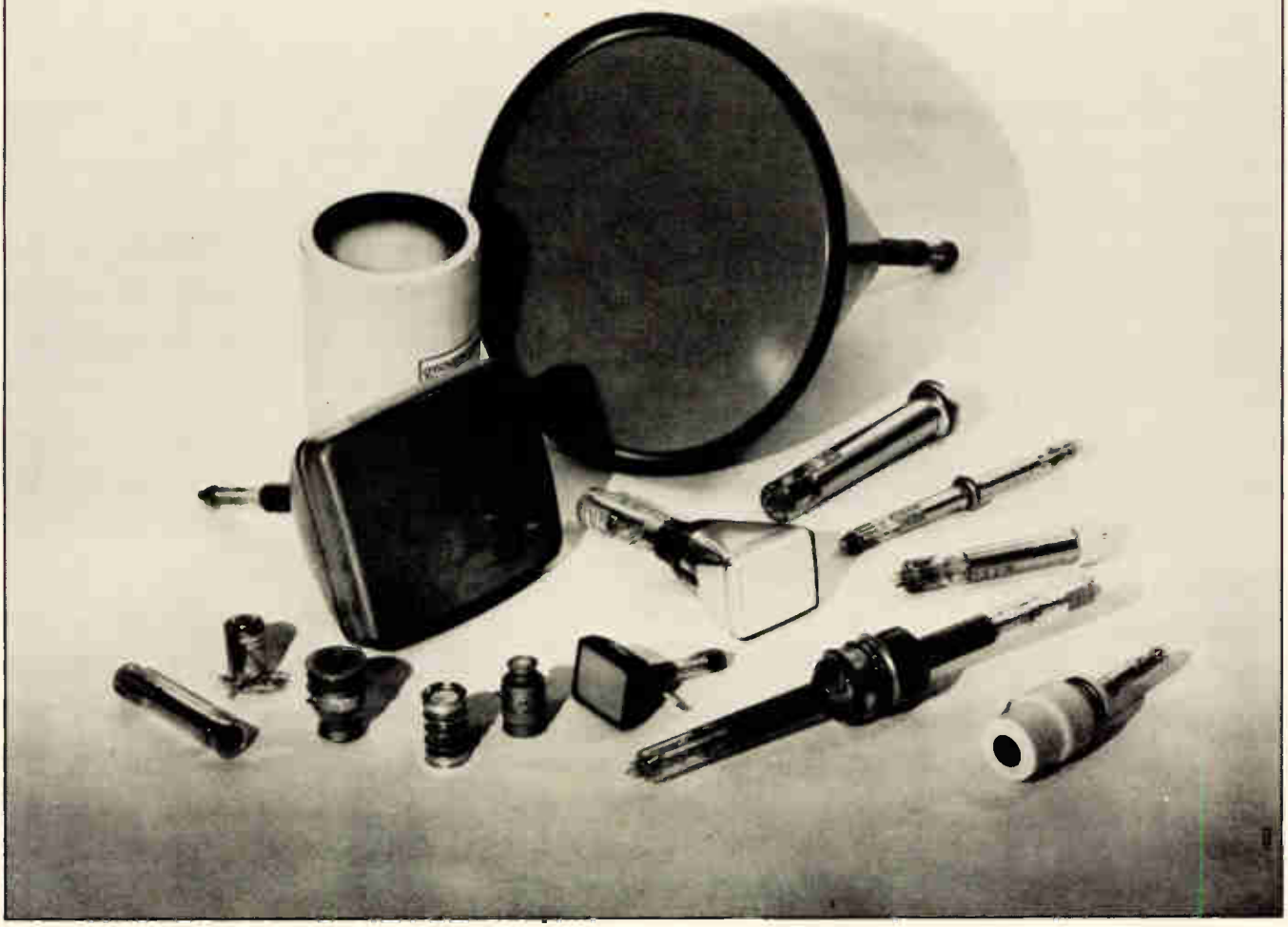

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Computers

Air freight takes to computers

Airlines and governments are using computers to sort out the complex paperwork and speed the routing of air cargo

The air freight business around the world has started to zoom, and airline companies, often aided by national government, are rushing to automate the documentation, routing, and even the transportation of cargo bound abroad.

The amount of freight shipped by air is forecast to increase more rapidly than passengers, according to A. D. Groenewege, director of cargo traffic service for the International Air Transport Association, Montreal, Canada. Groenewege says the 11,000 million ton-kilometers handled in 1971 by scheduled airlines worldwide will more than double to 25,000 million ton-km in 1975 and will nearly double again to 45,000 million ton-km by 1980.

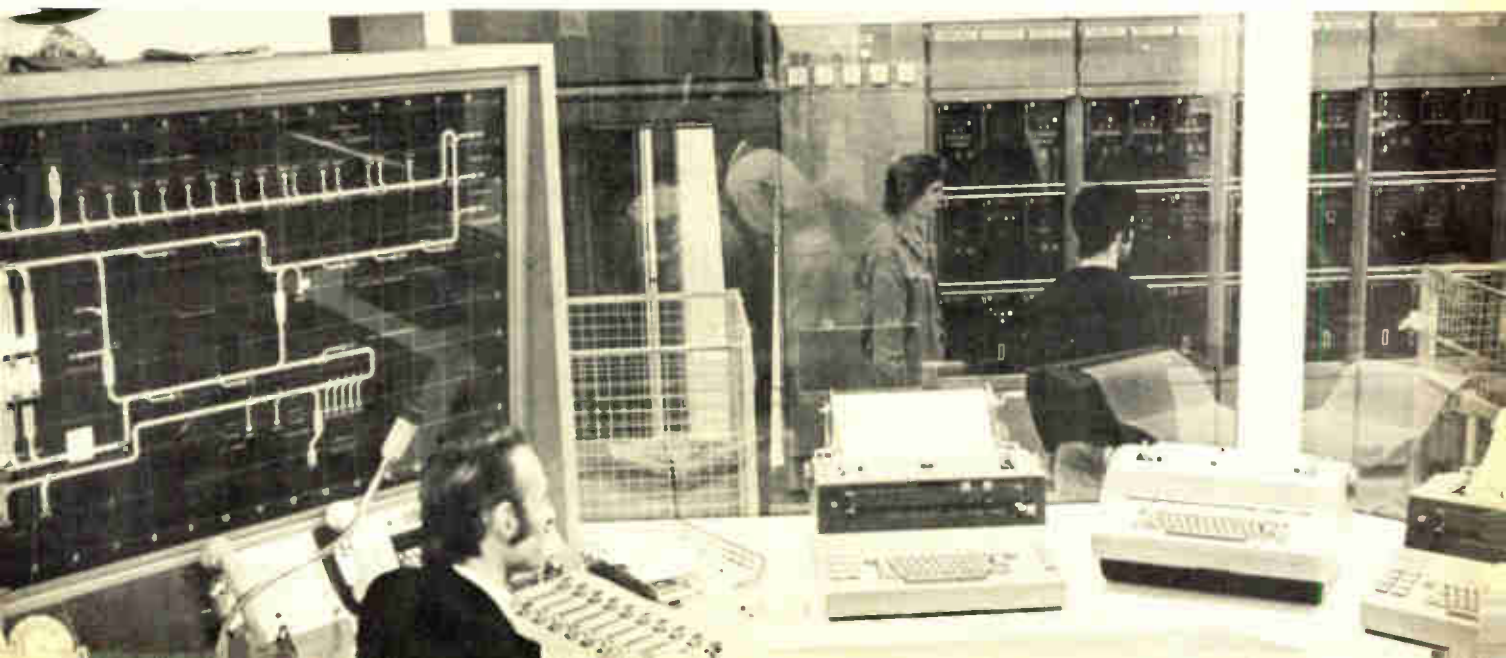
Carrying the cargo is no problem—all the major airlines have jumboed up and each Boeing 747, even with a full load of passengers, can carry half as much freight as a Boeing 707 cargo-only jet. Handling the freight on the ground, though, is a complex business. According to Elias K. Ghuneim, computer systems manager at Pan American World Airways, New York City, 46 different forms producing 320 different pieces of paper are needed to see an international shipment from a manufacturer to a buyer.

By now, Air France boasts automated freight terminals at Orly, Rome, London, Amsterdam, Frankfurt, and Stockholm. Pan Am, which claims to be the world's largest carrier of air freight and installed its first automated cargo center at Kennedy Airport in 1967, is considering how it might do the same sort of thing at some of its 125 other stations around the world. KLM Royal Dutch Airlines has no automated cargo system at Schipol Airport, near Amsterdam that has handled 120,000 tons of freight during its first full year of operation. SAS, whose cargo center at Copenhagen Airport was the first in Europe to use automated procedures, opened a $7 million semi-automated freight terminal in May at Kennedy Airport, and in December, United Airlines will begin installing 185 cathode-ray-tube computer terminals in 113 stations around the United States.

At London Airport an extensive computerized freight handling system is run as part of the British Post Office, on behalf of the airlines and British Customs. And this fall, the U.S. Department of Transportation will begin tests to determine what is required to operate a world-wide computer-centered data base to simplify document handling for international freight.

Sophisticated. The Air France freight terminal at Orly Airport is possibly the most sophisticated in the world. Not only are all shipments supervised by computer, but most of the moving of cargo is done automatically. The installation was designed to process up to 250,000 long tons of freight a year—some 9 million packages—and already this year it is expected to handle some 7.5 million packages totalling

Centered in Paris. The warehouse control station at Orly Airport gets its orders from a computer facility in Paris proper via phone lines.



170,000 long tons. Riding herd on all this will be a system known around Orly as "le SAFO"—an acronym for Système Automatique de Fret Orly—designed by SEMA, a French system company, in conjunction with Air France and IBM.

SAFO's pair of IBM 360/40s, with a solid leg up from two IBM 2314 disk memory files, keep track of each shipment from loading dock to plane (and vice versa). Some 120 intermeshed functions are involved—from reserving cargo space to truck delivery of small packages—and no fewer than 350,000 instructions are stored for the applications programs. SAFO works on-line and shoots back instructions or answers to queries in 3 seconds.

SAFO's freight-handling facilities use two automated conveyor circuits—one shuffles trays around for consignments up to 220 pounds and the other moves consignments up to 1,100 pounds into storage and out again in "toweyor" chariots. There's also an automatic basket line to shuttle the paperwork about the terminal.

The "toweyor" chariot line is the most spectacular. Each of the 3,533 chariots has an assigned parking bin in a massive stacker. When a consignment goes into a chariot, all the shipping data pertaining to it is fed to the computer. The chariot then is tugged around a floor chain-conveyor circuit to the stacker where an automatic crane puts it into its bin.

To get a shipment out, the shipping clerk at the delivery station sends a message from his terminal to the computer, and the computer in turn signals the warehouse control center. An operator there punches out the chariot number, and the stack crane puts it into the outgoing circuit. The average stacker crane cycle takes 60 seconds.

Not as elaborate, Pan Am's system at Kennedy airport uses an IBM 7080/7750 computer/communications data center plus some 30 Bunker Ramo cathode-ray-tube input/output consoles in the storage area. Electronically activated but manually controlled stacker cranes place cargo in storage bins, and magnetically encoded tow carts move containers around the terminal. The computer keeps track of all containers not only within a storage area, but inside an aircraft as well, according to Pan Am's Ghuneim. Such data as the number of pieces, weight, vendor, consignees and storage location are transmitted via Teletype prior to the arrival of the cargo so that the receiving terminal has a complete record of each shipment.

United Air Lines air freight computer center in Chicago, which will go into full operation in February of next year, is less ambitious again—its Univac 1108 computer will handle documentation only, and the freight itself will all be routed and loaded manually. Nevertheless, "the system should reduce the tracing of cargo shipments from hours to minutes," says a United spokesman. Eventually, United says, it plans also to automate the routing of containers directly between aircraft or storage areas to trucks.

Similarly, the already operational KLM system at Schipol Airport handles shipment documentation only. It uses two Philips DS714MK2 communications computers and a Telex network to transfer data from the central IBM 360/20 computer to a shipment's destination point before the goods arrive.

The $13 million London Airport Cargo EDP Scheme (Laces, for short) is built around two ICL 472 computers. Located about 3 miles from the airport, they are linked by telephone lines to an extensive CRT network.

One computer controls the terminal network in real time, and the other is used for administrative off-line batch processing (such as keeping the agents' accounts) and program development, and also acts as a standby machine. CRT terminals are rented to freight agents, the British Customs and the airlines.

When a freight waybill arrives, the airport staff key the data into the computer. When the actual freight arrives, they do the same with the package information, and the freight agents add customs information. If the computer comes back with clearance, payment instructions are issued and the agent's accounts is debited with the appropriate amount. At any time, the agent or an airline acting as an agent can inquire, through his CRT console, what the status of any consignment is.

Mike Atkinson, in charge of programing and operating the project, says that since it opened, system availability has been better than 98%.

Worldly. All these systems at the most handle rather less than a nation's air freight. The U.S. Department of Transportation, however, is planning a worldwide data communications system that would keep track of all international shipments, whether they go by sea or air. All documents relating to a shipment would be entered into a computerized data base without any paper being generated except at the shipment's beginning and end points.

To determine what the requirements of such a system might be, transmission tests will begin this fall. A data base will be compiled at DOT's Transportation Systems Center in Cambridge, Mass., and transmitted from Kennedy Airport over the aeronautical fixed telecommunication network to London Airport, according to Harold E. Harriman, documentation and procedures chief in DOT's Office of Facilitation.

Harriman foresees the system as operational in 2 to 4 years. It would be run by "the private sector," he says, and would require tens of thousands of consoles at thousands of airports round the globe. □

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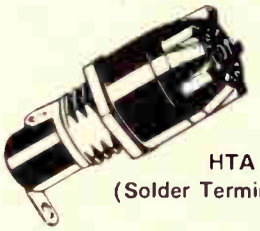

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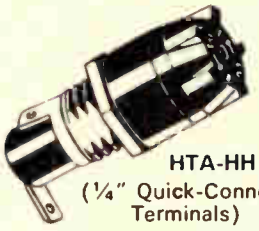

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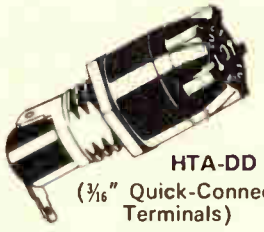

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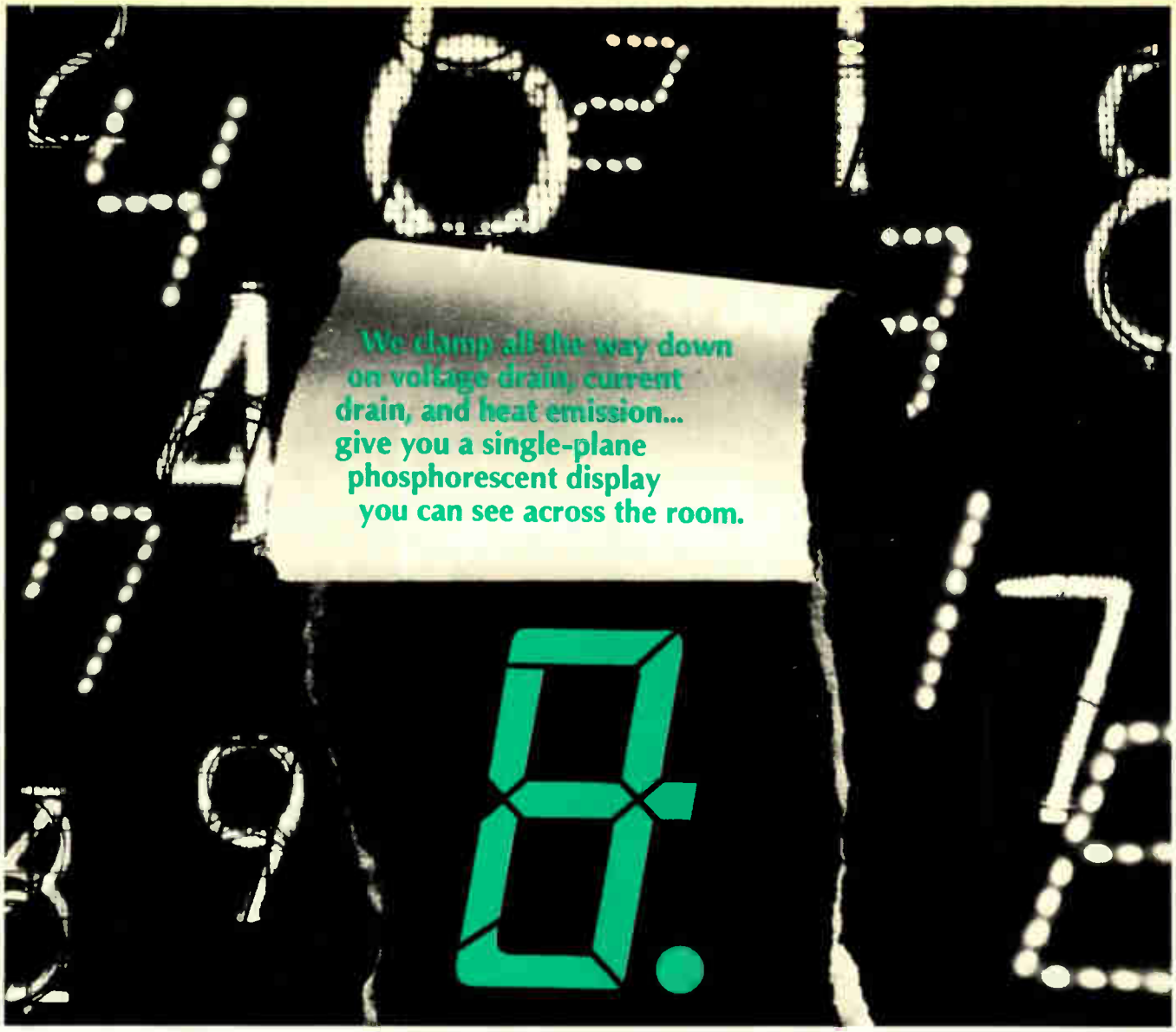

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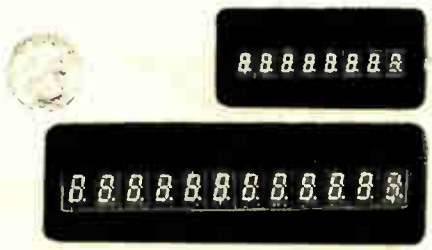

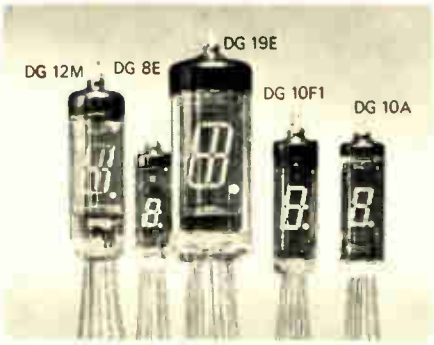

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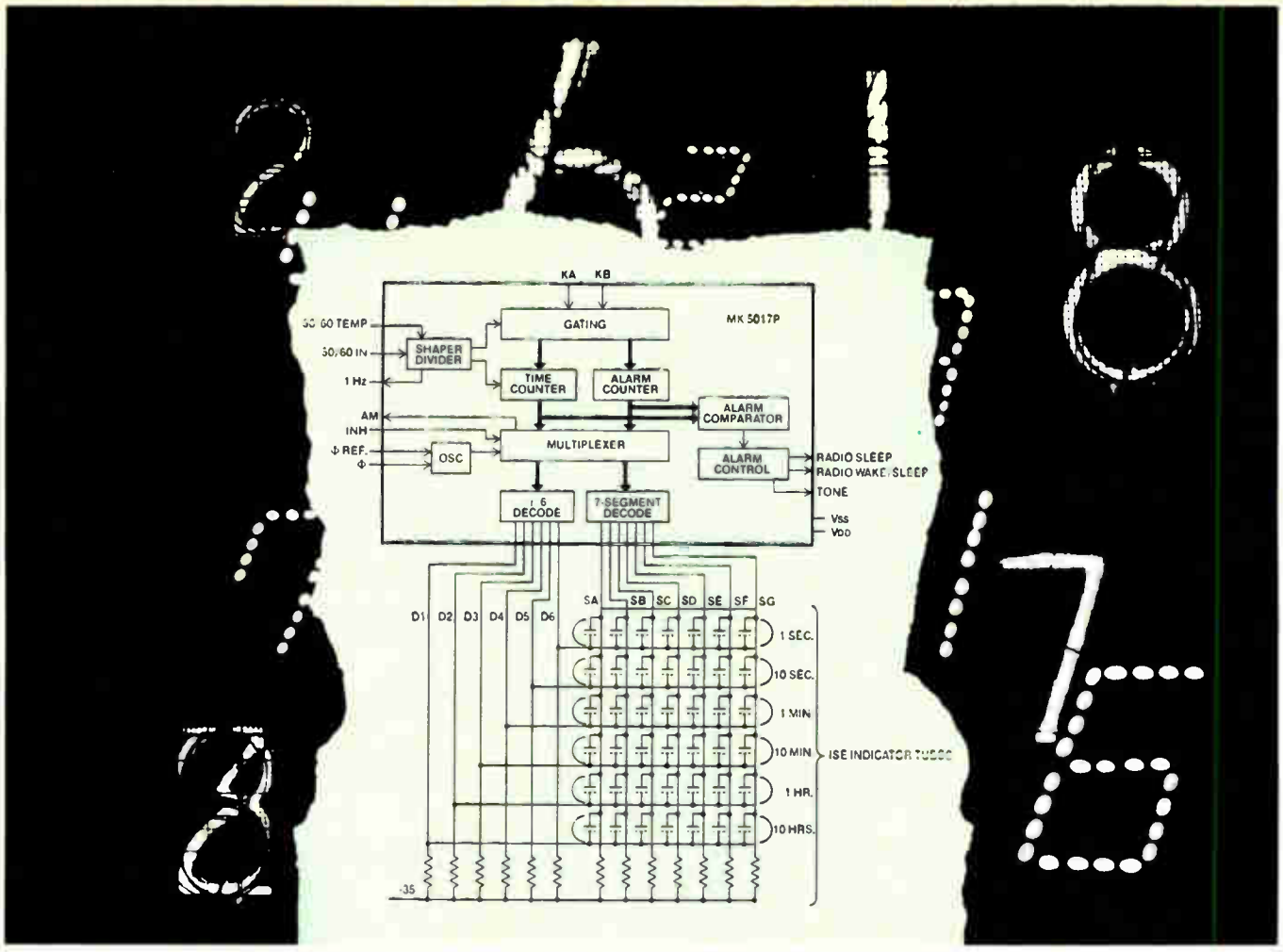

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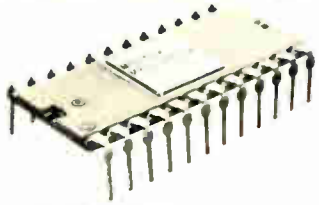

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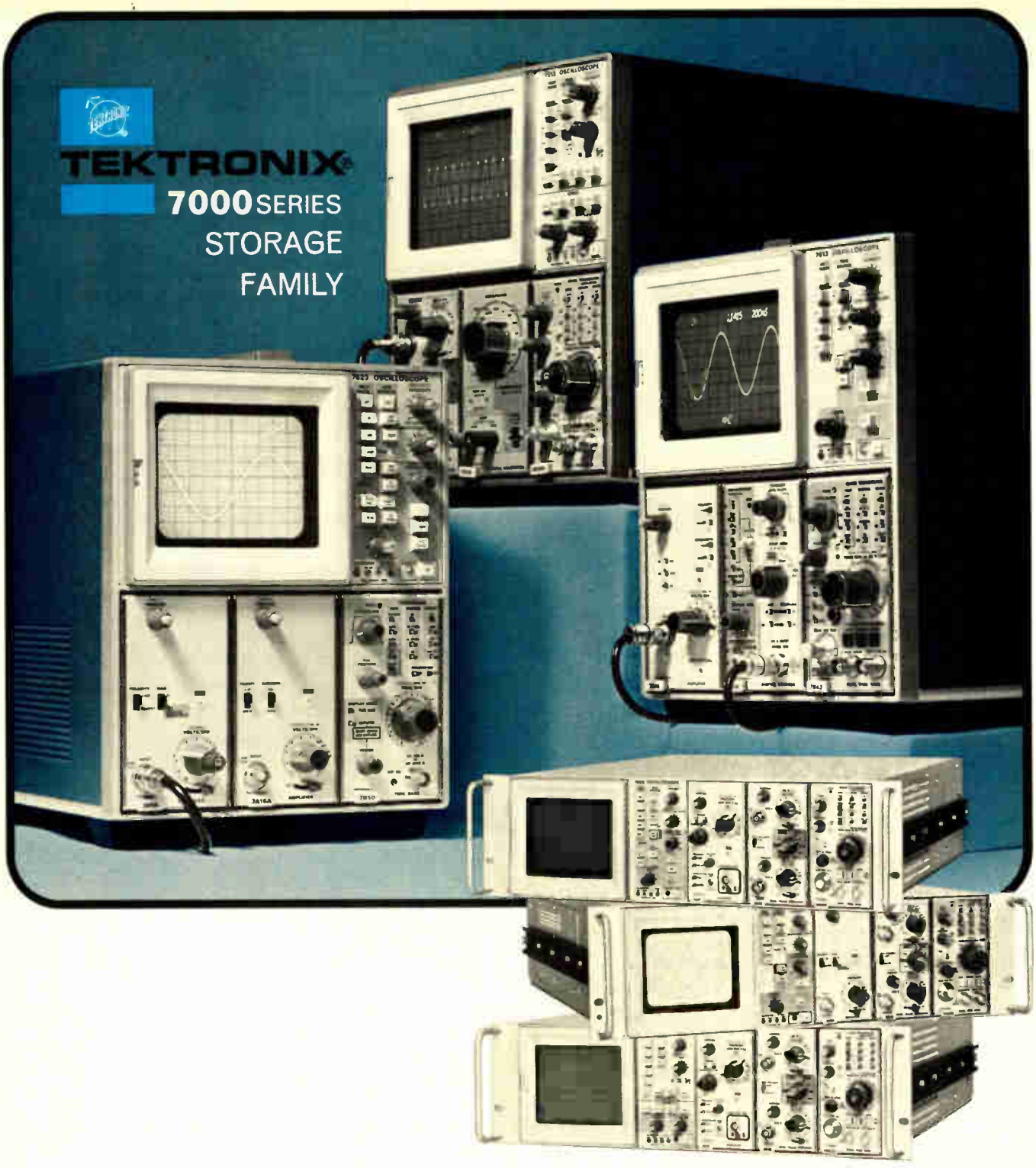

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Broadened markets fuel new growth in the West

There's widespread change among western electronics companies as Los Angeles prepares to host the Western Electronic Show and Convention Sept. 19–22.

First of all, semiconductor business is booming, which is a happy change from the recession-clouded Wescon shows of recent years. And the West Coast data processing industry, characterized by minicomputer and peripherals manufacturers, is "on the wave of another growth period."

And while Wescon itself should be about even with last year in total booths, show officials look for at least 5,000 more registrants than the 1971 count of some 25,500.

Besides a change for the better in the business outlook, though, there's a more evolutionary shift in the search for new markets. Most West Coast data processing companies that have been suppliers of individual processors or peripherals lines are convinced they've got to supply complete systems, whether they be for testing circuit boards or auto carburetors.

And in semiconductors, the promise of MOS and C/MOS is increasingly being translated into products as companies get more experience with these still relatively new technologies. MOS and linear IC sales are spurting, and although new processes continue to evolve, today's prime concern is product delivery.

The aerospace industry seems to be reconciled to the decline in big-ticket military and NASA programs, and companies are still sharpening their capabilities to go after contracts—both smaller and fewer—in its traditional business. But the big change in aerospace is the pervasiveness of diversification and the fact that it's beginning to pay off in new commercial/industrial markets. Some aerospace companies are even venturing into the withering consumer marketplace.

Aerospace industry buyers until recently have had a great influence on instrument manufacturers. But that looks like a thing of the past because instrument houses had to find other customers when aerospace business tailed off. Today's instrument buyer, say western manufacturers, are far more cost-conscious than ever, and some of them are less sophisticated than aerospace users. Thus, a number of instrument makers are broadening their lines to embrace the "economy" customer.

Wescon, itself, is facing up to change. It's reflected in this year's "professional program." Most of the 28 sessions cover technological trends and applications, but the recognition of a shift in what interests Wescon audiences is evident—more than 25% of the program deals with careers and management topics.

DATA PROCESSING

Expansion keyed to systems

Although some Western manufacturers of minicomputers and peripherals are hinting at shakeouts, mergers, and consolidations—particularly of companies in the IBM plug-compatible business—most are predicting that lightning will strike the other guy. But EDP officials agree on one thing—they've got to develop a systems capability to survive.

Both minicomputer and peripherals manufacturers are seeking to increase their share of the systems pie in such markets as time-sharing, circuit-board testing, banking, and assembly-line automation. But all hands are reevaluating their market mix between end-users and original-equipment manufacturers. And several minimakers are building more peripherals in-house.

Just as peripherals houses worry about IBM, the company that put them in business, the minimen are fretting about the growing capabilities—and consequent threat in the micro-minicomputer market—of semiconductor firms that have made their business mushroom. "Our founders saw that eventually processors would be made by guys with furnaces," says Raymond J. Noorda, executive vice president of General Automation Inc., Anaheim, Calif. And George Vosatka, president of Varian Data Machines in nearby Irvine, agrees: "We haven't gone after the $500 computer because we don't think we can compete with the IC manufacturers."

Absorption or oblivion?

Vosatka injects an optimistic note: "The very smallest companies will be the ones that will be absorbed, and I don't think they'll die. If everyone's growth projections for minis are valid, we're on the wave of another growth period." But Noorda is more pessimistic. He predicts that some of the smaller minicomputer manufacturers will drop out or merge, especially since some larger competitors, such as Texas Instruments and Burroughs Corp., are in the fray.

The outlook is similarly ominous for the peripherals manufacturers, especially those that make IBM plug-compatible equipment. "We have half-a-dozen competitors in each area," says John R. North, marketing manager of Pertec Corp., a Los Angeles peripherals manufacturer, "and I expect some will fall by the wayside."

Eugene Prince, vice president and general manager of the Marina del Rey-based Computer Products division of Ampex Corp., says, "I expect consolidation in the business, particularly in IBM-compatible equipment." Prince should know. Ampex was one of the first companies to take the plunge into the IBM-compatible business, and it is among the leaders moving to greener pastures. "We expect to have more end-user products, but less emphasis on IBM compatibility," says Prince. "It was a tremendously lucrative business, but IBM has placed severe restraints on us."

The shift in emphasis has been motivated largely by IBM's recent announcement of the System/370 model 158 and 370/168, which especially jolted manufacturers of plug-compatible peripheral equipment because the machines contain virtual memory, integrated disk-file control, and MOS memories. The move capped a year-long IBM effort to discourage plug-compatible equipment manufacturers.

Memorex jolted

A big jolt has been absorbed by Memorex Corp., Santa Clara, Calif., which until recently has been the most vocal critic of IBM policies. Now, however, Memorex is moving into systems minimizing the future of IBM additions. "The peripheral industry, as a growth industry, is dead for at least 12 to 18 months," says J. Garrett Fitzgibbons, president of MRX Sales & Service Corp., the Memorex marketing arm.

"The trend is for IBM to pull all the electronics into the main box, leaving just a mechanical assembly out there," Fitzgibbons adds. "And IBM can tool up for larger production runs, so its costs will be much lower."

Because of this conviction, Memorex is going after the systems business in incremental steps. Unlike RCA Corp., though, Memorex chose a policy of coexistence with IBM. "The way RCA went after IBM was like telling someone you were going to steal his wife; but if you said that you were going to steal his garbage can, maybe he'd let you," quips Fitzgibbons.

He says that the key to success is Memorex's large lease base. "We are now in 2,500 choice IBM locations with our peripherals. And when we add a new piece of equipment to our line, these customers are apt to try it. If they like our disk, maybe they'll try our controller; and we hope that when they're in the market for a new computer, they'll look at ours." Memorex this spring introduced two mainframes of its own.

IBM and integration

Ampex's Prince reports that his division has introduced Univac computer-memory replacements, and future possibilities include computer communications and time sharing—equipment that, unlike disk controllers, "IBM can't integrate." A similar route is being contemplated by Richard Dadamo, president of the Electronic Memories & Magnetics Corp.'s newly reorganized Memory Products group in Los Angeles. EM&M has a

Computer Products division making add-on memories for IBM computers. Although those products won't be abandoned, Dadamo hopes his group can eventually get into more types of end-user products that aren't IBM-compatible.

After a number of organizational shuffles, all EM&M memory products have been consolidated under Dadamo. Included are cores, stacks, core systems, end-user systems, subsidiary Caelus Memories Inc., which makes disk files and disk packs, and SEMI, the company's semiconductor memory subsidiary.

Another IBM-shy peripherals firm is California Computer Products Inc. in Anaheim. CalComp, correctly anticipating a slowdown of growth in its plotters and computer-output microfilm equipment a few years ago, bought into Century Data Systems, which successfully entered the disk business. CalComp sells CDS products to end-users in the U.S., while CDS sells directly to OEMs. But CDS, one of the first firms with a replacement for the IBM 3330 superdisk, lives under IBM's guns. CalComp has blunted this threat with products that don't compete with IBM (IBM has been a customer for plotters, in fact), by OEM sales, and with a plug-in replacement for the Univac Fastrand memory.

OEM versus end user

Meanwhile, minicomputer makers are still arguing over whether it is more profitable to supply OEMs or end users. Hewlett-Packard Co., Varian Data Machines, and General Automation concentrate on selling their relatively conventional computer systems directly to end-users, while Naked Mini innovator Computer Automation and microprograming pioneer Microdata Corp. eschew end-users in favor of OEMs, who handle their inexpensive computers as system components.

Peripherals manufacturers also split into similar camps. While Ampex, CalComp, and EM&M fight for IBM's pre-370/158 and 168 end-user plug-compatible business, Data Products Corp. and Pertec Corp. sell their peripherals only to OEMs.

General Automation's Noorda divides his business into three areas: products (processors), 25%; standard systems, 50%; and special systems, 25%. Gross margins are more telling at 50%, 60%, and 20%, respectively, pointing out why the company concentrates on developing and selling standard systems, which reward increased volume with lower unit costs.

In emphasizing sales of standard systems, General Automation first concentrated in two industrial areas—automobile production and electronic/electrical production controls—neither of which had any recognized suppliers. General Automation systems now test car-idle, carburetor performance, and electrical systems, and also control coil winding, wire wrapping, and component insertion.

Much of Noorda's thinking parallels that of Varian's Vosatka, who says, "Three years ago, our business was almost exclusively OEM, but we determined to go into the end-user market, and it's now about 50/50. We'd like the figure to be 75/25—with commensurate growth, of course. Much growth has come from acceptance of minis outside of the traditional scientific and control fields." Moreover, Varian has recently expanded into software sales. The company's new Vortex operating system is being used by lawyers and drug firms, as well as traditional businesses.

The systems business is nothing new to Hewlett-Packard Co., Palo Alto, Calif. William P. Nilsson, marketing manager for the Data Systems division, attributes much of the division's success to its policy of supplying complete systems with peripherals, software, and other support.

H-P's peripherals and computer operations have been combined into one group, says Nilsson, "to tailor the organization to go after new business." Now the products are marketed along functional lines. One is the "GEM" group—for government, educational, and medical users. The second classification is industrial/commercial, and the third is OEM. H-P's traditional engineering customers in the electronics and aerospace industry are still served by the company's "instrument" sales force.

'Mules' stick with OEMs

The one West Coast minicomputer maker that's sticking to its concentration on the OEM market is Computer Automation Inc., Newport Beach, Calif. The firm's Naked Mini price was cut from the $6,000 range to about $3,500 a year ago.

William P. Nilsson
Hewlett-Packard Co.

J. Garrett Fitzgibbons
Memorex Corp.

Raymond J. Noorda
General Automation Inc.

Says Sol Zasloff, vice president for marketing: "We felt our customers didn't need everything. They didn't need a fancy panel or power supply or cover. They wanted reliability and low cost. They didn't need a temperamental racehorse; they needed a mule." Zasloff continues, "Of 1,000 of our computers in the field, maybe 15 went to end-users. The thing we see is a computer, but to the users, it's just like a resistor."

For the future, Zasloff predicts more of the same—with lower prices, higher reliability, and program compatibility. However, there's one big but: Computer Automation makes and sells a successful computer-controlled circuit-board test system, developed initially for in-house testing. Zasloff says that the company is looking for other systems functions that it can develop by building on its present strengths.

In nearby Santa Ana, Microdata Corp., a minimaker that pioneered in microprograming, shows signs of shifting its strategy away from exclusive concentration on OEM sales. N.H. Hawkins, marketing vice president, says Microdata is going after end-user business, though Hawkins expects OEMs to continue to contribute a major part of his business. The major end-user thrusts in both systems and processors are in the education and telecommunications markets.

Minimakers build peripherals

The company is also rapidly adding interfaces and peripherals to supply more parts of systems. Microdata now buys its peripherals, but Hawkins says that the company will soon introduce one new internally developed peripheral and another obtained through a marketing arrangement.

Microdata isn't alone in its efforts to develop its own peripherals, as Digital Equipment Corp., Data General Corp., and Hewlett-Packard already do. Varian makes the Statos electrostatic printer/plotter for graphic and alphanumeric printing at up to 5,000 lines per minute, and president Vosatka intends to build more peripherals. General Automation buys all of its peripherals now, but vice president Noorda plans to acquire some in-house capability. "We need industrial-oriented, rugged peripherals, but we find that vendors aren't always responsive. When we can't find what we need, we'll have to develop our own."

In northern California, Four-Phase Systems Inc., Cupertino, is also going the "do-it-yourself" route with peripherals—most recently with a cathode-ray tube terminal. Four-Phase makes multi-terminal computer systems, including one for data entry into large IBM networks.

A new system will handle 32 terminals for airline reservations, flight data, and banks. Four-Phase has been buying CRT terminals, but will begin building them in-house. John M. Clark Jr., marketing vice president, says, "The volume has increased to the point where it is now more economical for us to build the units ourselves." These units are mostly electronic, rather than mechanical, like a printer or disk drive.

If this build-it-yourself trend concerns peripheral equipment makers, they aren't showing much sign of it. Two of the major manufacturers of minicomputer-oriented peripherals are Pertec, with more than 20,000 tape drives in the field, and Data Products Corp., which claims to be the largest independent maker of line printers. Both firms build other products, as well.

The largest portion of Pertec's peripherals business is in tape drives, but the company is getting into low-cost disk files through acquisition of Computer Memory Devices, and into low-cost line printers through its most recent acquisition, Eikon.

Data Products, Woodland Hills, Calif., has recently reoriented its marketing thrust toward OEMs after an unsuccessful foray into the end-user market during the recession. The company's main product is line printers designed for use with minicomputers. Due for introduction later this year are a new minimum-cost 300-line-per-second printer for the terminal and mini market and a top-of-the-line high-speed printer.

But Data Products is changing directions in a Connecticut-based facility that makes telecommunications products, the second-ranking product line in sales. A major effort at the facility is to convert from defense to commercial products, with special emphasis on test equipment for telephone companies and multiplex systems for data-communications networks.

Information nets beckon

Data networks themselves have become attractive to two Western computer companies—Varian and Xerox Corp.'s Computer Systems operation in El Segundo, Calif. Varian's Vosatka says the company has supplied more than 100 minicomputers to Tymshare Inc., Palo Alto, Calif., for that company's nationwide data network. Vosatka adds that, although Tymshare is putting together the system, Varian Data could supply 80% of the hardware.

Xerox has been emphasizing customized information systems for the past year or so, which has accounted for a significant part of its business; more than 750 systems are in operation. Xerox has recently integrated the former Xerox Data Systems, principally a maker of scientific computers, into the Computer Systems operation.

Xerox has also acquired disk maker Diablo System Corp., of Hayward, Calif., which developed a new printer that may replace many teleprinters and IBM input/output Selectric typewriters. Like the other firms, Xerox seeks to broaden its information-systems business while continuing to serve traditional aerospace and engineering markets. □

SEMICONDUCTORS

Selling products instead of processes

Western semiconductor makers are riding the crest of a new sales surge. Established digital technologies are sharing in a first half boost over the same period in 1971 that amounts to more than $30 million. Units shipped are up a whopping 60% [*Electronics*, Aug. 28, p. 30]. MOS sales, too, are expected to post at least a 20% increase over last year, and linears are taking off again. The mood in the West, then, is one of optimism and more than a little maturity.

And 1972 may be remembered as the year that western semiconductor manufacturers became less concerned with selling technology for its own sake than with delivering products. Mike Markkula, marketing manager for North America at Intel Corp., Santa Clara, Calif., probably sums it up best. Markkula regards n-channel, C-MOS and ion implantation as "just modifications on a theme—MOS. These are just tools that make it easier for us to do the things we want to do."

Jack Gifford, director of analog products at Intersil Inc., Cupertino, Calif., adds, "Circuit design is very important. You have to be able to apply the new technologies, otherwise they'll do you no good." Intersil has a mature micropower bipolar process originally undertaken to deliver super beta transistors for another application but now being used for the company's bipolar watch circuits. The company also has C-MOS in production for watches and for linear multiplexers.

N-channel arrives

N-channel MOS "has come of age basically because of a lot of work that has gone into refining the process," maintains Earl Gregory, vice president and director of marketing at Electronic Arrays Inc., Mountain View, Calif. He says that it took Electronic Arrays two years to get n-channel into production, but since March, the company has introduced three 1,024-bit random-access memories employing it. The fastest of the three, the EA1500, has an 85-nanosecond access time.

Motorola's Semiconductor Products division, Phoenix, Ariz., was late into MOS, admits Jack Haenichen, vice president and director of MOS and computer-aided design operations. But Motorola has made a big commitment to both C-MOS and n-channel, preferring to leapfrog p-channel and get off the ground fast with the newer technologies. There's evidence that both are ripening. "It looks like C-MOS will develop into the next standard medium-speed logic form like 54/74 TTL has been," Haenichen observes. "By Dec. 31, we'll have introduced 40 new C-MOS parts this year and expect to do the same next year."

Haenichen also maintains that Motorola is past the engineering stage in n-channel: "We think we're the largest shipper of n-channel in the country, although most people don't realize it. The largest program is in a custom, high-density 4,096-bit read-only memory; we're shipping a hell of a lot of them." Motorola also expects to announce a 4,096-bit n-channel RAM by the end of this year.

Haenichen puts the MOS world in good perspective: "Our present view is that p-MOS sales will rise until 1975, then plateau and start to fall. Then n-channel and C-MOS will be dominant because of their advantages."

Proof of the pudding

Two other MOS houses are proceeding as if they agree with Haenichen, working on the newer processes in development but getting the most mileage out of their proven p-MOS processes in current sales. At American Micro-systems Inc. (AMI), Santa Clara, Calif., Warren Wheeler, president of the Micro-products group, points out that "p-channel MOS is the only process around that we have enough data on to employ in a systems design." Upstart North American Rockwell Microelectronics Co. (NRMEC) has zoomed from a question mark just three years ago to sales of more than $30 million by exploiting a p-channel process.

NRMEC, in Anaheim, Calif., and AMI, among others, are also interested in complete system sales. NRMEC made the move earlier this year by marketing complete calculators, while AMI, after divesting itself of a calcu-

Mike Markkula
Intel Corp.

lator operation, is exploring the mini- and medium-sized computer systems business.

Meantime, refinement of the newer MOS technologies continues. National Semiconductor Corp., Santa Clara, Calif., is working on a 4,096-bit n-channel RAM, will have a 1,024-bit n-channel RAM next month, and has taken a C-MOS approach to logic. AMI is also showing customers a 1,024-bit n-channel RAM. And the list of other n-channel developers includes Signetics Corp., Sunnyvale, Calif.; Texas Instruments in Dallas; Mostek Corp., Carrollton, Texas; and Intel.

Fairchild Semiconductor, Mountain View, Calif., doesn't expect to have n-channel or C-MOS devices before the end of next year, says Robert Seeds, manager of MOS technology. Instead, the company is combining its Isoplanar process with MOS to achieve a "40% savings in density over conventional p- and n-channel," Seeds says.

Making technology produce

As this process improvement proceeds, most western semiconductor houses appear similar in one respect—they all by now regard technology as basically a tool for putting products into customers' hands. For instance, National's director of marketing, Floyd Kvamme, says that ion implantation, widely regarded as a laboratory technique two years ago, can now be used in production "for speeding up standard p-MOS devices. Our ROMs, for example, used to have a maximum access time of 1 microsecond and typically 850 nanoseconds. We implanted them and now we're running typically 520-ns access times."

Ion implantation is also bearing fruit at Signetics. The firm was the first to use an ion-implanted step to build an n-channel RAM, which is a completely static 1,024-bit device that operates from a single 5-volt supply and is TTL- and DTL-compatible. The innovation was key to achieving the low threshold voltages necessary for bipolar inputs and high-logic-swing bipolar outputs.

Floyd Kvamme
National Semiconductor Corp.

National is another on the market with C-MOS logic. The firm calls its family 54/74C. Richard Bennett, MOS product marketing manager, points out that the family has the low-power advantages of C-MOS plus relatively high speed—45 ns per gate. It's also pin-for-pin and power supply compatible with TTL.

Two Southern California firms with a major commitment to C-MOS are Hughes Aircraft Co. and Solitron Devices. The Hughes Microelectronic Products division in Newport Beach is shipping C-MOS watch circuits to Timex, among other watch customers, while Solitron, in San Diego, has contracts "from several major watch manufacturers, with others under discussion," says Joe McNeal, sales manager. The only customer he'll name is Optel. Solitron is also introducing C-MOS versions of 54/74 TTL.

Even as this variety of MOS processes is spawning more and more products, linear ICs, long in a sales slump, are coming back mightily. Part of the resurgence is again the result of technology maturation. National's Kvamme says the biggest breakthrough has come with the application of super beta transistors in the low power domain. National's newest generation of operational amplifiers uses such transistors to get very low input current with high gain.

Linear revival

At Fairchild, Will Steffe, manager of the analog product design and development group, adds that in linears, "the biggest improvement has come in power technology. We've learned how to build safe power devices on the same chip as small-signal devices without affecting the properties of the small-signal circuits." The technique is used in Fairchild's Series 7800 voltage regulators, the μA 706 5-watt audio amplifier, and in a 15-watt op amp, the 791.

Super beta has come of age at Intersil, too, and Motorola expects to have its super beta process back in hand by the fourth quarter. Intersil and Fairchild are also offering linear ICs using field-effect transistor inputs. Intersil's 8007 FET input op amp is a monolithic version of an earlier custom hybrid design.

As linears make their comeback, TTL rolls on as undisputed leader in digital logic sales. But the battle lines are shaping up in emitter-coupled logic. Motorola's MECL 10,000 series has taken the spotlight. MECL was almost 10 years ahead of the market's readiness, but the 10,000 line has significant alternate sources now in National, Signetics, and TI, although TI's is not identical to Motorola's. The only other ECL contender is Fairchild's 95100 ECL series. Most sources believe, however, that ECL's big sales years will begin in 1974. □

AEROSPACE

Diversification begins to pay off

The Pentagon wants more money for defense in fiscal 1973, and at least one major new aerospace award that will trigger electronics sales—the space shuttle—has been pocketed by a West Coast company. But from the pace of new business ventures among Coast aerospace and electronics firms, including diversifications through both acquisitions and internal start-ups, it's apparent that efforts to cultivate non-Government markets remain attractive, and a few have already been successful.

The $2.6 billion space shuttle contract that went to North American Rockwell Corp. [*Electronics*, Aug. 14, p. 44] is a pointed reminder that there's not going to be any stampede away from the traditional NASA and military markets that western companies have served. But after many failures at diversification, it looks like the application of aerospace-oriented expertise to other Government buyers, and to the commercial and industrial marketplace, is beginning to work. What's more, a few of the aerospace giants are attempting the toughest diversification of all—into the consumer market.

Throughout the business, though, whether it be in commercial or Government markets, "the trend is away from exotic equipment and systems." That's the feeling of James R. Mellor, Litton Industries' senior vice president, who adds, "We've been creative in technology all along. Now we're trying to apply creativity to reducing costs and also to improving reliability and maintainability."

Diverse routes to diversification

Two of the most dramatic diversification moves have been the steps into the consumer world taken by North American Rockwell and Hughes. Both started by supplying MOS circuits to consumer equipment manufacturers, then got into making the whole product. NR's Microelectronics Co., Anaheim, Calif., jolted the industry in June with the announcement that it was manufacturing complete calculators for Sears, Roebuck & Co. and two other retailers. And NR is acquiring Unicom Systems, a distributor of calculators with numerous retail outlets that could also be used for other kinds of business machines. With less fanfare than NRMEC, Hughes Aircraft Co. is also beginning to assemble consumer products, putting together electronic watches with light-emitting diode displays in Mexico.

Another consumer business Hughes is after is cable TV. The company's Theta-Com subsidiary, operating franchises in Manhattan and Los Angeles, is experimenting with two-way transmission in El Segundo, Calif., and is active in manufacturing cable equipment. And to tie together cable TV networks and provide nationwide distribution, Hughes—supplier of such communications satellites as the Intelsat 2 and 4 and the Canadian Anik domsat—has applied to the FCC for permission to operate a domestic satellite system for itself and General Telephone and Electronics. GTE would use the system for its telephone subsidiaries, which are concentrated in Florida, California, and Hawaii, to reduce dependence on AT&T.

The lure of commerce

But few aerospace firms are actually moving into consumer products, feeling that the shift to the commercial/industrial world is tough enough. Direct application of aerospace experience is the key to most of the new commercial products. Litton Industries, Beverly Hills, Calif., has organized a Business Telephones group in its Litcom division. The group, using technology developed in Government programs, is breaking into the commercial field with business telephone equipment, such as PABX switchboards for hotels and large offices, and even handsets.

Already the company has received a large contract for communications at the huge new Dallas-Ft. Worth airport, and Mellor expects five or six other such contracts ahead. "The FAA has been all talk in the past," he says, "but now it's starting to spend money."

Another firm applying aerospace technology to civilian problems is NR's Information Systems Co. (Narisco). It looks for substantial growth in public-utility management systems, such as that it developed for the Philadelphia Electric Co., and is also looking in other directions. J.C. Cozad, NR's Electronics group vice president for financial management, points out that "We won't butt heads with IBM mainframes. Peripherals are our major interests." That's why Narisco has just bought a power utility control system product line from Philco-Ford Corp. The products are principally CRT displays and display generators.

One unusual spin-off of aerospace technology has occurred in Hughes's Electron Dynamics division, where heat-pipe technology developed to cool satellite travelling-wave tubes is now being applied to surgery and cooking. The Hughes Cryostik applies the intense cold from liquid nitrogen to the end of a slender pipe to remove warts and reduce hemorrhoids. The same heat-pipe technology can provide very even heat for restaurant and military field-kitchen griddles.

Boeing Electronics, Seattle, a group formed last year, makes monolithic and thin-film circuits. It is also involved in systems work and is pushing a voice scrambler for police applications. Its latest product is an rf transis-

tor, which features exceptionally low distortion, aimed at the cable TV industry.

One route to diversification, of course, is acquisition of unrelated activities. Six months ago, for example, Northrop Corp. acquired Berkeley Scientific Laboratories Inc., a supplier of clinical data-processing systems. The company has just split the operation, with one group going after hospital users. The other will pursue minicomputer-based business-data systems for companies and institutions that can't justify the costs of large data-processing installations.

Collins Radio, headquartered in Dallas, is beginning to look more toward the civil agencies of the Government for sales and toward new, non-Government markets. The company sees a future in marine radio, especially as the Government puts more and more controls on navigation and safety. Collins is also beginning to adapt its well-equipped worldwide service locations to handle other companies' equipment.

Cubic Corp. is going strong in transportation-related electronics with two separate ventures. One is the recent acquisition of Western Data Products, which makes automatic ticketing equipment for trains and rapid-transit systems. Three years ago, Cubic bought the small U.S. Elevator Co. and introduced electronic controls. Since then, sales have grown from under $1 million to a projected $25 million or more by the end of the year.

Stretching the Federal dollar

Despite all the diversification efforts—and there are many more in non-electronic areas—companies are not ready to abandon sales to the Government. A lot of effort has gone into developing new types of defense and aerospace business as the traditional markets wane.

As Minuteman, the F-111, and other programs wind down, for example, NR's Autonetics division—the bulk of its Electronics group—seeks to broaden into other defense areas to replace them. "We have a real challenge ahead of us in the next few years keeping at the sales level of the past," says Cozad. "We can't maintain that level if we stick to the business we've been in. Unfortunately, though, we don't visualize any single huge program like Minuteman ahead."

Cozad feels that the group's newly organized Missile Systems division is one of its growth areas. Thomson-CSF of France has licensed NR to build its advanced Crotale (Rattlesnake) ground-to-air missile, if the Army accepts it. "This would give the Army a next-generation SAM without the cost of development," says Cozad.

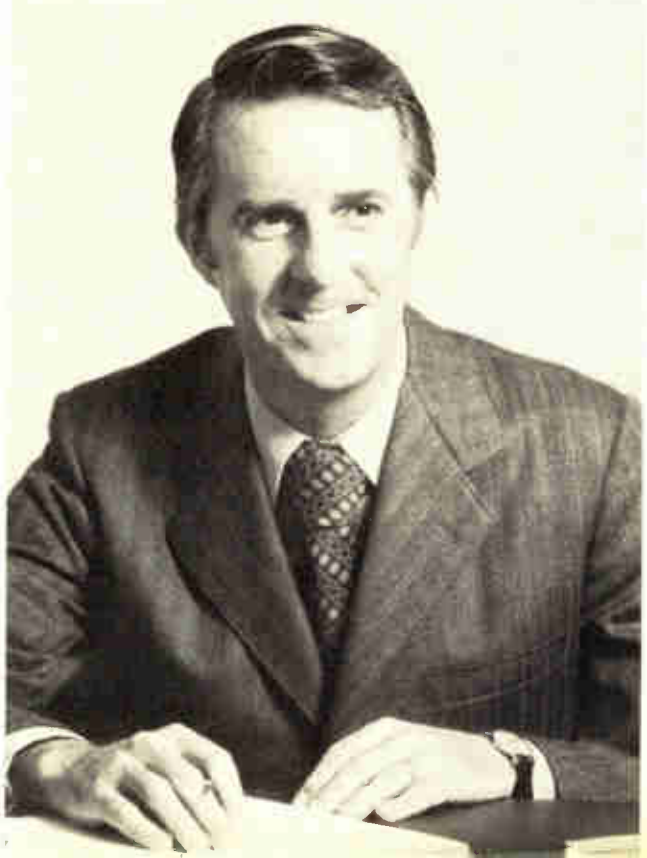
TRW Systems group in Redondo Beach, Calif., according to H.F. Del Muro, head of marketing for the Electronic Systems division, "made a decision not to go too far afield from the business we know best—communications, especially space-related communications. We're reversing an earlier decision to get into the tactical-missile business, for example."

One of ESD's recent concentrations is in triple-diffused LSI, including gigabit devices for high-speed analog-to-digital converters in secure-voice-communication applications. The group is investigating licensing.

Litton Industries has been under fire in its shipbuilding operations, specifically for cost overruns and delays in the LHA and DD-963 destroyer programs. But other defense business, grouped under Mellor, is increasing, while Litton is diversifying and expanding operations overseas. Inertial navigation, down the past few years, is looking up now with contracts for the international F-5E fighter and B-1 bomber. And now, in the SCAD program, Litton has its first missile inertial-navigation contract.

Litton's Data Systems division in Van Nuys, Calif., just received a $13.5 million order for the Tactical Operations System (TOS) that illustrates an increased demand for commonality. TOS was designed to use hardware and software developed earlier by Litton for its Tacfire automated artillery fire direction system and its AN/TSQ-73 Missile Minder. Mellor points out that this type of commonality is really having an effect. "Everyone is looking at costs—not just on my level, but down to the engineer. That wasn't done when I was doing military design work." □

James R. Mellor
Litton Industries Inc.



INSTRUMENTS

Catering to the cost-conscious

To fuel new growth, the West Coast instrument manufacturers are turning more and more to low-priced products for the cost-conscious or unsophisticated user. Their approach is changing to follow two fundamental shifts in the instruments business.

First, the biggest market of past years—the aerospace industry—is still becalmed by a dearth of major new program starts, which means that high-priced digital multimeters and oscilloscopes aren't selling at anywhere near the volume of former years. Second, the advent of complex LSI functions happily has allowed the western instrument houses to bring out new products that can be sold for less than $1,000 or even $500. Aimed at industrial markets, these instruments fill the gap left when aerospace orders faded drastically.

In broadening their market base with lower-priced lines, instrument manufacturers have encountered a new kind of customer, too. He's not the sophisticated user who could often troubleshoot and correct minor problems with the instrument, which is typical in the aerospace industry. The new customer is not always electronics-oriented, and often an instrument has to be protected from damage by built-in safeguards.

Shopping for value

Al Oliverio, marketing manager for the Hewlett-Packard Co., Palo Alto, Calif., Electronic Products group, says that to broaden its market, H-P is building instruments designed to be used by people who are not interested in how the instrument works or how it is calibrated—only that it works when they need it. All of this started during the economic slowdown a few years ago when "people stopped buying instruments on specs alone," says Oliverio, "and they started looking for value." And now H-P, as well as Tektronix, Dana Labs, John Fluke and Cimron Instruments, to name a few, are making instruments aimed at the value-conscious customer, who is often an industrial maintenance or service man.

James F. Helfrich, marketing manager at Dana Laboratories Inc., Irvine, Calif., probably speaks for his colleagues at competing companies when he says, "While our main instrument business still lies with the sophisticated, more-expensive instruments, we are looking towards the industrial market for growth." Along this line, Dana introduced what it calls a "goof-proof" multimeter, earlier this year [*Electronics*, May 8, p.151]. Both 3½- and 4½-digit versions are available, and both can be used efficiently by unskilled people.

Both units feature an LED display that is blanked if the battery power is too low for the instrument to operate to its full specifications, thus preventing false readings. Further protection is offered by means of interlocking cams that prevent the user from setting improper combinations of ranges and functions.

The John Fluke Co., Seattle, Wash., is another company going after the industrial digital multimeter market [page 102]. The Fluke unit is internally protected so that up to 1,200 volts can be applied to the instrument, even on the 100-millivolt scale, without damage. On the ohms scale, up to 130 volts rms can be applied without causing damage, and the current input is protected by a 2-ampere fuse.

But while the Fluke meter is designed for the unsophisticated user, and is priced for his pocketbook at $299, it by no means is unsophisticated itself. For such instrument makers as Fluke to put more value into their products and still sell them for less money, they have had to turn to the semiconductor makers and their LSI subsystems. The Fluke DMM, for example, contains what is probably the first commercially available monolithic integrated circuit that incorporates both bipolar and p-channel MOS transistors in an analog circuit.

No-frills approach

Both Fluke and H-P, with its multimeter system introduced last spring [*Electronics*, June 5, p. 135] chose to leave off the frills to keep the price down. Autoranging, for example, was not included in either instrument.

The H-P modular system was developed so that the customer doesn't have to keep on rebuying the power supply and display each time he buys a new instrument function. The heart of the system is a power-supply display unit and the plug-ins consist of a d-c voltmeter, a multimeter, a battery pack, and a binary-coded-decimal output module. Oliverio says that others are planned.

The unsophisticated scope user hasn't been forgotten

James F. Helfrich
Dana Laboratories Inc.

either. Last year Tektronix Inc., Beaverton, Ore., introduced the Model 211, a laboratory-quality single-channel 500-kilohertz scope that's battery-operated, priced at $500, and intended for field maintenance [*Electronics*, Oct. 11, 1971, p. 107].

Like the Fluke DMM, the key to the scope's price, performance, and size is linear LSI. Most of the 211's circuitry is contained in three monolithic ICs, all designed and made by Tektronix. And also like the Fluke instrument, the circuits use MOS and bipolar transistors.

Although Cimron Instruments' Chuck Hasley, product marketing manager, agrees with many of his western counterparts about the trend to lower-priced instruments, he's apparently encountering a more demanding customer than some. Hasley says that for all classes of instruments, there's a demand for better normal-mode rejection. In the low-priced field particularly, more customers are also asking for autoranging.

"Users are complaining that they're wearing out the switches on non-automatic units," Hasley comments, "and they now have enough money to pay for autoranging." Cimron is in the Electronic Instrumentation division of Lear Siegler Inc., Anaheim, Calif.

Early market discoverers

While H-P, Dana, Fluke, and Tektronix are now turning to the low-cost, easy-to-use instrument market for growth, that market is by no means new. As early as 1968, Systron-Donner Corp., Concord, Calif., offered a low-priced easy-to-use integrated-circuit 4-digit frequency counter, the Model 114, with a frequency range at 1 hertz to 12.5 MHz, that sold for $395.

Al Oliverio
Hewlett-Packard Co.

J. E. Niebuhr
Systron-Donner Corp.

The lower prices have been made possible, in part, by the availability of complex semiconductor functions. J.E. Niebuhr, marketing manager for Systron-Donner's Instrument group, points out, "With complex integrated circuits, we have more function available within a given package, and so our cost of engineering comes down. Thus we can give the customer more performance for less dollars." And that's important—whether the user is sophisticated or not.

Although Systron-Donner also has a $300 digital multimeter in its line, and other easy-to-use instruments "in the sub-$500 area" are planned, the company isn't putting its seed money into low-cost products. Nor is Non-Linear Systems Inc., Solana Beach, Calif., where the emphasis is almost exclusively on high-price, high-quality business, says instrumentation marketing manager William Faulkner. There's no attempt at NLS to get a piece of the low-cost action in its mainstay digital measurement product lines, but the company is diversifying into the systems business—specifically into moderately priced data-acquisition systems.

At E-H Research Labs, Oakland, Calif., the low-cost instrument trend began two years ago with what the company calls its Generation 70 line. The first two products are a $395 pulse generator and a $545 MOS driver. Richard Aston, vice president of manufacturing at E-H, says, "We intend to continue development on the Generation 70 line, and there will be some new products added in six months or so."

Program blends technology, careers

This year, the staff and directors of the Western Electronics Show and Convention have extended their awareness of the continually changing role of the electronics engineer. Instead of the typical technical program of a decade ago, which consisted of more than 40 vertical sessions, Wescon has assembled what it calls—for the first time—a professional program.

Of the 28 sessions scheduled for Sept. 19 to 22 at the Los Angeles Convention Center, about 20 are on technical subjects, but non-engineering topics are sprinkled liberally among the presentations. Don Larson, Wescon's general manager, explains the recently emerging shift toward engineering management in the program content: "Each department in a company is becoming a profit center, so engineers have to be concerned with marketing—they have to take on greater responsibility."

And Ted Shields, the show's assistant general manager, sheds light on how the program committee arrived at its outline: "The committee pulled this program together, based on the premise that diversification is happening. The technologist has to know how his circuits will cost out, and he is sometimes forced into being a member of the marketing team." There's also a strong indication in the program of concern for engineering as a career.

The technical program

The program committee, however, has attempted to focus on technical trends and the application of technology to new tasks with such hot subjects as magnetic bubbles, computer networks, digital displays, programmable calculators, and trends in modern data-communications test equipment. The working engineer is also the target of sessions that are devoted to the applications of ICs in consumer products, electronic systems for autos, electronics in traffic and highway systems, digital processors in flight control, and trends in medical instrumentation.

Nor has the impact of the switch to computers in devices and systems design been overlooked. Computers, computer networks, software, and peripherals are the subjects of eight full sessions.

In the bubble domain, speakers from Hewlett-Packard, IBM, Rice University, and the Autonetics division of North American Rockwell will approach magnetic bubbles from a materials standpoint, will assess propagation methods, plus bubble logic and memory organization, and will ultimately home in on applications for this fledgling technology. It's significant, though, that no speaker from Bell Laboratories, the bubble pioneer, is included in the session.

The session devoted to competing technologies for digital displays—session 10—could produce some fireworks. Gas discharge displays will be discussed by a Burroughs Corp. speaker and light-emitting diodes by a Monsanto Co. representative, while liquid crystals will be covered in a paper from Ilixco.

In sessions related to computers, a much-talked-about, but as yet little-seen technology—electrically alterable nonvolatile semiconductor memories—is the topic of session 4, with papers scheduled by speakers representing NCR, Nitron Corp., Litton Industries, and Intel Corp. The emphasis of four of the five papers is on applications, particularly in computer peripherals, indicating that these memories may be on the threshold of acceptance.

The career program

But with all its technology emphasis, the career-oriented portions of the program are particularly appropriate in a region that's been decimated by unemployment as the halcyon days of the aerospace industry faded. Session 3, entitled "New Career Opportunities for Engineers," will examine the skill profile of the unemployed engineer, point out programs to aid him, show him emerging fields of opportunity, and suggest how he might enter those new fields.

Bruce Angwin, director of the medical-engineer program in the Department of Labor's technology utilization project, is session organizer and chairman. He explains that the session has grown out of at least two studies conducted for the Labor Department by the National Society of Professional Engineers. He says that the "whole session is aimed at applying skills to fields unrelated to the aerospace industry. If an engineer doesn't find employment in his skill, that skill is lost, and that's a national resource that shouldn't be lost," Angwin concludes.

That resource needn't be lost, and one way to prevent it will be explored in session 5, entitled "Technology Transfer—a Growing National Interest," organized by Robert Diehl, of the Jet Propulsion Laboratory. "The timing is just right for such a session," Diehl asserts, because, even though the market hasn't yet jelled in pollution control or transportation, for example, "the Federal Government has taken the initiative" in spurring technology transfer. The presentation will outline state and local government programs in technology transfer, including programs sponsored by the National Science Foundation, the National Bureau of Standards, and the Environmental Protection Agency. "These programs," Diehl stresses, "will create a market for industry in the

next 10 years, but that market is fragmented now."

One vocation that offers an immediate job market for skilled engineers—be they displaced aerospace engineers or employed elsewhere—is health care. Francis M. Long, professor of engineering at the University of Wyoming, will chair session 15, "Biomedical Engineering: Educating Engineers for Careers in Health-Care Delivery," a session organized with the cooperation of the biomedical committee of the American Society for Engineering Education. Long says that, while one aim of the session is to discuss the possibility of retraining displaced aerospace engineers to work in health care, an equally important goal is to evaluate the adequacy of training for health-care delivery.

The management role

No fewer than six sessions imply recognition that the engineer will likely become a manager or will eventually be concerned with marketing, profits, world competition, product producibility, finding venture capital, or protecting proprietary technology. Sessions 6 and 22 cover "Aggressive Marketing in a Climate of Change" and "Marketing Methods for the Dynamic 70s," respectively. The former stresses direct-mail marketing, changing views on the role of media in marketing, the growing importance of distributors, and recognition that today's electronics market is worldwide. The latter, in part, treats the 1970s as a decade of communications and stresses the importance of considering that climate in marketing.

Geoffrey Ziman, president of Zi-Tech Corp., Palo Alto, Calif., an importer of high-technology products, has organized and will chair a session entitled, "The Dwindling Technology Gap—What It Means to U.S. Electronics Manufacturers." He founded Zi-Tech on the premise "that the U.S. is going to see more imports of high-technology products, and we find that it's true, so we're asking why the technology gap is dwindling. The U.S. has enjoyed some advantages because of the recent history of heavy aerospace spending. Those advantages are gone, so U.S. companies will have to work harder for their bread."

Other papers are devoted to such topics as how smaller U.S. firms can exploit differences between technology in this country and Europe, color-television technology at home and abroad, and the political and economic aspects of the technology gap as it relates to nationalism.

Producibility—the translation of engineering design into manufacturing language that ultimately leads to the fabrication of products within target costs and to specifications—is of increasing concern at a time when U.S. commercial electronics firms face withering competition from abroad, and when so many defense procurements lead to costly overruns. That's why Alfred Levy thought it would be timely to organize a session dubbed "Producibility: The Critical Engineering-Manufacturing Interface."

Levy is responsible for producibility engineering at RCA's Electromagnetic and Aviation Systems division, Van Nuys, Calif.—Most of his speakers are from a newly formed IEEE group on manufacturing technology, "so there's evidence of a real concern for producibility," he maintains. Individual papers will be devoted to military, commercial/industrial, and aerospace hardware producibility.

Both engineers and managers are the target of session 23. Thomas Schatzel, a Santa Clara, Calif., patent lawyer, is organizer of "The Business Venture and Use of Patents, Trademarks, Trade Secrets, Copyrights, and Proprietary Information." He says the session's objective "is to make electronics firms aware of these tools and what they'll provide."

He points out that there's been almost no change in the U.S. patent system since 1836 and questions how well the system is serving its function. Along with that topic, speakers will discuss recent laws and Supreme Court decisions of the last five years affecting proprietary information, including tape piracy and the patentability of computer programs. □

Panel to probe new goals

A top management panel will assess new goals in electronics as part of Wescon's professional program at 2 p.m., Sept. 20. The panel, to be held in Room 216 of the Los Angeles Convention Center, has been organized by Charles V. Kovac, vice president for marketing at North American Rockwell Microelectronics Co. As panel chairman, Kovac represents a manufacturer of MOS LSI.

The five panel members offer a cross section of the electronics industries, including traditional equipment makers, so-called "new" firms, associations and societies, publications, and the computer companies.

IBM's vice president for operations at its components division, Erich Bloch, will speak for computer manufacturers, while Robert L. Boniface, vice president for marketing at Hewlett-Packard Co., will present the view of traditional equipment makers.

J.E. Smith, president of the Business Products group at Victor Comptometer Corp., has been designated the spokesman for new electronics firms. Victor recently began converting its calculator lines from electromechanical to electronic components. John J. Guarrera, president of Safety Communications Inc. and an IEEE regional director, will present the associations and societies point of view.

Daniel A. McMillan III, publisher of *Electronics*, will be the representative for electronics publications.

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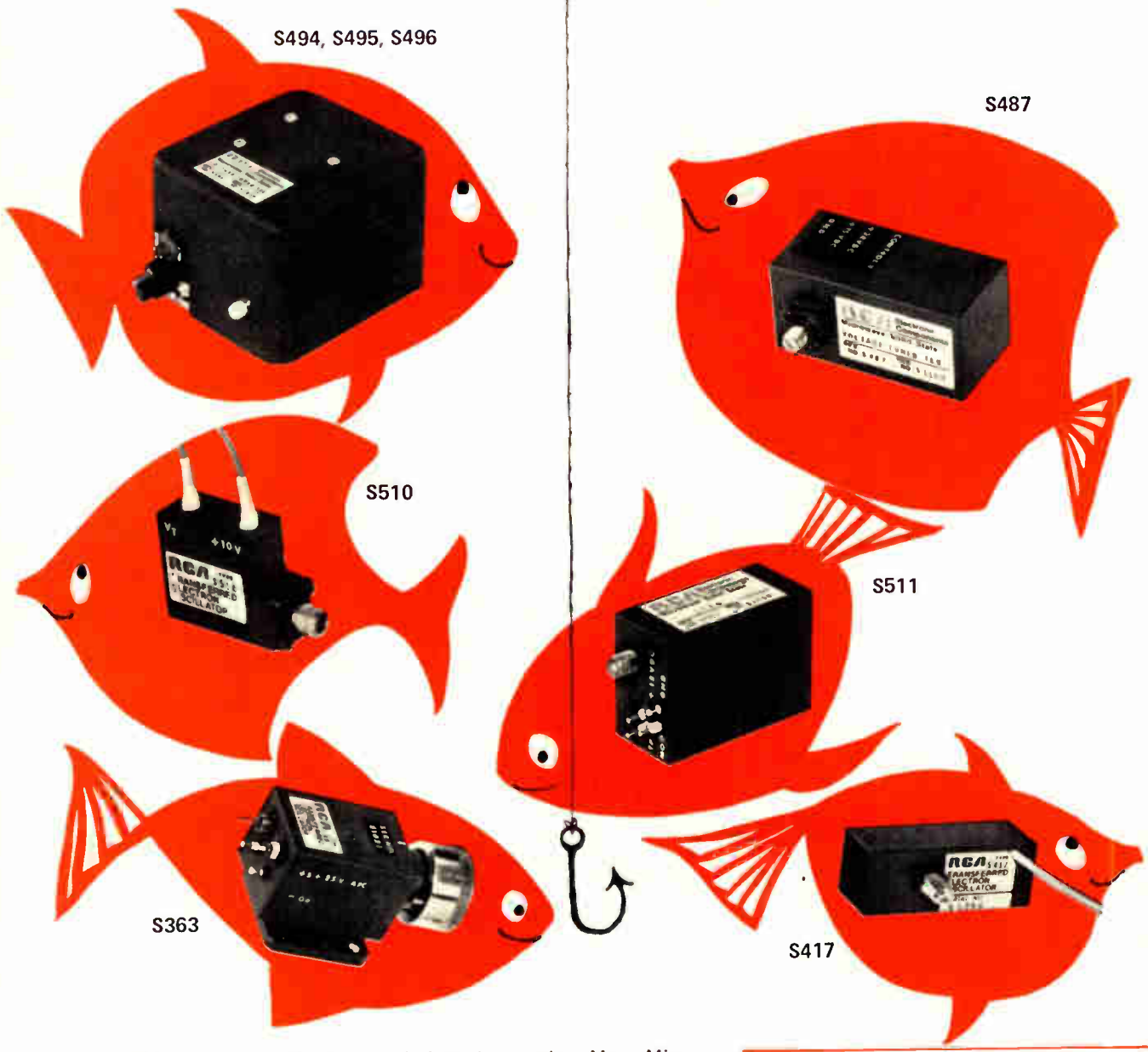

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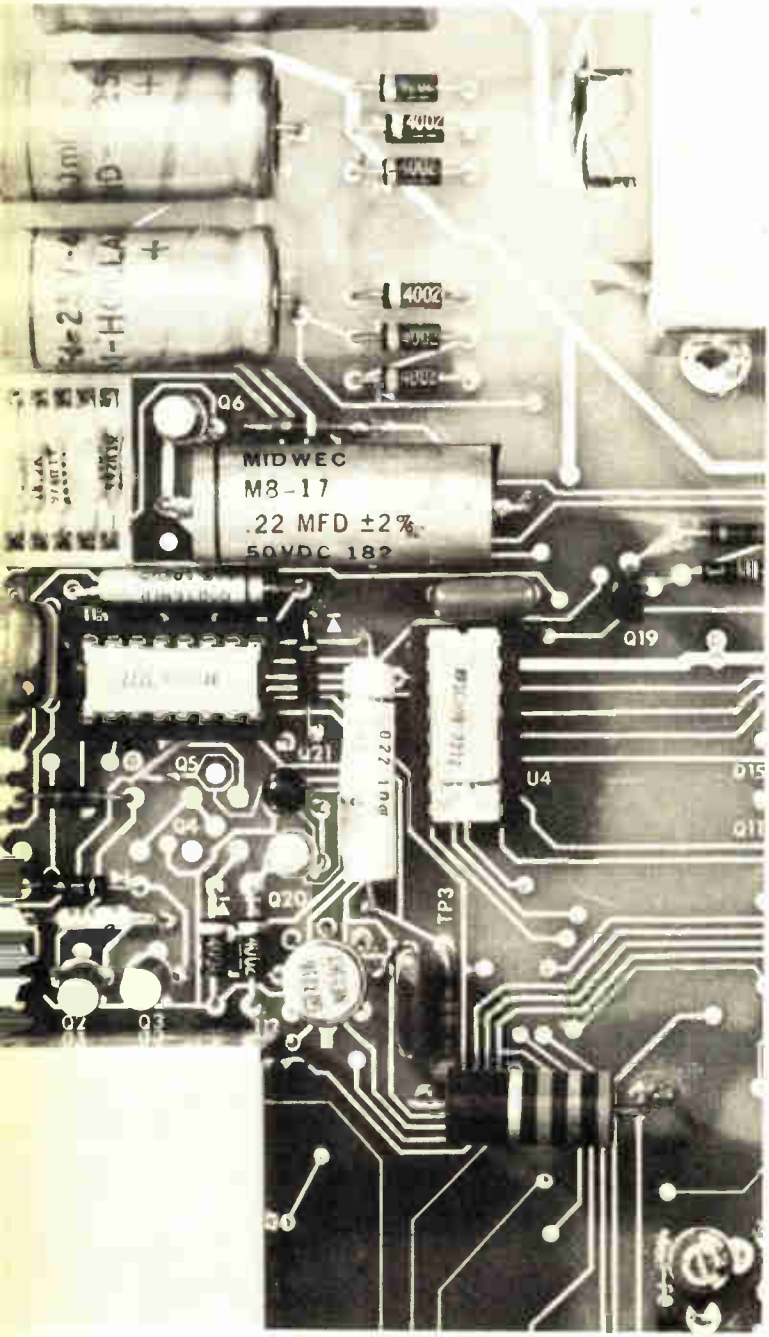
RCA
Microwave Devices

RCA Family Type	Family Freq. Coverage (GHz)	Device Tuning Range	Typ. PO	Comments
S494	2.0 – 4.0	Elect. 2 GHz	10 mW cw	Electronically tunable ± 40 MHz linearity
S495	4.0 – 8.5	Elect. Any 3 GHz	10 mW cw	Electronically tunable ± 50 MHz linearity
S496	7.5 – 12.0	Elect. Any 4 GHz	10 mW cw	Electronically tunable ± 60 MHz linearity
S487	8.0 – 12.0	Elect. 500 MHz	30 mW cw	ΔF ± 10 MHz −45C to +85C
S510	8.0 – 12.0	Elect. 500 MHz	30 mW cw	Low AM/FM noise
S511	8.0 – 12.0	Mech. 400 MHz FM 30 MHz	60 mW cw	ΔF ± 50 MHz −54C to +100C
S363	14.0 – 16.0	Mech. 500 MHz Elect. 80 MHz	5 mW cw	ΔF ± 15 MHz −40C to +95C Hermetically sealed
S413	4.0 – 8.0	Mech. 500 MHz	10–120 mW cw	ΔF ± 6 MHz −40C to +70C
S427	8.0 – 12.0			
S417	4.0 – 8.0	Mech. 500 MHz	1 – 7 W Peak	ΔF ± 10 MHz −20C to +70C
S431	8.0 – 12.0			

LSI converts an old technique into low-cost a-d conversion

Abandoned years ago because of its high parts count and need for costly components, the voltage-to-frequency converter has been revitalized by advances in large-scale integration

by Norman Strong, *John Fluke Manufacturing Co., Seattle, Wash.*



The v-f converter, housed in the two IC packages on the left-central portion of the circuit board, is the heart of Fluke's new multimeter.

☐ Sometimes it pays to revive a discarded technique because of the progress technology has made in the meantime. It certainly paid a project team confronted with the problem of choosing a low-cost a-d conversion technique for a new 3½-digit-multimeter—the company's first effort in the low-price field.

The team reviewed all the methods ever used in the hope that low-cost custom LSI circuits might make some obscure or abandoned technique attractive once again. The goal was a minimum-cost a-d converter that would provide the 0.1% accuracy required by a 3½-digit meter, while overcoming several shortcomings of the well-known dual-slope integrator.

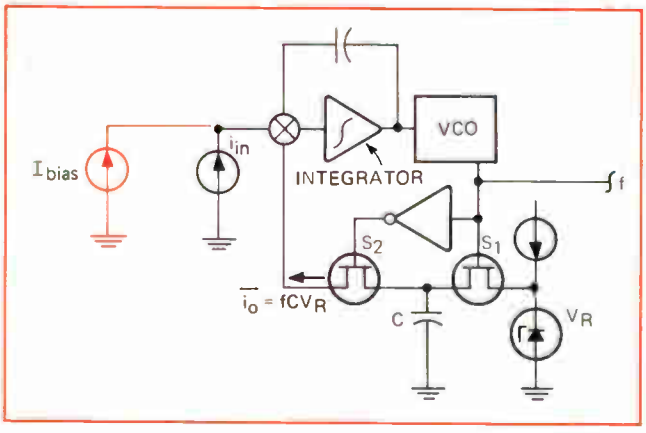
As good long-term stability and reliability were also important, the resulting investigation led to the once common voltage-to-frequency converter. This technique is rarely used now because of its extremely high parts count and its dependence on many stable—hence costly—components.

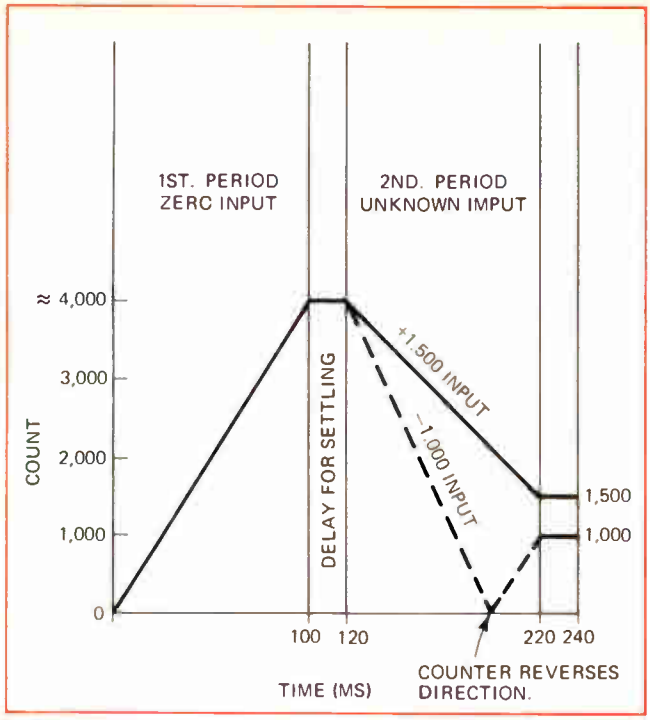
Integration is the way

The integrating converter has almost completely captured the low-cost market, and for some very good reasons: it is low in cost, low in parts count, and has excellent noise-rejection properties. Its only important disadvantage—low conversion speed—is of little consequence in a bench instrument.

Among integrating techniques, dual-slope integration

1. Bias. Without an added bias supply, the basic voltage-to-frequency converter is impractical—it requires the VCO output frequency to go to zero when i_{in} does, and it's strictly unipolar.





2. Timing. During the first period, the converter counts the VCO center frequency. Then it reverses direction and counts the VCO output frequency with the input signal applied. In this way, zero offset errors are removed and other systematic errors are cancelled.

is presently most popular in the industry. But despite its accuracy and stability, this ratio-measuring technique does have drawbacks. Bipolar operation gets rather complicated, invariably requiring much additional circuitry as well as separate calibration adjustments for each polarity. Automatic zeroing, too, can become rather sticky, requiring considerable analog switching and a sample-and-hold circuit.

The voltage-to-frequency type of a-d converter, however, held out the hope of eliminating these drawbacks, and at the same time allowing much of the circuitry to take LSI form. The final design fulfilled this promise—it solves both the bipolarity and the zeroing problems, and constitutes an advance in the state of the art.

Like the dual-slope approach, v-f conversion is an integrating process. But instead of counting a fixed frequency for a variable length of time, as the dual-slope converter does, the v-f converter counts a variable frequency for a fixed period of time. In both cases the final accuracy depends on the accurate conversion of a voltage into time or frequency.

The starting point

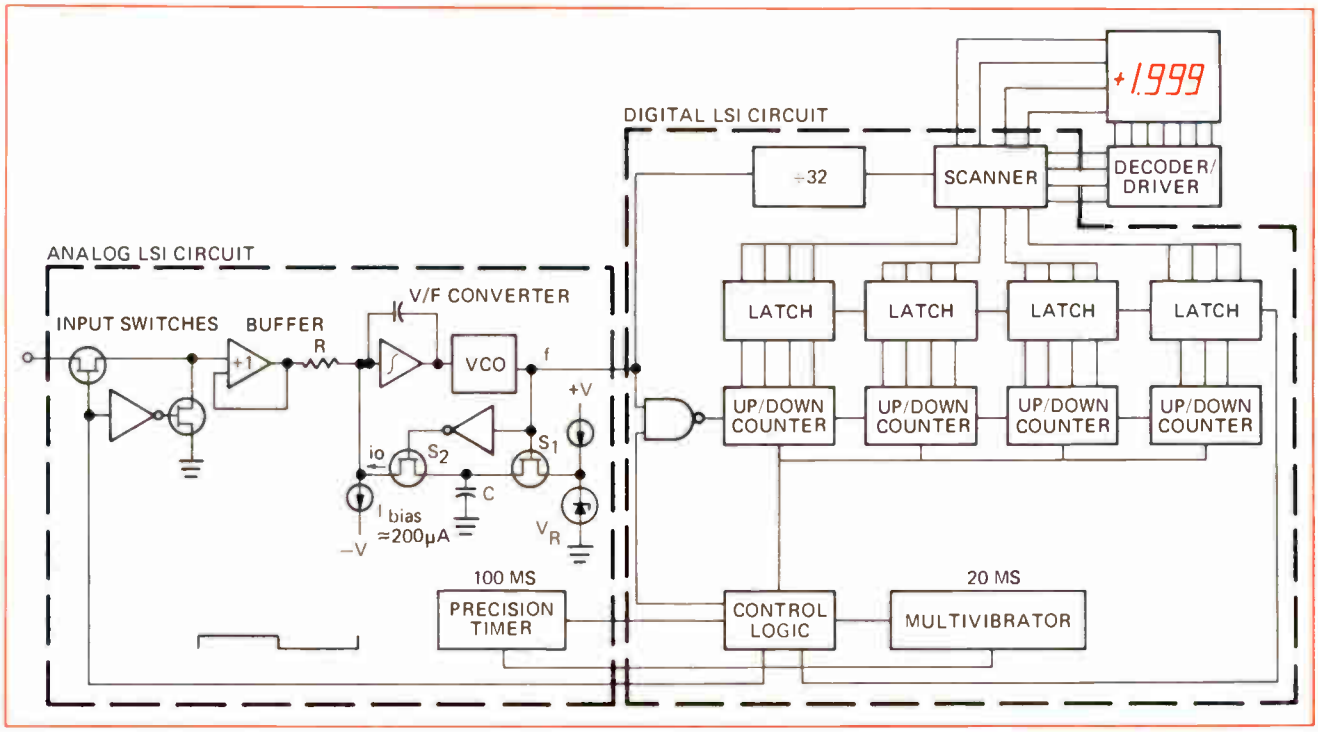
Figure 1 is a block diagram of a negative-feedback v-f converter. Although it is obviously a current-to-frequency converter, the voltage terminology is retained for simplicity's sake and because the unit will ultimately become a v-f converter.

If they were perfect, components S_1, S_2, C, and V_R (Fig. 1) would constitute a precision frequency-to-current converter. On one half of a cycle, S_1 turns on, placing a charge CV_R on the capacitor. On the other half cycle, S_1 turns off and S_2 dumps the entire charge into the input of the integrator. This is repeated every cycle, giving rise to an average output current of $i_o = fCV_R$.

Since the integrator, the voltage-controlled oscillator, and the frequency-to-current converter form a closed negative-feedback loop, the frequency, f, will stabilize at a value that makes the sum of the currents into the summing junction equal to zero; that is, $i_o + i_{in} = 0$.

But since $i_o = fCV_R$, it is clear that $i_{in} = -fCV_R$, and f

3. LSI. Almost all of the circuitry for the complete a-d converter fits onto two custom LSI chips. The analog chip is unusual in that it contains both p-channel MOS and bipolar transistors. Note that the decoder/driver and display are not included in the LSI chips.



is proportional to the negative of i_{in}. The circuit of Fig. 1 is therefore a linear I-f converter. However, as it stands it is not very practical. For one thing, it requires that the frequency go to zero when the input does—a prodigious requirement for any practical VCO. For another, it can only accommodate one polarity on the input, at least until negative frequencies become available.

The solution to both these problems is to add a fixed input current bias, I_{bias}, as shown in color in Fig. 1. If I_{bias} is chosen to be much larger than the range of i_{in}, then the total input current and, hence, the output frequency will undergo much smaller percentage changes, and will not reverse polarity, as i_{in} moves through its bipolar range.

Side effects

The price of adding the bias current is the loss of calibration and polarity information. But this problem can be overcome.

With the bias current added, it is clear that the relationship between output frequency and current is given by $i_{in} + I_{bias} = -fCV_R$. If two successive measurements are made changing only i_{in} between the two,

$$i_{in1} + I_{bias} = -f_1CV_R \quad (1)$$

and

$$i_{in2} + I_{bias} = -f_2CV_R \quad (2)$$

Subtracting Eq. 2 from Eq. 1 gives

$$i_{in1} - i_{in2} = -CV_R(f_1 - f_2) \quad (3)$$

But if i_{in1} is set equal to zero,

$$i_{in2} = CV_R(f_1 - f_2) \quad (4)$$

and the unknown input current is a function of the difference between two frequencies. To measure this frequency difference, the signals are gated into a reversible counter, which counts up during f_1 and down for an identical period during f_2. With the proper choice of period, C, and V_R, the difference stored in the counter will be a digital representation of i_{in2}.

What if i_{in2} is negative? Frequency f_2 will be greater than f_1 and the counter will count down past zero during f_2. The problem is solved by reversing the count direction at zero so that it is once again counting up. The final count will then be the same regardless of the polarity of i_{in2}. The correct polarity is indicated by the fact that the counter went past zero and reversed direction.

Time scheme

The operating cycle of the converter is illustrated in Fig. 2. During the first 100-millisecond period, the input is shorted and the VCO is running at its nominal center frequency of 40 kilohertz, so that the counter accumulates a count of approximately 4,000. Next, the input voltage is switched into the converter, and 20 ms is allowed for settling. At the beginning of the second 100-ms period, the counter is reversed.

If the input voltage were zero, the counter would count back down to zero by the end of the second 100-ms period. Since the v-f converter has a sensitivity of −10 kHz per volt, a +1.500-v input voltage (indicated by the solid line in Fig. 2) reduces the VCO frequency by exactly 15 kHz so that, after the second period, a count of 1,500 remains in the counter.

The dotted line shows the count sequence for a −1.000-v input. In this case the frequency of the VCO is increased by 10 kHz and causes the counter to count down to 0, reverse direction, and count back up to 1,000 during the second period. The count reversal during this second period causes a negative sign to be displayed.

Note that offset currents have no effect on the converter's performance. They can be looked upon as part of I_{bias}, and since they do not change between the two measurements, they have no effect on the final reading. The same reasoning applies to the VCO: as long as its center frequency remains stable for the 220 ms needed for one complete converter cycle, there is no need for it to be precisely 40 kHz. Thus, both the autozero and bipolarity problems are solved in the new converter by being handled digitally rather than with analog circuitry.

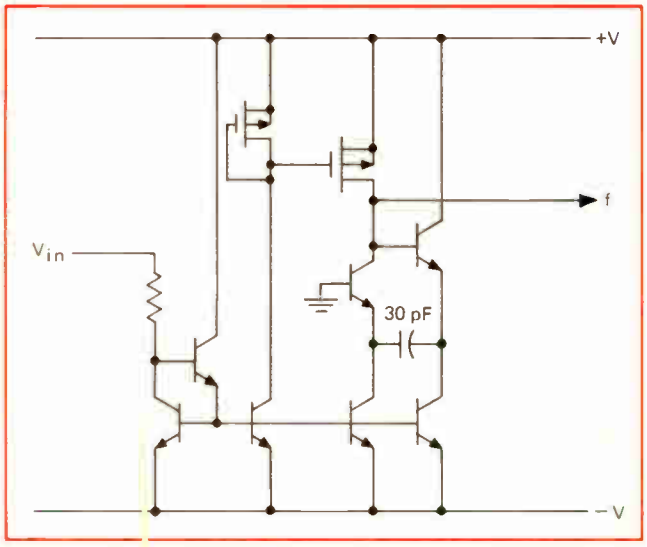
In the complete a-d converter (Fig. 3) a buffer is added to the basic v-f converter to reduce source loading, and a resistor converts the output voltage of the buffer amplifier to a current. The value of this resistor determines the range. Thus, when the converter is used in a multimeter, changing a single resistor changes the converter's range.

The input switches that precede the buffer select either zero or e_{in} as the input for the v-f converter under the control of a precision 100-ms multivibrator. The 20-ms settling period mentioned earlier follows each change of state of the input switches, to give the v-f converter time to settle to its new frequency.

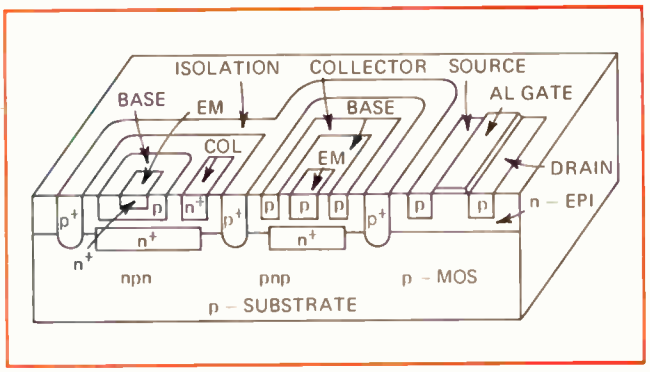
The digits in the counter can be transferred to a storage register at the end of each measurement cycle. From this register they can be made to drive a display.

Two-chip conversion

An a-d converter that's the heart of a low-priced digital multimeter also has to be as cost-effective as possible. Siliconix was therefore asked to put almost the entire converter circuitry on two IC chips. One chip conditions the analog input signal and converts it to an output frequency proportional to the input voltage. The other chip processes the variable-frequency signal to



4. VCO. This simplified version of the voltage-controlled oscillator shows the MOS timing capacitor and MOS transistors, all of which are integrated onto a single chip.



5. Four in one. Siliconix process integrates p-channel MOSFETs, npn and pnp bipolar transistors, and Schottky diodes on one chip.

produce four binary-coded decimal outputs for driving a display decoder.

The analog chip has to contain a buffer amplifier with an extremely high input impedance, two general-purpose operational amplifiers, FET analog switches, a zener diode with an exceptionally low temperature coefficient, and a VCO with a maximum deviation from perfect linearity of only 0.05%. This VCO is an emitter-coupled multivibrator with an MOS timing capacitor, entirely contained on the chip (Fig. 4).

The digital chip has to carry an up-down counter with a capacity of at least 8,000 counts and the ability to count at rates from dc to 500 kHz, storage latches, data strobe signal multiplexing, and control logic for the analog chip.

The analog chip design was based on a Siliconix process with which p-MOS FETs, npn and pnp bipolars, and Schottky diodes can be integrated on the same chip (Fig. 5). The company has used the process for the past five years, but never before on a linear IC with such complex circuits and such demanding specifications.

The p-MOS FETs were used not only as the analog switches, but also as the constant-current elements for the bias networks, thereby eliminating the need for resistive loads. This helped to reduce chip size by 25% over the conventional lateral pnp approach to bias design. Other benefits of the p-MOS bias technique are zero loading of the common voltage reference line and an improved bias-current match.

Using p-MOS FETs in a differential configuration as the front end of the buffer amplifier allowed Siliconix to provide the required picoampere level of input currents. The offset correction circuitry has a dynamic range of ±50 mV, so care had to be taken to reduce the notoriously high p-MOS differential offset voltage. Through proper geometric layout and good oxide processing techniques, the offset voltages have a typical value of 20 mV. The p-MOS inputs also give a large bandwidth for the amplifier, typically a 10-megahertz, 0-decibel crossover instead of the 500 kHz for lateral pnp.

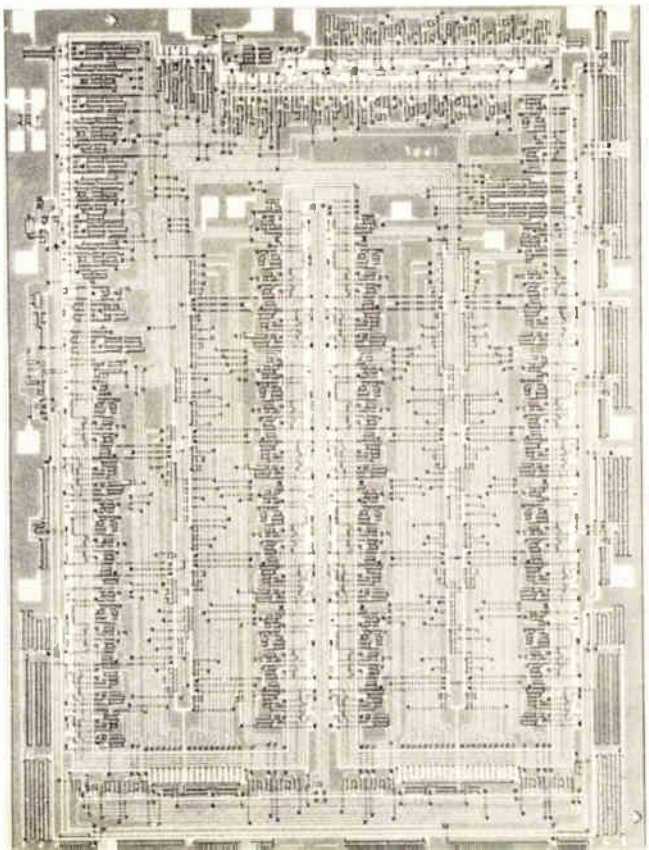
The inclusion in the circuit of a zener diode with a low temperature coefficient was a challenge for the process. The diode is a reverse-bias npn emitter-base junction in series with a forward-bias emitter-base junction. Base impurity concentration was adjusted to give the proper temperature coefficient.

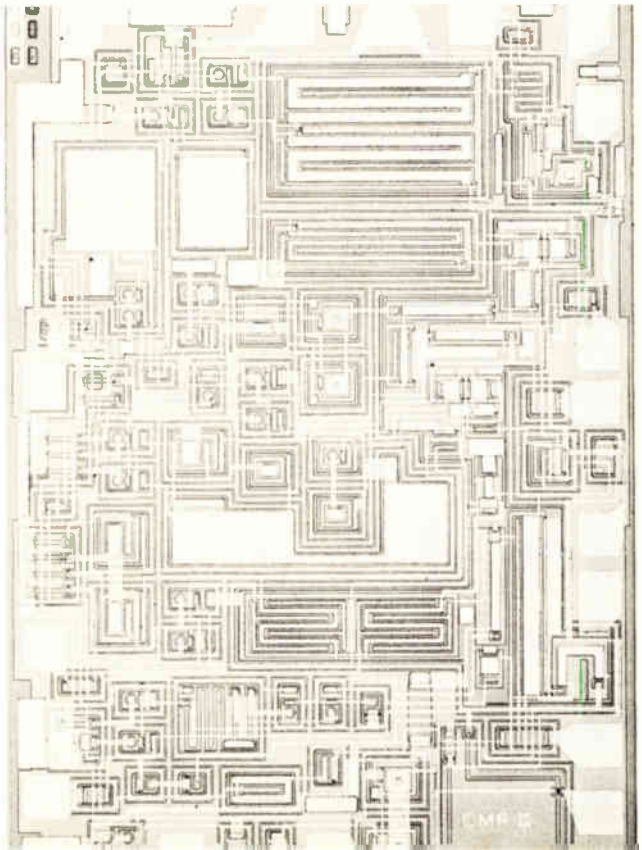
The digital chip employs convention 1-0-0 p-MOS/LSI processes. The chip measures 170 by 130 mils and contains 1,200 transistors. The strobe and BCD outputs are fully TTL-compatible with a fan-out of 2. Additional p-MOS level signals are generated to control the p-MOS analog switches on the analog chip. The chip operates from +5-V, −15-V power supplies. □

ACKNOWLEDGMENT

The author is indebted to Richard Van Saun, chief engineer, for the conception of the v-f converter, and to Peter Duryee, senior design engineer, for the design of the digital portion of the circuitry.

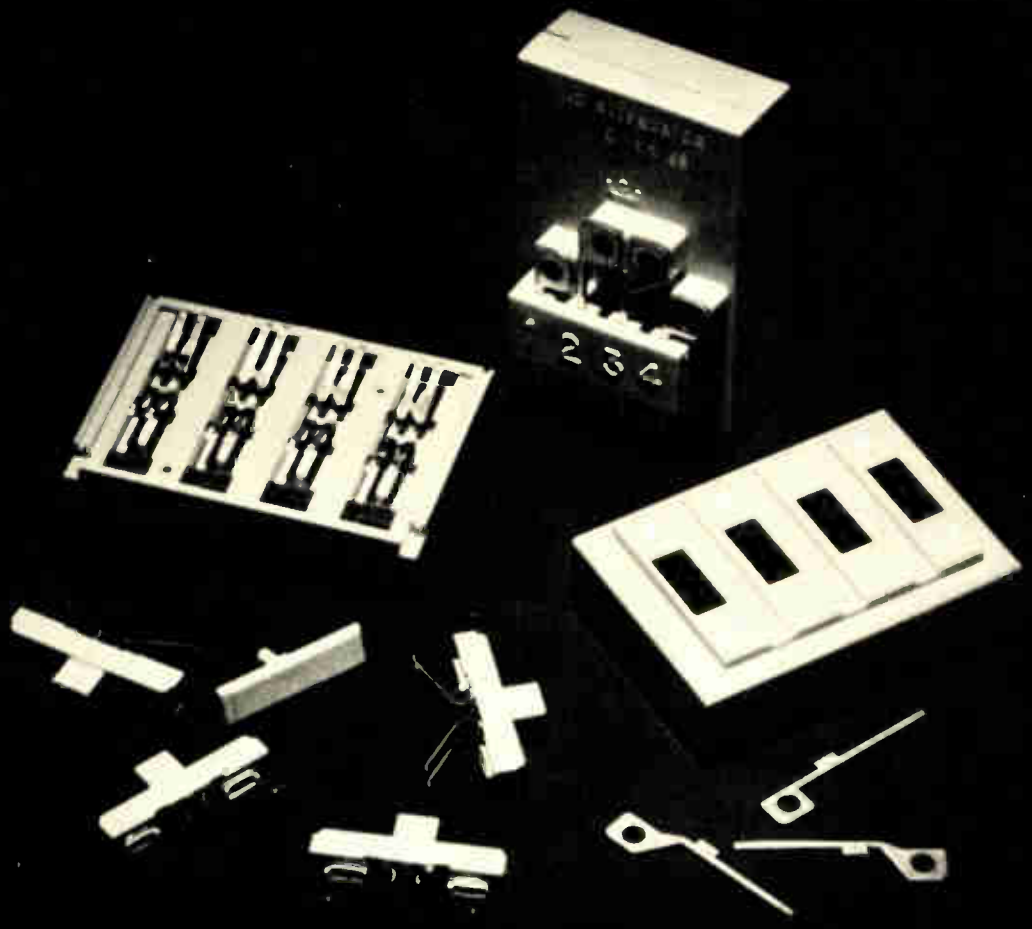
6. Chip shots. Analog chip (left) includes stable zener diode. Digital chip (right) uses conventional 1-0-0 p-MOS/LSI processes.



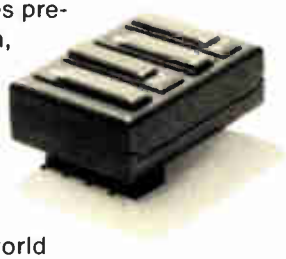


If TRW can produce precision attenuator switches in volume

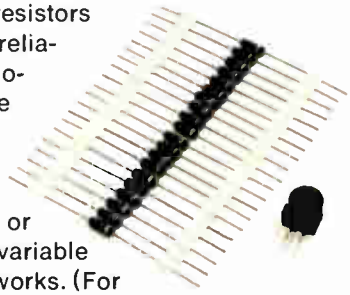
...think what TRW can do for you in fixed and variable resistors, low cross-talk cable and film capacitors.



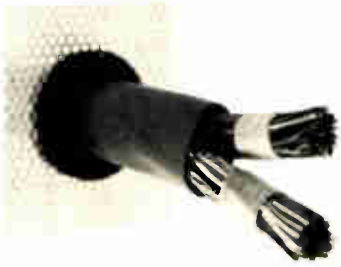
TRW/Cinch ceramic substrate attenuator assemblies illustrate Cinch's abilities to control the contact spring forces precisely during fabrication, and to weld tiny gold dots to the spring materials. Advanced manufacturing techniques such as these have helped make Cinch a leading world producer of connectors, sockets, and other electromechanical devices. (For further information, circle 89 on the reader service card.)



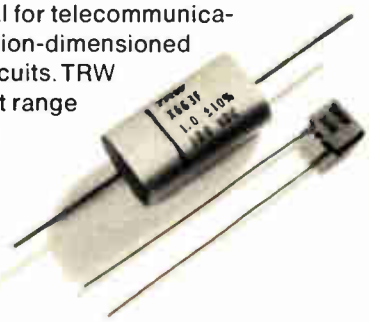
TRW/IRC resistive products cover the spectrum—from 20-year life Metal Glaze™ resistors with superior stability and reliability to Circuitrim® potentiometers in every conceivable size and style. TRW/IRC is your complete source for all types of fixed resistors (carbon composition, thick or thin film, and wirewound), variable resistors and resistive networks. (For further information, circle 90 on the reader service card.)



TRW/Holyoke wire, cable, and cable assemblies are produced in unlimited variety to meet critical requirements. These include such demands as lowest cross-talk for telecommunications, minimum impedance discontinuities for RF, and enhanced flame retardancy for home entertainment wiring. Shown is a 52-pair telephone cable, an example of a long-life, high-reliability requirement. (For further information, circle 91 on the reader service card.)



TRW metallized film capacitors are available to fit almost any design requirement. Typical are the tape-wrapped X663 (ideal for telecommunications use) and the precision-dimensioned X440 for high-density circuits. TRW makes by far the broadest range of film capacitors—both metallized and foil—in terms of dielectrics, case styles, shapes, capacitances, and voltages. (For further information, circle 92 on the reader service card.)



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Multivibrator clock obeys digital commands

by Patrick L. McGuire
General Dynamics, Electrodynamic division, Pomona, Calif.

A simple variable-frequency multivibrator clock source can be made data-dependent by controlling the current into the multivibrator's timing network. When timing resistor values are selected in increments of two (doubling the preceding value), the relationship between binary input and frequency output is linear within 8%.

Inverters with open-collector outputs act as input buffers, providing the necessary pulldown of current from the timing resistors. Diodes are added to prevent signal interference at the inverter outputs.

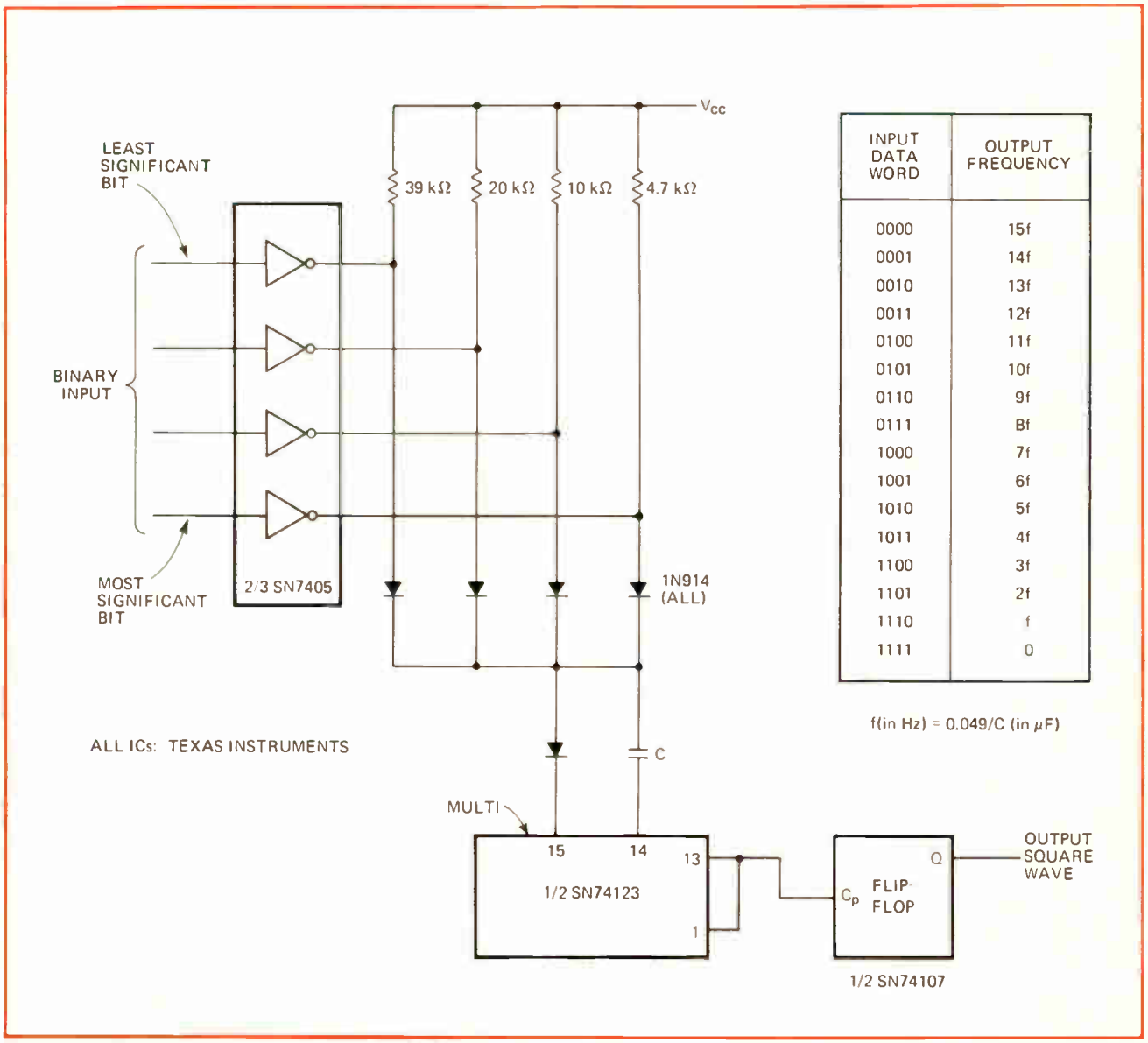
Circuit output is a square wave having a frequency of half the pulse rate from the multivibrator. Output frequency depends on the value of timing capacitor C:

$$f = 0.049/C$$

where f is in kilohertz and C in microfarads.

The graph shows the multiple of f determined by each input data word. □

Programable clock. Controlling current through multivibrator enables binary input to determine frequency of output square wave. Input/output relationship is practically linear because values of adjacent timing resistors differ by factor of two. Inverters buffer current from timing resistors, while diodes guard against signal interaction between bits. The flip-flop halves output pulse rate from the multivibrator.



INPUT DATA WORD	OUTPUT FREQUENCY
0000	15f
0001	14f
0010	13f
0011	12f
0100	11f
0101	10f
0110	9f
0111	8f
1000	7f
1001	6f
1010	5f
1011	4f
1100	3f
1101	2f
1110	f
1111	0

f(in Hz) = 0.049/C (in μF)

Op amp with feedback makes full-wave rectifier

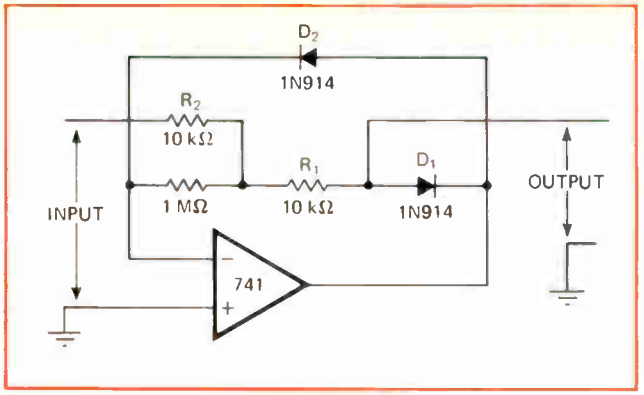
by Richard Knapp and Roger Melen
Stanford University, Palo Alto, Calif.

A feed-forward resistive element allows one operational amplifier to do the job of two op amps—perform full-wave rectification of low-level signals. The resulting circuit is useful for a wide variety of frequency-doubling and small-signal rectification applications, such as ac-to-dc converters, absolute-value detectors, and frequency multipliers.

For both positive and negative inputs, the op amp's inverting input is always at virtual ground. And for either input polarity, output voltage is developed by input current flow through feedback resistor R_1.

Diode D_1 is forward-biased during positive inputs, while diode D_2 remains off. Input current flows primarily through resistor R_1 to the output. During negative inputs, diode D_2 conducts and diode D_1 is off, maintaining the op amp's inverting input at virtual ground.

Circuit output impedance is approximately equal to the resistance of diode D_1 for positive voltages and to the sum of $R_1 + R_2$ for negative voltages. □



Full-wave rectifier. Inverting input of operational amplifier remains at virtual ground for both positive and negative input voltages so that output voltage is always developed by input current flow through feedback resistor R_1. Diode D_1 conducts only during positive inputs, and diode D_2 is on only for negative inputs. Normally, two amplifiers are required to perform full-wave rectification.

Gray-code generator avoids output glitches

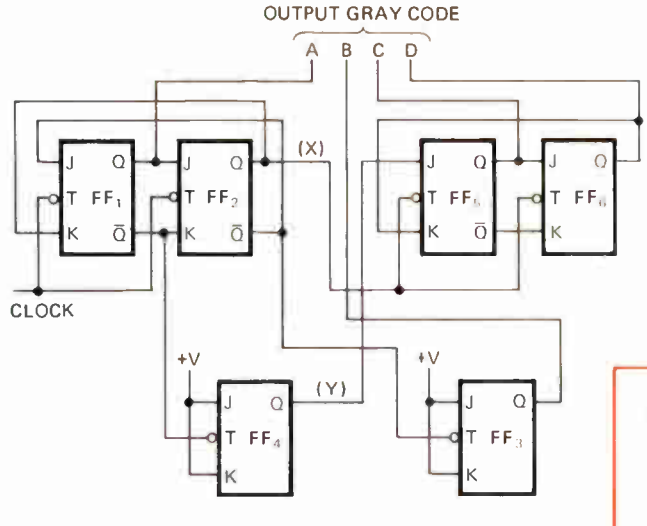
by Carl Moser
Western Electric Co., Winston-Salem, N.C.

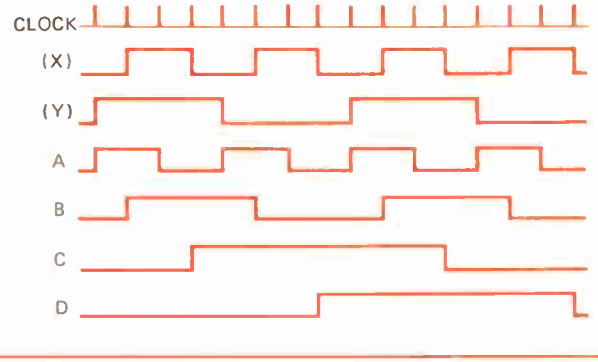
When binary signals are ANDed together, undesirable glitches can be generated at a circuit's output if one or more signal transitions are simultaneous. A Gray-code generator can be built with six J-K flip-flops that are arranged so that only one signal transition occurs at any particular time. Therefore, the four output signals forming the Gray code can be ANDed without glitches.

Flip-flops FF_1 and FF_2 are wired as a Johnson counter. The Q output or FF_1, which is 90° out of phase with the Q output of FF_2, provides the A Gray-code output line. Flip-flop FF_3 is toggled by the $\overline{Q}$ output of FF_2, causing it to produce the B Gray-code output line.

The other three flip-flops, FF_4 through FF_6, form a modified Johnson counter. FF_5 and FF_6 are toggled simultaneously by the Q outputs (labeled X and Y in the diagram) of FF_2 and FF_4. Output lines C and D are generated by FF_5 and FF_6, respectively.

Since the circuit is asynchronous, its maximum operating frequency is limited by the delay of the flip-flops. For correct output code generation, all the flip-flops must be cleared initially. □





Stopping glitches. Output lines of Gray-code generator have no simultaneous signal transitions, permitting them to be ANDed together without creating glitches. Six flip-flops comprise complete generator. FF_1 and FF_2 are connected as Johnson counter, while FF_5 and FF_6 form modified Johnson counter. FF_3 supplies one of the output lines; FF_4 is part of simultaneous toggling scheme for FF_5 and FF_6.

Active filter has separate band and frequency controls

by John Jenkins
Montgomery, Ala.

The bandwidth and center frequency of an active bandpass filter can be controlled independently by two separate resistors. Moreover, the filter's gain remains at unity over its full tuning range. Filter Q range is 2 to 200, while center frequency is 1 to 10 kilohertz.

The circuit shown in (a) has these properties, but it requires a variable inductor, which is usually difficult to tune, can be large, and cannot provide good temperature stability. The transfer function for this LC filter is:

$$e_o/e_i = (s/R_1C_1)/(s^2 + s/R_1C_1 + 1/LC_1)$$

Replacing the inductor with an active RC network, as illustrated in (b), yields a temperature-stable circuit. If all the components are ideal and $R_2C_2 = R_3C_3$, the equivalent inductance can be expressed as:

$$L_{eq} = R_2C_2R_f \text{ henries}$$

and the 3-decibel bandwidth as:

$$BW = 1/(2\pi R_1C_1) \text{ hertz}$$

and the center frequency as:

$$f_o = 1/[2\pi(R_fC_1R_2C_2)^{1/2}] \text{ Hz}$$

A wide range of component values can be used in the circuit, which is easy to design, once the desired filter specifications are established. As an example, a filter will be designed with a 5-Hz bandwidth, a center frequency of 1 kHz, and a maximum output voltage of 1 volt peak-to-peak. A few important operational amplifier specifications must also be known. Typically, input resistance (R_i) is greater than 40 kilohms, output resistance (R_o) is less than 200 ohms, voltage gain (G_v) is more than 10,000, and output voltage swing (V_{os}) exceeds 20 v pk-pk.

To solve the design equations, let:

$$K_1 = (R_fC_1R_2C_2)^{1/2} = 1/(2\pi f_o) = 1.59 \times 10^{-4}$$
$$K_2 = R_1C_1 = 1/(2\pi BW) = 3.18 \times 10^{-2}$$
$$K_3 = (R_fC_1/R_2C_2)^{1/2} = [(V_{os2}/e_{omax})^2 - 1]^{1/2} = 19.98$$

then the filter's time constants can be computed:

$$R_1C_1 = K_2 = 3.18 \times 10^{-2}$$
$$R_2C_2 = K_1/K_3 = 7.96 \times 10^{-6}$$
$$R_fC_1 = K_1K_3 = 3.18 \times 10^{-3}$$
$$R_f/R_1 = K_1K_3/K_2 = 0.1$$

For most applications, a few simplified guidelines can be followed to choose component values: resistor R_1 should be less than 400 kilohms, resistor R_2 should lie between R_{i2} (about 40 kilohms) and 1 kilohm, the load resistance should be greater than 1 kilohm, and factor $(1 - R_3C_3/R_2C_2)$ should range between 0 and resistance ratio $(R_f/R_1) \times 10^{-2}$.

This last constraint requires that time constant R_2C_2 track R_3C_3 within +0% and -0.1%. Therefore, these resistors and capacitors must have closely matched temperature coefficients and operating temperatures. Metal-film resistors and NPO-type capacitors that are mounted close together can be used. (The R_2C_2 and R_3C_3 time constants can be aligned by first opening the filter's input to obtain maximum Q, then increasing R_3 until oscillation occurs, and then decreasing R_3 until oscillation just stops.)

A set of typical component values is noted in (b). As indicated, resistor R_1 tunes filter bandwidth, while resistor R_f adjusts center frequency. □

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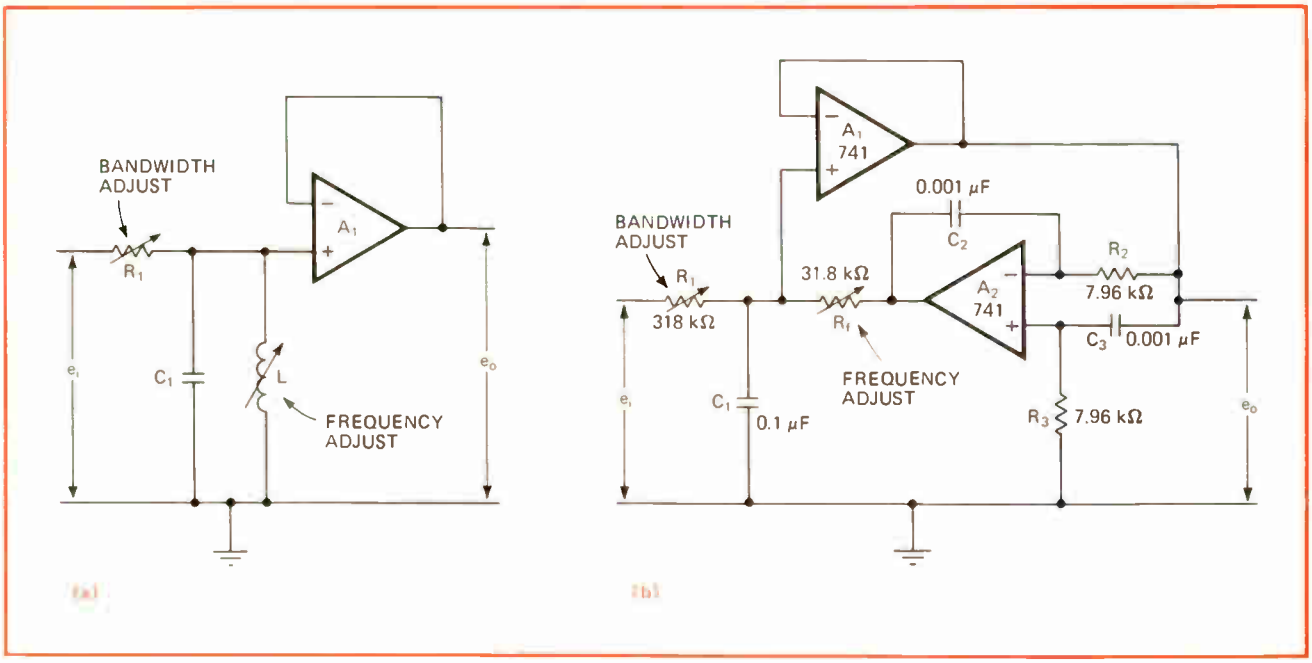
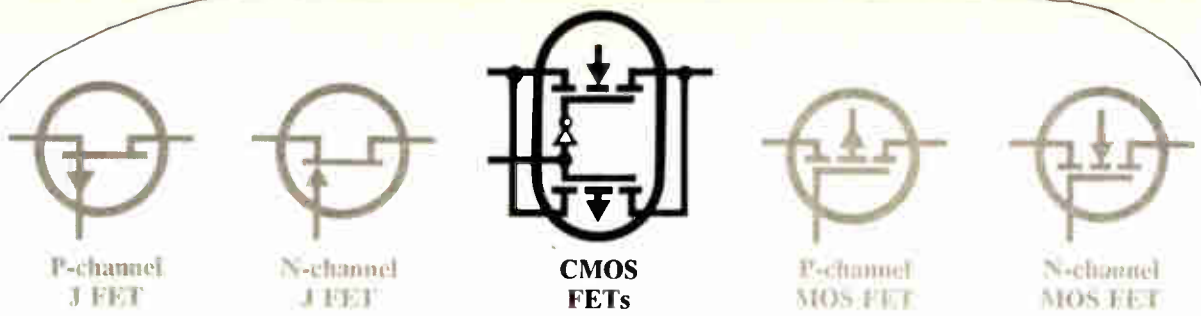
Active circuit ousts variable inductor. Bandpass filter (a) offers independent center frequency and bandwidth adjustments. Hard-to-tune variable inductor can be replaced by active circuit (b) that provides an equivalent inductance and better temperature stability. Fully active filter is easy to design and will operate over a broad range of component values. General-purpose amplifiers can be used.





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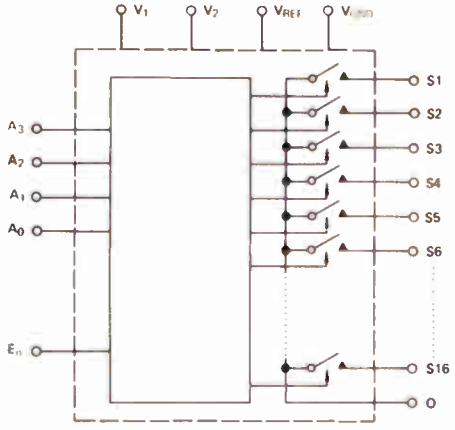
Switch 16 channels with CMOS DG506.

Here is a single-pole 16-channel multiplexer using paired CMOS FETs, with drivers controlled by a 4-bit binary word input plus an Enable-Inhibit input — all on one chip! Check the functional diagram and then refer to the decode truth table to see what binary word input selects which switch.

The DG506 features:

- ±15 V Analog signal range
- Break-before-make switches
- ON resistance <500 ohms
- TTL, DTL, and CMOS direct control interface
- 36 mW standby power

DG506 Function Diagram



Decode Truth Table

A_3	A_2	A_1	A_0	E_n	ON SWITCH
X	X	X	X	0	NONE
0	0	0	0	1	1
0	0	0	1	1	2
0	0	1	0	1	3
0	0	1	1	1	4
0	1	0	0	1	5
0	1	0	1	1	6
0	1	1	0	1	7
0	1	1	1	1	8
1	0	0	0	1	9
1	0	0	1	1	10
1	0	1	0	1	11
1	0	1	1	1	12
1	1	0	0	1	13
1	1	0	1	1	14
1	1	1	0	1	15
1	1	1	1	1	16

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Aerospace computer technology catches up with ground gear

Whether micro, rugged mini, small or large, aerospace computers now sport most of the technical advances that characterize third-generation general-purpose computers—yet they still meet military specifications

by Cay Weitzman, *System Development Corp., Santa Monica, Calif.*

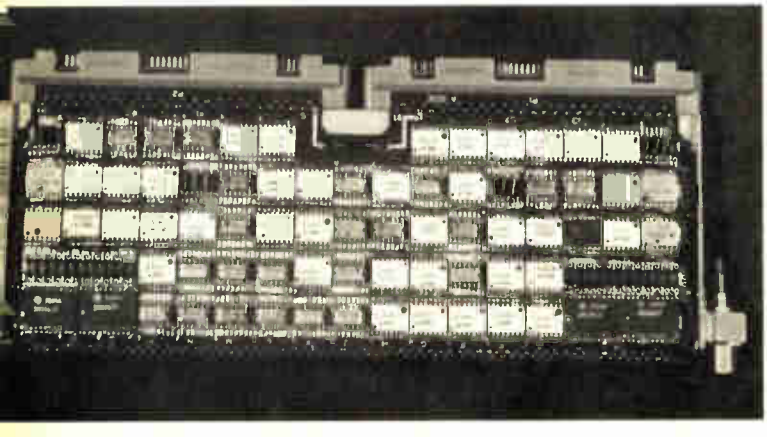
☐ The trend to extreme microminiaturization that is evident in most, if not all, aerospace computers stems only partly from the need to pack a given amount of computing power into a smaller and smaller space—though one of today's options is a highly miniaturized machine no more than 10 cubic inches in volume and weighing half a pound. Partly, too, there is the growing complexity of aerospace missions, which requires much more computing capacity to be packed into a given space. And partly also there is the shifting economic balance between software and hardware, with the cost of the former rising, and the cost of logic circuits and memory decreasing.

Out of this combination of factors emerge new technologies in packaging (see Figs. 1 through 6), microprograming and multiprocessing.

Most of the new machines have been designed around medium- or large-scale integrated circuits, and are microprogramed. As the cost of LSI decreases and as the speed of read-only memories to contain the microprograms increases, the microprogramed computer will become even more common in aerospace applications.

Significantly, small and medium-size avionic computers now incorporate features that a few years ago were available only in such relatively large commercial real-time machines as Xerox Data Systems' Sigma 5, Honeywell Information Systems' H-632, and System Engineering Laboratories 85 and 86. These features include watchdog timers; floating-point arithmetic; multilevel priority interrupts, both internal and external, built into the hardware; multiple register blocks; high-speed multiplication and divison; independent peripheral processors for input and output; and multiport memories with direct access from the peripheral machines.

1. Multilayer board. IBM's 4 Pi computer uses this design, one of the packaging schemes employed by aerospace machines. Other computers use two-sided boards. Both types plug into a multilayer motherboard or a backplane with wire-wrapped interconnections.



At the other end of the scale, airborne command posts today have functional requirements that resemble those previously associated only with large ground-based command and control systems. They process inputs from similar arrays of similar sensors, display the results in much the same way, and communicate with other systems. As a result, their architectures show the influence of earlier ground-based systems, like the Burroughs Corp. D825; but they have evolved into more sophisticated systems with multiple memory and input/output units and capable of multiprocessing. Two decades of this evolution are summarized in the chart on p. 118.

Classes of computer.

The four principal classes of aerospace computers, the general characteristics of which are summarized in the table on page 119, are:

- Microminiature computers, which have limited computational power.
- "Ruggedized" versions of commercially available minicomputers.
- Small-scale computers, like the commercial minicomputers, but with modified design goals.
- Medium-scale and large-scale computers.

The microminiature computers, in the first class, are general-purpose machines. But as the most critical requirements are very small size, low power dissipation, and light weight, their computational capability suffers.

A micromini may be designed with the most advanced hardware technology available to meet extreme reliability, size, and power requirements, regardless of cost. Or it may be designed for only a limited area of application, where cost-effectiveness is a more important consideration and less advanced technology is adequate. In general, both the advanced and the cost-effective microminis have limited storage capacity, are awkward to program, and cannot easily be simulated on other machines.

The second class of aerospace computers, the "rug-

gedized" machines, modifies the design of commercial computers to meet military specifications. These specifications require the equipment to operate satisfactorily under more extreme degrees of temperature and humidity, and also call for various levels of dustproofing or watertightness, resistance to vibration, and other protective measures. But the basic reason for following commercial designs is that here cost is the most critical factor, as opposed to the size, weight, and power requirements of the microminis.

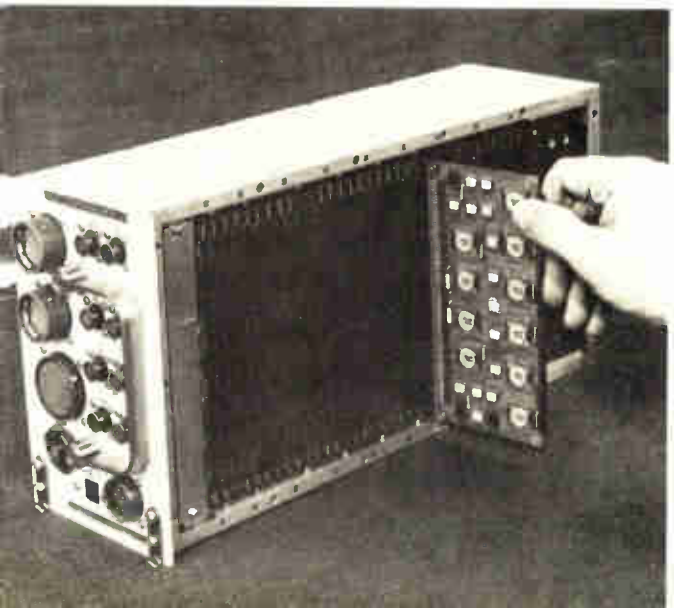
Most computers in this second class, although intended for avionic applications, don't meet military specifications in full. Undoubtedly their main advantages derive from the experience gained with their commercial cousins, and the extensive software that is available in the commercial market. In addition, these toughened machines can work with commercial peripheral equipment, so that new software can be developed in the ground-support facility at greatly reduced cost.

Small-scale aerospace computers of the third class are designed from scratch to meet military specifications. Though their computational capability is comparable to that of commercial minicomputers, small size and low power dissipation are also essential, if to a lesser degree than with the microminis. In addition, the small avionic computers may require many special input/output interfaces. In general, these computers are developed for a specific task, unlike the "ruggedized" computer of the second class. Because of their special-purpose design, they are usually significantly more expensive than machines of the second class, which can be and are sold in much greater numbers.

These first three classes as a group are likely to be found in such applications as electronic countermeasures systems, navigational systems for reconnaissance, weapons control, protecting targets from enemy attack, and cockpit display control.

Finally, for the medium-scale and large-scale computers of the last class, the ruling requirement is throughput. Generally these machines execute at least 300,000 instructions per second. This capability makes them suitable for those spaceborne and airborne command and control applications that involve data entry and analysis, information retrieval, and display and data communications control, in addition to the usual data-processing jobs.

2. Smaller cards. Control Data Corp.'s Alpha-1 computer is assembled from 34 five-layer boards that fit between two aluminum plates with integral card guides. Honeycomb construction of plates permits forced-air circulation to absorb heat from cards.



It goes almost without saying that these machines employ compact packaging techniques and use highly screened components that have been conservatively derated. Less obviously, they also often incorporate built-in diagnostic test circuits, which add 5% to 10% to the amount of hardware but permit rapid fault location.

Medium- and large-scale single-processor systems appear in the Grumman Aerospace Corp. F-14 Tomcat, a Navy strike aircraft; the McDonnell Douglas Corp. F-15, an Air Force strike aircraft; and the Grumman E2C, a Navy airplane for electronic countermeasures. Multiprocessor systems are used in programs such as the Boeing Co. airborne warning and control system (Awacs); Raytheon's SAM-D air-defense missile system, being built for the Army; and the modular space station, with its space shuttle.

Multiprocessor systems, though they have been used successfully in some applications for over a decade, still attract mixed reactions. For the B-1 bomber application, for instance, General Dynamics Corp., Hughes Aircraft, North American Rockwell, and the Boeing Co. proposed multiprocessor systems—but IBM proposed a number of independent small computers, based on its AP-1 model of the System 4 Pi, to be scattered at various points throughout the avionics systems in the B-1. The Kearfott division of the Singer Co., also proposed the independent single-processor approach—and won the contract [*Electronics*, June 19, p. 44].

Regardless of other pros and cons of multiprocessors, however, one caveat arises regarding their use in aerospace systems. The classic multiprocessor, in which several processors share a single memory bank, is incompatible with a requirement for very reliable operation. Thus it is better to think in terms of interconnected processors that have independent memories. Though this setup bends—some would say shatters—the classic definition, it permits much more reliable operation because independent interconnected processors can stay on the air with degraded performance even when one of their number isn't operating, whereas the whole system goes down if any part of a large single memory bank fails.

Many makers

The various classes of aerospace computers are manufactured by two main groups of companies. The first consists of those firms that build primarily large commercial mainframes, such as International Business Machines Corp., Burroughs Corp., the Univac division of Sperry Rand Corp., and Control Data Corp. The second is identified primarily with large computer-based military systems, and includes Hughes Aircraft Co. and Litton Industries. There is also a third group that manufactures elements of weapons systems, such as radar, guidance control, electronic countermeasures equipment, and military aircraft, and includes companies like the Arma division of Ambac Industries, Bunker Ramo Corp., Raytheon, the Kearfott division of Singer Co., and Northrop Corp.

Manufacturers in the first category capitalize on their

technological know-how in the commercial world by transferring it to militarized computers. For example, IBM's System 4 Pi is compatible with the company's System 360 commercial computers, and uses many of the same components. Likewise, RCA originally developed its current Series 200 machines to be compatible with its commercial Spectra 70 line—though, because the latter has now passed into Univac control as the Series 70, RCA is now free to modify its aerospace machines any which way, perhaps even to make them compatible with IBM's System 370 instead.

Commercial compatibility has several advantages. It reduces the cost of simulation and program development, and may even permit direct military application of many programs previously developed for commercial use.

The alternative, developing a military computer from scratch, as Control Data did with its Alpha series, has drawbacks. The computer is likely to have word lengths, data formats, and so on, that are optimized for its application, and therefore present obstacles to the use of standard peripheral equipment—even when the peripherals are made by the same company. On the other hand, the fact that the machine is optimized, say, for real-time command and control processing means that it incorporates features such as direct memory access, modular core blocks, and fast and flexible interrupt processing, that are absent in commercial machines of corresponding capability.

Military system manufacturers have usually developed their computers for specific programs. For example, Litton's L-3050 and Hughes' H-4118 were built for the tactical fire direction system, Tacfire, and the 407-L airlift command post respectively. Both of these computers were designed during the 1960s, and have been replaced by new, more powerful real-time machines; but like more powerful machines of their day they had multiport memories, partitioned memory blocks, multiple registers, high-speed multilevel interrupt structures, and separate processors for controlling input and output.

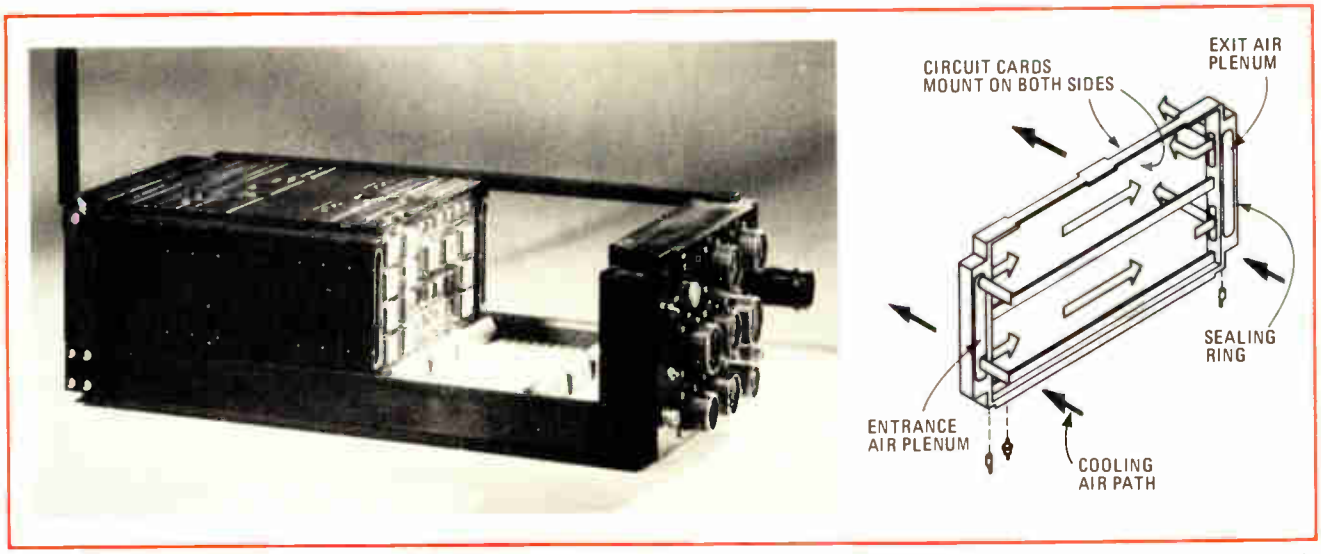
To whatever class they belong, aerospace computers are more specialized than their ground-based counterparts. Accordingly, particularly if they're microminiature or small-scale, they need smaller collections of control logic and so have been less in need of microprogram control. Moreover, technologies suitable for building read-only memories to contain microprograms, although sufficiently advanced for use on the ground nearly a decade ago, were too large and heavy for aerospace applications until semiconductor read-only memories became available rather recently.

Aerospace microprograming

Consequently, microprograming is only now becoming an important aspect of aerospace computer design. It offers the prospect of bridging the wide gap between assembly-language coding and programing in a higher-level language. This gap was bridged long ago in ground-based general-purpose computers, in part with the aid of microprograming. But it has remained open in aerospace computers because of the great difference in architecture from one computer to another, and the consequent difficulty of generating a compiler program that would translate from such a high-level language to machine language.

Even computers within a single family have not lent themselves to high-level programing. Each model of IBM's 4 Pi computers, for example, has a different complement of input-output equipment, a different interface, and a different data format. Not unexpectedly, therefore, computers from diverse manufacturers also vary in how they make use of general-purpose base registers, indexing, accumulator registers and accumulator-quotient registers, long or short instruction formats, and so on.

Nevertheless, microprogram control is part of the Adapt computer from Garrett Airesearch, one of the first microminis to use it. The Adapt's read-only memory modules are organized into 256 words of 80 bits each that define the steps necessary to execute the computer's 52 instructions.



3. Built-in airpipe. Singer SKC-2000 is assembled from two-card modules that form air passages for cooling. When all the modules are in place, they form plenums for air supply and removal. Hughes Aircraft computers also use two-card modules, but in that design the air supply is through side walls with honeycomb construction.

4. One-sided. In RCA's computers, components are soldered to single-sided eight-layer boards plugged to a backplane. One or two rows of cards make up one subunit—a central processor, an I/O processor, or a memory—that mounts in a liquid-cooled frame.

A rather larger aerospace computer that is microprogramed is the Raytheon RAC-251. This computer contains feedback paths from some of the control memory outputs to the address register of the control memory. By this means the microprogram, which resides in the control memory, can establish its own sequences instead of relying on external controls [*Electronics*, Jan. 5, 1970, p. 88].

Finally, and perhaps significantly, IBM's latest airborne multiprocessor—the CC-1 command and control computer—has more microprogramed control than any other aerospace computer.

Multiprocessors

Several different architectural designs appear in presently available aerospace multiprocessors. The simplest is a decentralized switching configuration used, for example, in the Univac 1832 (Fig. 7). There, the switching associated with each memory module or processor module is physically packaged in that module. Although the concept is simple, it suffers from the disadvantage that each module requires a large number of cables and connectors.

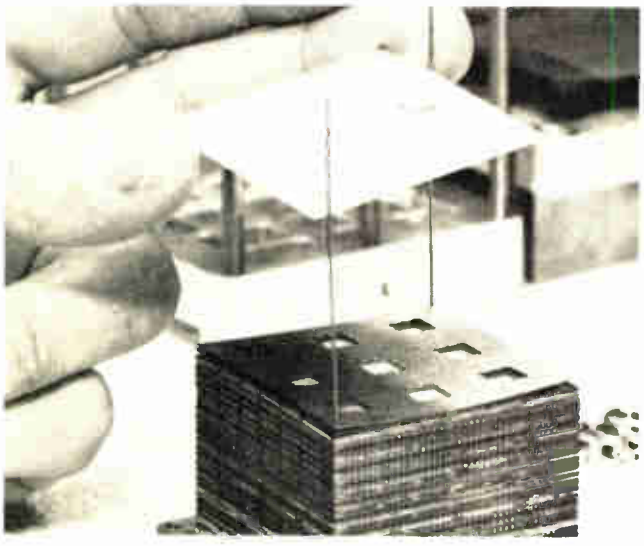
This interconnection problem is relieved in the RCA-215 (Fig. 8), which contains a passive signal-distribution unit containing all the interface logic. This arrangement makes the entire system's reliability depend largely on the satisfactory operation of the unit—a weakness that is countered by dividing the unit into sections, each of which serves, and receives its power from, a particular memory module. Such a decentralized power arrangement retains the system's fail-soft capability.

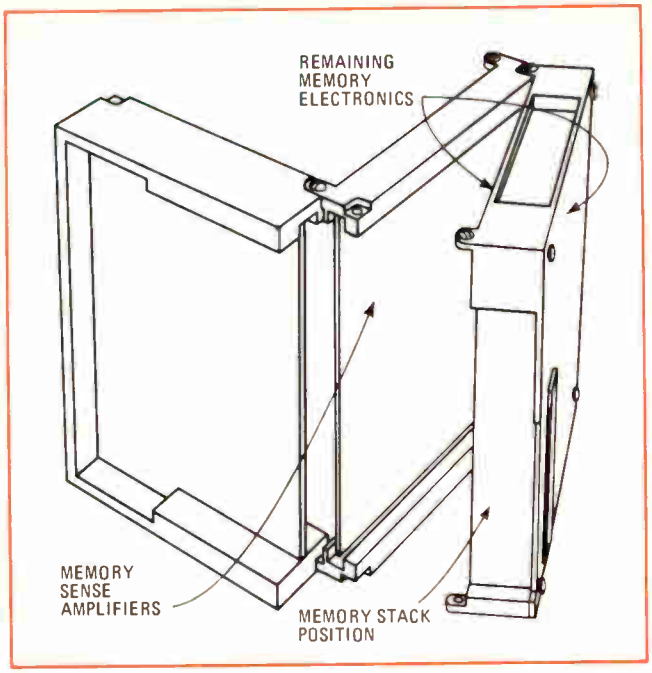
The distribution block used in the Hughes Aircraft H-4400 is even more centralized. Called a memory-processor switch (Fig. 9), the unit contains a full-fledged processor, with registers, a redundant power supply, and a redundant master system clock from which the individual clocks in the processor and memory modules are synchronized.

Every multiprocessor system, whether airborne or ground-based, requires an executive program that must operate in one and only one of the processors to oversee the operation of the others. Both the Univac 1832 and the Hughes H-4400 use a "floating executive," which means that any processor in the system can take over the supervisory function. But the former carries out its automatic reconfiguration—transfer of executive function—with recovery routines in a memory capable of nondestructive readout, while the latter does it in its memory processor switch. Besides seeing that only one processor has the executive function at any given time, this switch controls diagnostic operations and handles all system-level interrupts, by which the system responds to external events that, among other things, trigger reconfigurations.

In contrast, the RCA-215 instead of having a floating

5. Planar Coax. Bunker-Ramo Corp. has developed this packaging technique using 2-inch-square wafers 7 mils thick. Wafers carry active devices and conductor patterns. Gold buttons make contact between wafers. Package can be opened for repair.





6. Folded Array. Control Data Corp.'s 469 computer is packaged on three 4-inch-square modules on hinges. Array is folded when in operation, opened for testing and repair. One module contains the processor, another the memory, the third the sense amplifiers.

executive, maintains a single executive function through instructions stored in a reserved portion of memory unit No. 1, with a recovery nucleus in unit No. 2. This approach works because No. 1 and No. 2 are unlikely both to fail at the same time.

IBM's new command and control multiprocessor, the CC-1 (Fig. 10), has features borrowed from several other IBM commercial and aerospace computers. For example, architecturally it resembles a pair of interconnected System 360 model 65s, while at the microprogram level its instruction set and its diagnostic programs are taken in part from those for the 370/145. It has a multiport memory similar to that of some models of the 4 Pi, in which each processor and each input/output channel is connected to its own port in each of several memory modules. It uses a single supervisor program executed equally by either processor.

Like the Univac machine it uses decentralized switching. However, the input/output controllers for the CC-1 and, incidentally, for the RCA-215 also, are descendants of the selector/multiplexer channels of the System 360. The selector channel in that system (and in the subsequent System 370) establishes a connection to a high-speed peripheral unit and completes a data-transfer operation before relinquishing control. The multiplexer channel can connect to several low-speed units and transfer data a byte at a time in either direction to all units as they demand service.

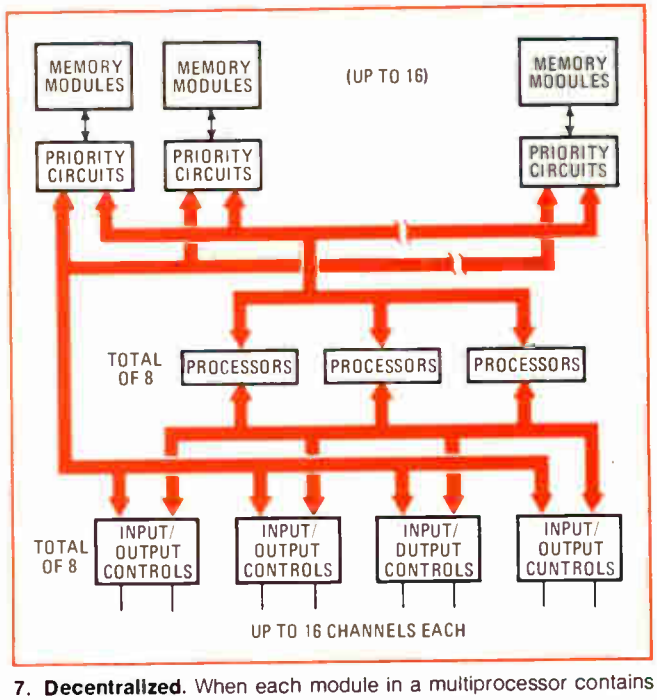
An organization that is different again is the data bus that is shared by all memory and processor modules. Generally this architecture is unacceptable in aerospace applications where high reliability is paramount, because a short circuit might disable the whole system and because only one data transfer can be in progress at one time on the bus, thereby limiting the system's throughput. (A transformer-coupled coaxial bus developed at the Jet Propulsion Laboratory of the University of California overcomes the potential short-circuit problem). However, the PDP-11R20, which is a ruggedized version of Digital Equipment Corp.'s PDP-11, uses this architecture, and has been proposed for applications where low cost is important.

Multiprocessor without multiprocessing

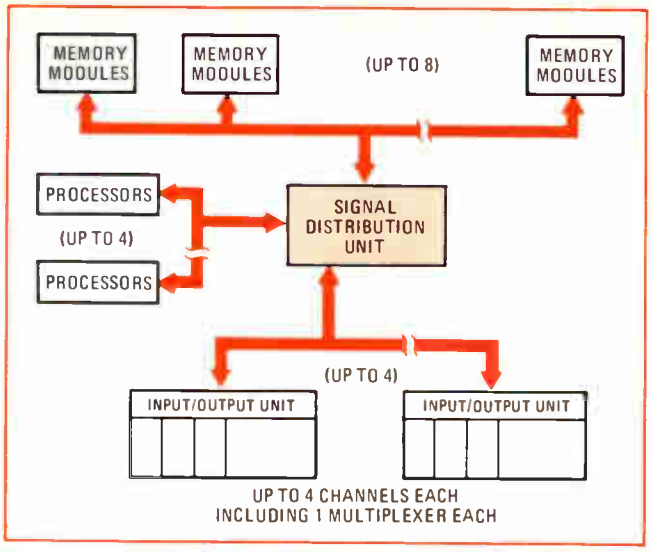
Several interconnected processors are used in the Jet Propulsion Laboratory's STAR computer (Fig. 11), but they are used only for fault detection and backup. When one fails, or when a memory module fails, it is switched out of the system and replaced with one of the others. (STAR, in this case, is an acronym for self-test and repair: the JPL machine is not to be confused with Control Data Corp.'s STAR-100, in which the name is an acronym for string array). The system is designed for high availability and long-time operation in aerospace applications where maintenance is impossible or impractical—it was originally designed for the Grand Tour deep-space mission to the outer planets of the solar system.

STAR is built around a hard-core monitor called the test and repair processor (TARP), which rolls back the program to a built-in checkpoint and restarts it if an error is detected. Each 32-bit instruction includes four bits that establish a modulo 15 residue check—each 32-bit word, that is, considered as a binary number, must be divisible by 15. If it is not, the TARP assumes that a transient error has occurred, and rolls back the program. If the error shows up again at the same point, the TARP assumes that the error is permanent, not transient. It shuts off the power to the fault unit and powers up a standby to take over, again from the same checkpoint.

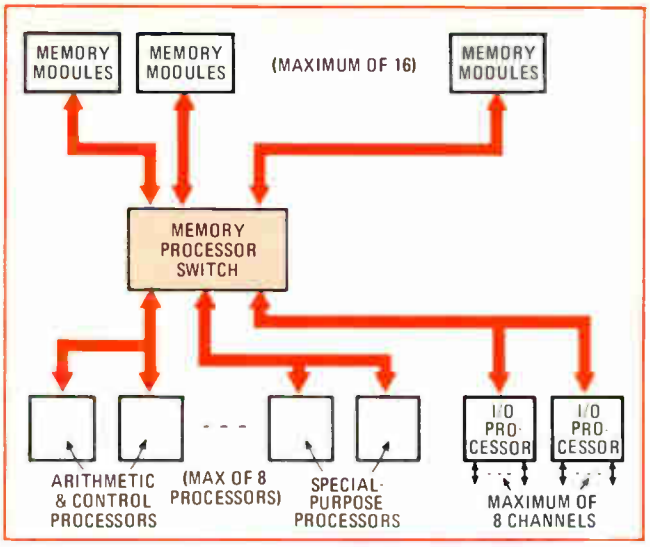
Although the Grand Tour has been cancelled, other less ambitious deep-space missions are likely to be planned. In any case, the lessons learned in designing



7. Decentralized. When each module in a multiprocessor contains its own switching, as in the Univac 1832, the basic configuration is simple, but the interconnections require much cabling.



8. Passive switch. If all interface logic is put in one unit, which RCA calls the signal distribution unit, interconnections become simpler.



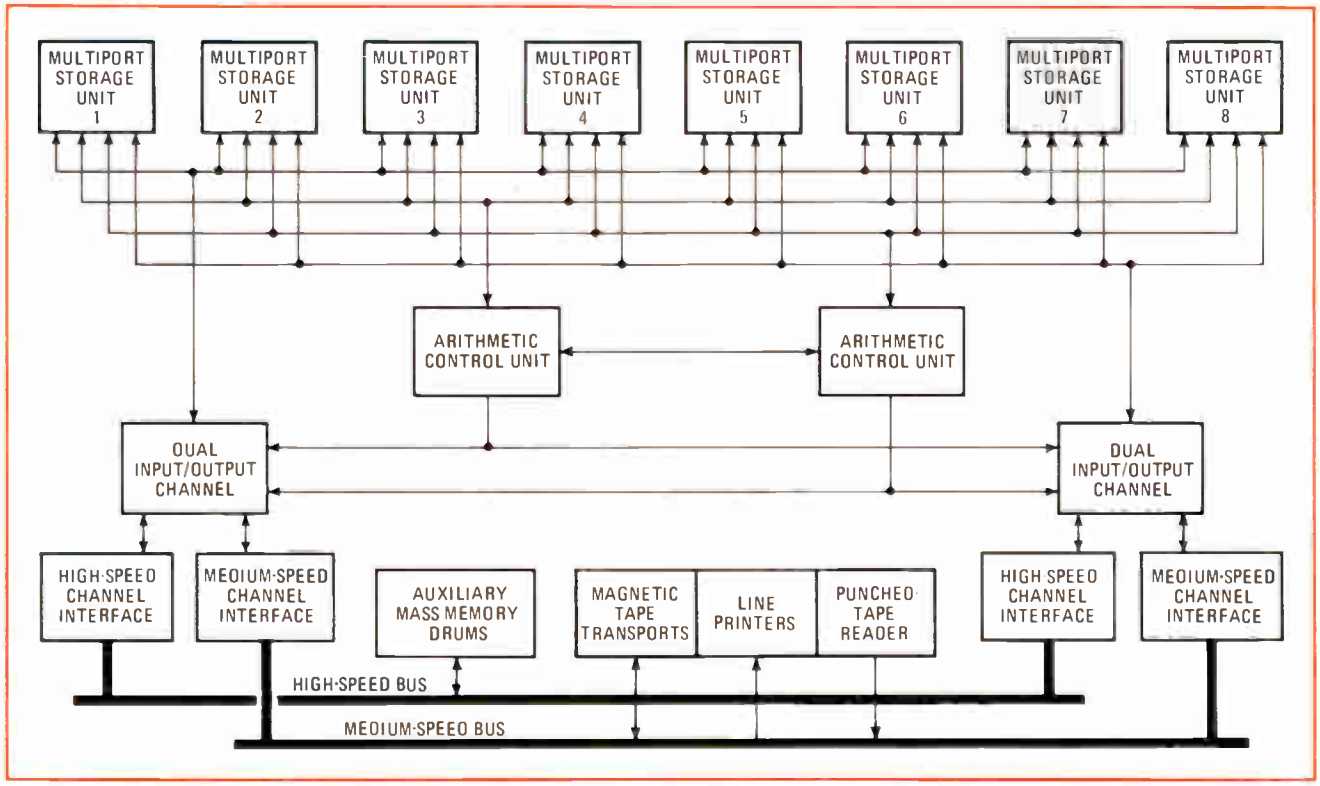
9. Active switch. Hughes Aircraft H-4400 devotes a whole separate computer to the switching function in the multiprocessor.

the STAR are applicable to other programs that require extremely high reliability and system operational life longer than component life. Its common-element structure will be useful in systems where partitioned logic, alterable control programs, high-speed cache memories, and modular switched multi-processors are applied to obtain high throughput, high availability, and easy programing.

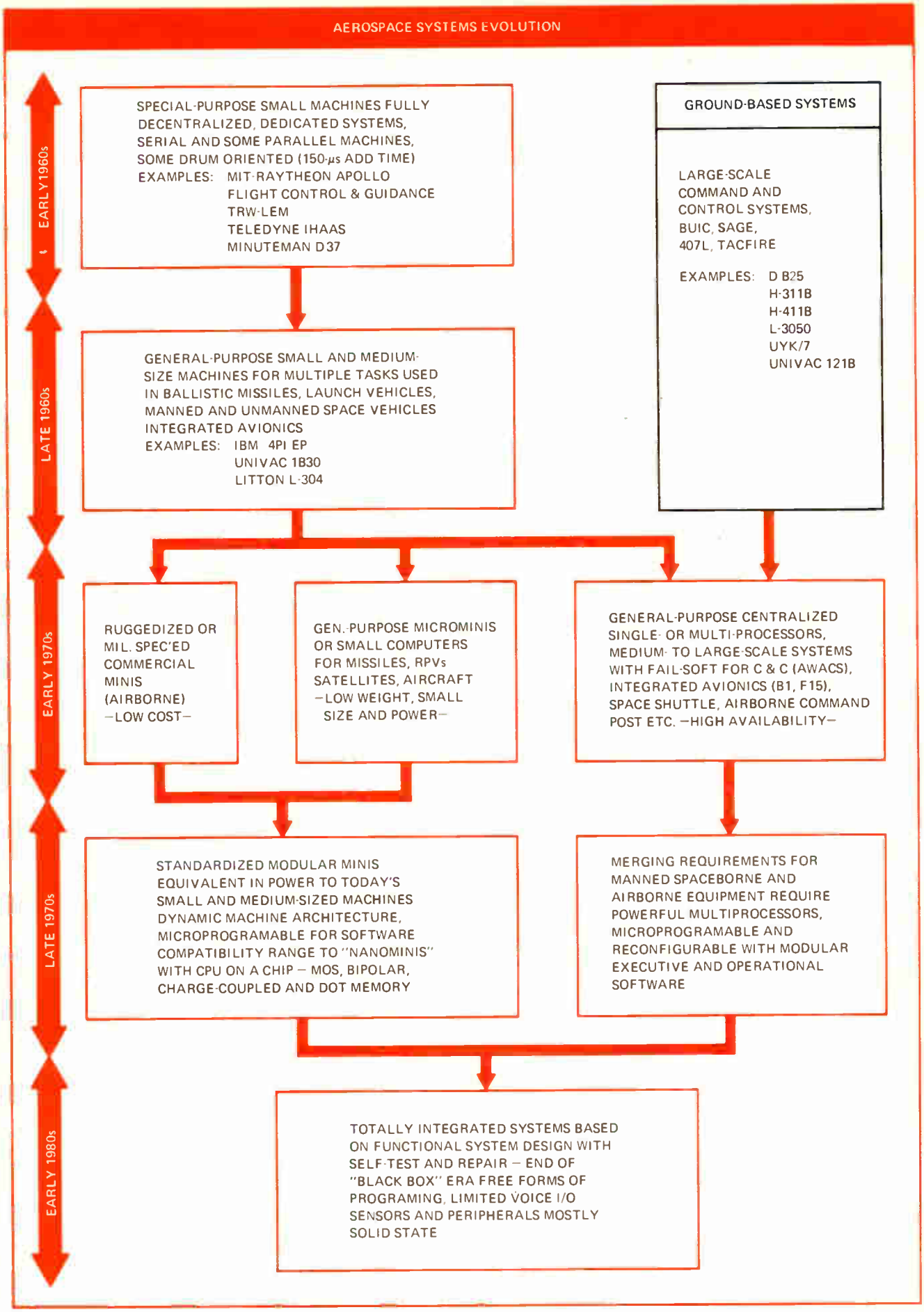
Future trends

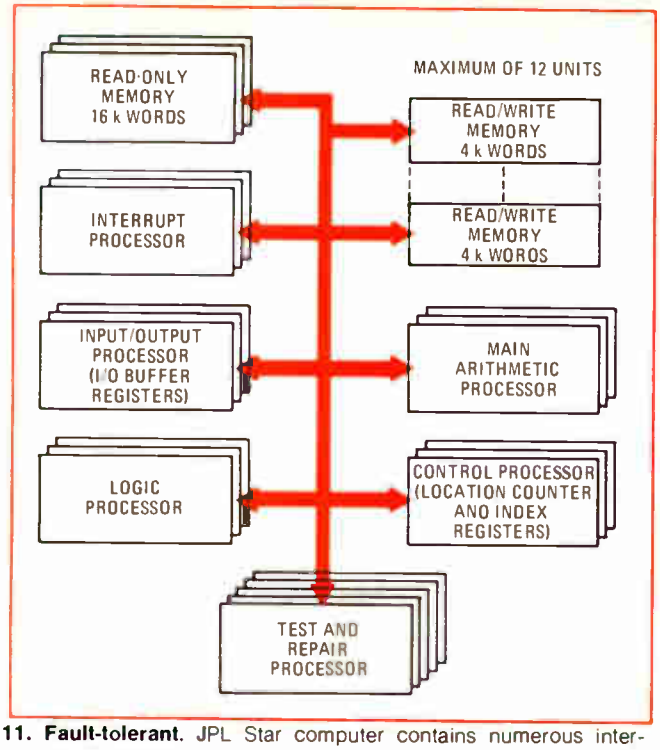
Present designs point to the ideal next-generation aerospace computer as an assembly of a very limited number of building blocks. One of these will be a sequential processing module to be served by several different kinds of memory module, including a small fast-access module, a medium-size medium-speed module, and a large unit with a relatively long access time—but nevertheless nonrotating. Firmware modules will also be available which the designer will plug into the hardware modules to set up multiplexers, peripheral controllers, diagnostic units, digitizers, and other subassemblies.

With this approach, a few different modules built from LSI or super-LSI chips (having over 1,000 gates each) will be sufficient to build a system of any degree of complexity, and to provide backup as spares for any



10. Microprogramed computer. IBM's new CC-1 borrows architecturally from System 360, in microprogram from System 370, and in memory structure from earlier 4 Pi aerospace computer.


AEROSPACE SYSTEMS EVOLUTION
EARLY 1960s
LATE 1960s
EARLY 1970s
LATE 1970s
EARLY 1980s
SPECIAL-PURPOSE SMALL MACHINES FULLY DECENTRALIZED, DEDICATED SYSTEMS, SERIAL AND SOME PARALLEL MACHINES, SOME DRUM ORIENTED (150-μs ADD TIME)
EXAMPLES: MIT-RAYTHEON APOLLO FLIGHT CONTROL & GUIDANCE
TRW-LEM
TELEDYNE IHAAS
MINUTEMAN D37
GROUND-BASED SYSTEMS
LARGE-SCALE COMMAND AND CONTROL SYSTEMS, BUIC, SAGE, 407L, TACFIRE
EXAMPLES: D B25
H-311B
H-411B
L-3050
UYK/7
UNIVAC 121B
GENERAL-PURPOSE SMALL AND MEDIUM-SIZE MACHINES FOR MULTIPLE TASKS USED IN BALLISTIC MISSILES, LAUNCH VEHICLES, MANNED AND UNMANNED SPACE VEHICLES INTEGRATED AVIONICS
EXAMPLES: IBM 4PI EP
UNIVAC 1B30
LITTON L-304
RUGGEDIZED OR MIL. SPEC'ED COMMERCIAL MINIS (AIRBORNE) —LOW COST—
GEN.-PURPOSE MICROMINIS OR SMALL COMPUTERS FOR MISSILES, RPVs SATELLITES, AIRCRAFT —LOW WEIGHT, SMALL SIZE AND POWER—
GENERAL-PURPOSE CENTRALIZED SINGLE- OR MULTI-PROCESSORS, MEDIUM- TO LARGE-SCALE SYSTEMS WITH FAIL-SOFT FOR C & C (AWACS), INTEGRATED AVIONICS (B1, F15), SPACE SHUTTLE, AIRBORNE COMMAND POST ETC. —HIGH AVAILABILITY—
STANDARDIZED MODULAR MINIS EQUIVALENT IN POWER TO TODAY'S SMALL AND MEDIUM-SIZED MACHINES DYNAMIC MACHINE ARCHITECTURE, MICROPROGRAMABLE FOR SOFTWARE COMPATIBILITY RANGE TO "NANOMINIS" WITH CPU ON A CHIP — MOS, BIPOLAR, CHARGE-COUPLED AND DOT MEMORY
MERGING REQUIREMENTS FOR MANNED SPACEBORNE AND AIRBORNE EQUIPMENT REQUIRE POWERFUL MULTIPROCESSORS, MICROPROGRAMABLE AND RECONFIGURABLE WITH MODULAR EXECUTIVE AND OPERATIONAL SOFTWARE
TOTALLY INTEGRATED SYSTEMS BASED ON FUNCTIONAL SYSTEM DESIGN WITH SELF-TEST AND REPAIR — END OF "BLACK BOX" ERA FREE FORMS OF PROGRAMING, LIMITED VOICE I/O SENSORS AND PERIPHERALS MOSTLY SOLID STATE



11. Fault-tolerant. JPL Star computer contains numerous interconnected processors that back up one another to provide continuous operation, in spite of failure of one or more modules. Test and repair processor oversees the fault-tolerant operation.

module that fails. Furthermore, in line with the STAR concept, these spares can be connected to the system through a switch when it is first built, and activated immediately by a diagnostic unit when a failure is detected. A floating executive will maintain system control, and by altering the firmware, it will be able to maximize throughput and capability dynamically.

Several of these features are already available or have been seriously proposed—indicating that systems with these capabilities will be available in the late 1970s. Eventually, however, such systems will yield to a totally integrated concept, each system being designed from functional specifications only, without regard to what "black boxes" are available off the shelf. □

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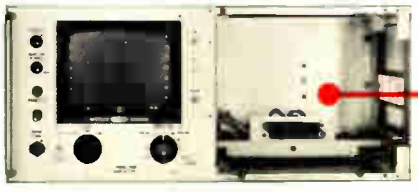
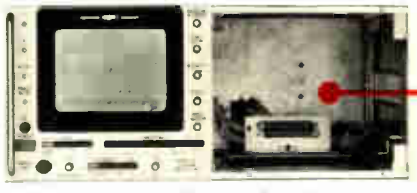
AEROSPACE COMPUTER CATEGORIES

FEATURES \ CATEGORY	MICROMINI	RUGGEDIZED, COMMERCIAL MINI	SMALL	MEDIUM AND LARGE (MULTIPROCESSORS)
MEMORY				
Cycle time (μs)	1.0 to 5.0	0.9 to 2.6	1.0 to 3.0	1.0 to 2.0
Word length (bits)	12 to 24	16 or 18	16 to 24	32
Storage type	Core, plated wire, MOS/LSI	Core	Core, LSI	Core
Memory capacity (words)	1,024–131,072	1,024–65,536	2,048–131,072	Up to 262,144
PROCESSOR				
Number of instructions	30 to 70	50 to 100	20 to 120	60 to 180
Register	None or very limited	Typically 2	Limited	Many
Addressing modes	Two or less	Three or less	Several	Many
Throughput (in thousands of instructions per second)	70 to 200	70 to 200	70 to 300	Medium: 300–500 Large: 400–600 Multiproc.: >1000
Other features	–	–	–	Many macros
INPUT/OUTPUT				
Speed, direct memory access	250 to 400 kHz	300 kHz to 1 MHz	300 to 1 MHz	500 kHz to 1.4 MHz
Other features	–	–	Some with A/D and D/A converters	Serial, parallel operation under CPU control Large number of I/O processors
PERIPHERALS	Limited or none	Large number, mostly commercial, mil specs unnecessary	Limited	Adequate, some commercial
PACKAGING				
Cooling	Conduction	Generally fan cooled	Conduction	Forced air, liquid, or conduction
Size (ft^3)	Less than 0.5	0.5 to 5.0	0.5 to 1.0	6.0 to 25.0
Weight (lb)	0.5 to 10	40 to 60	More than 10	50 to 700
RELIABILITY				
MTBF (hr)	7,000 to 25,000	1,000 to 10,000	2,000	1,000
COST				
Minimum configuration	$50,000–$80,000	$20,000–$50,000	$40,000–$150,000	$120,000–$400,000 (Multiprocessors over $500,000)

Now you can choose from 2



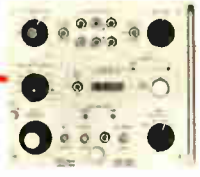
710B standard persistence main frame



711 variable persistence main frame

NEW

800B audio plug-in



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to 50 KHz

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NEW

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Electronic fuel injection reduces automotive pollution

An MOS read-only memory is at the heart of a British system that minimizes pollutants by measuring exact quantities of fuel and timing their insertion into combustion chambers

by Malcolm Williams, *Joseph Lucas (Electrical) Ltd., Shirley near Solihull, England*

☐ In a massive effort to limit automotive exhaust pollution, one of the devices being evaluated carefully is an electronically controlled fuel-injection system.

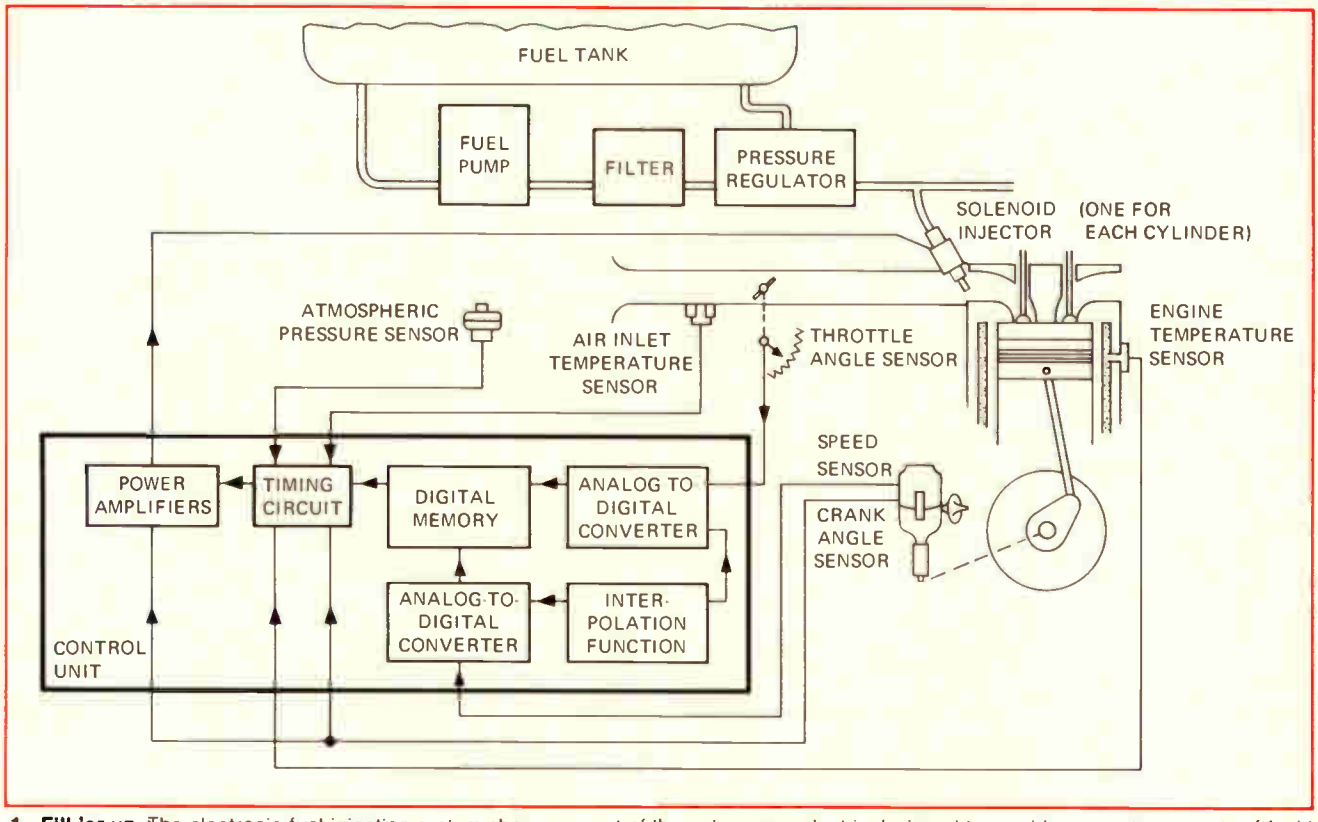
Besides the advantage over standard carburetion of increased power offered by fuel injection, the accurate cylinder-to-cylinder fuel distribution and optimum fuel control under turbulent manifold air conditions enable fuel injection to minimize exhaust pollution.

It is unlikely, however, that a fuel-injection system alone will meet the latest legal emission requirements, and some form of exhaust treatment also will be necessary. Nonetheless, the cost of exhaust treatment in a vehicle fitted with fuel injection would be lower than it would be without fuel injection.

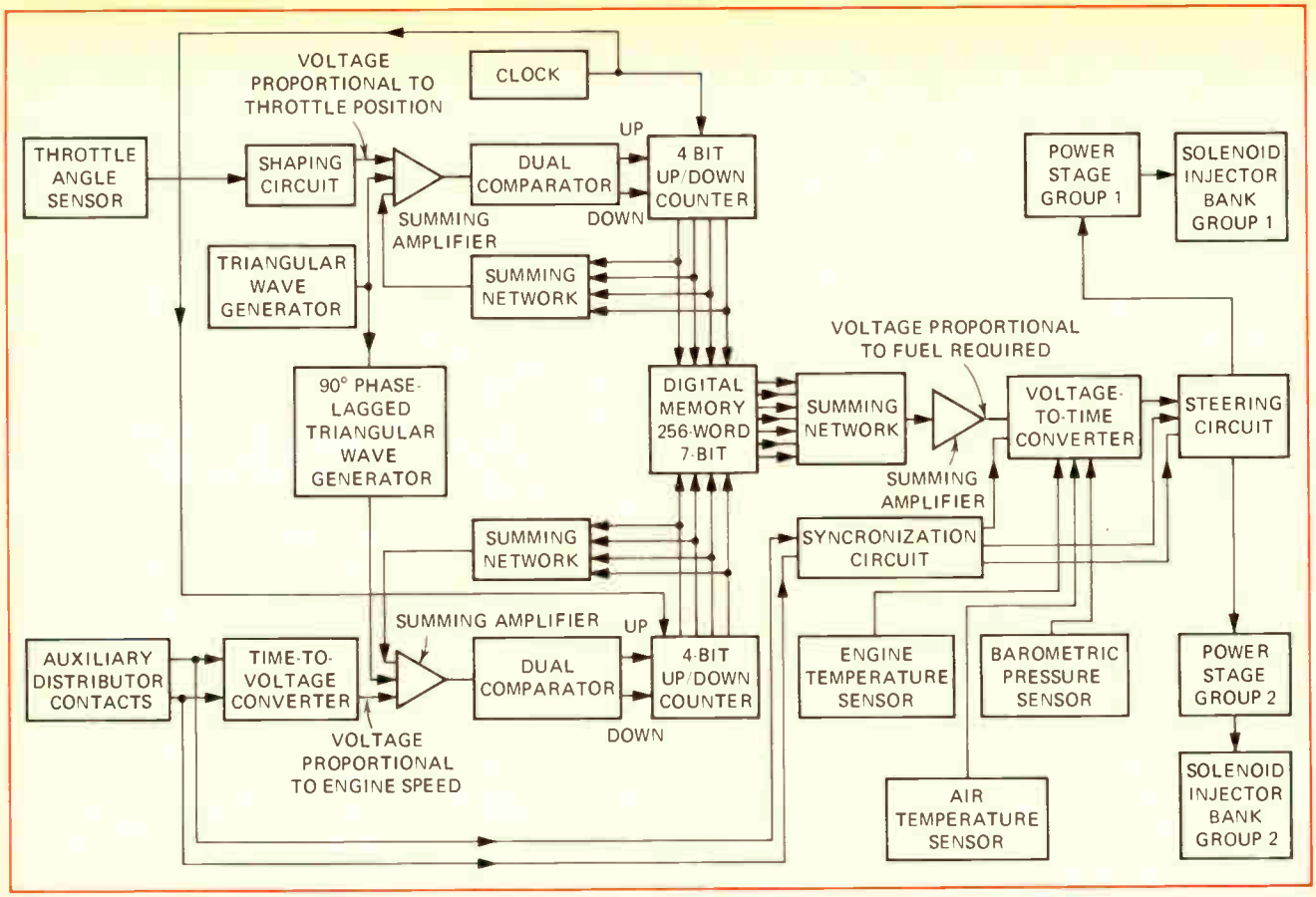
To achieve low-pollution exhaust emissions, a high air-to-fuel ratio is required over the engine's complete working range. This minimizes wasted fuel, and, as a consequence, gives rise to fewer partially burnt pollutants. It is also important to obtain an accurate measurement of engine conditions and fast, accurate measurement of air-mass flow. The system must be able to supply the optimum amount of fuel when the air in the inlet and exhaust manifolds is resonating.

The engine parameters that best meet these requirements are throttle angle and engine speed. But the cost of a complex control function is prohibitive if standard analog electronic techniques are applied. However, by using a digital memory to store the fuel-demand characteristics, a system becomes economically attractive.

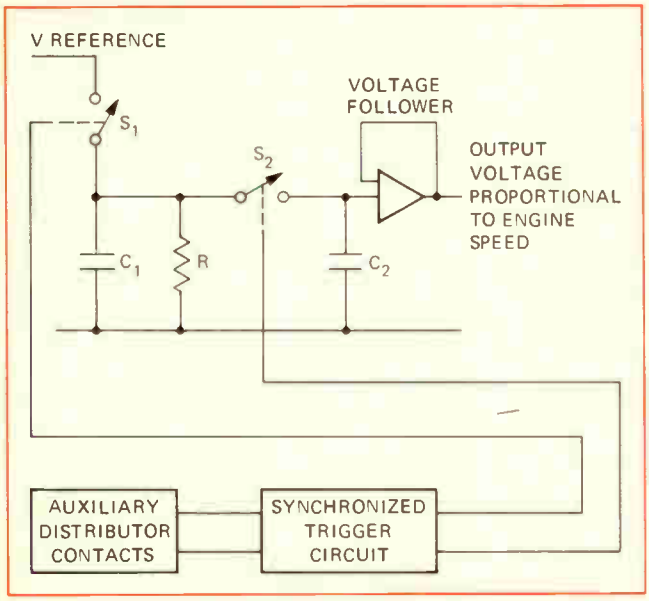
A prototype fuel injection system has been developed for a standard 150-cubic-inch, six-cylinder Triumph sedan. Engine speed and throttle angle information are stored in a digital memory containing 256 seven-bit words. Each word in the MOS read-only memory repre-



1. Fill 'er up. The electronic fuel-injection system shown as part of the auto power plant is designed to provide accurate amounts of fuel to the engine cylinders, based on demand (throttle angle), engine speed, engine temperature, and ambient conditions.



2. Electronic controller. The complete fuel-injection system comprises TTL, MOS, and linear devices to process analog information from engine and throttle to produce signals that help determine the exact fuel quantity to be fed into each cylinder.



3. Speeding ticket. To get engine-speed information, auxiliary contacts are mounted on the distributor. The circuit shown above converts the time measured between contact pulses into analog voltage. This voltage is converted to digital signals.

sents a different quantity of fuel. By reading out the right word at the right time, the correct quantity of fuel is injected into the induction port of the engine. The selection of the word is controlled with the information supplied by strategically placed sensors that monitor the engine's condition and driver's demand (Fig. 1).

Both digital and linear ICs were used. Their functions include counting, comparison, and amplification to convert analog data into a form that will address a digital read-only memory and for interpolation between the exact digital steps. Interpolation is necessary because the memory covers the range of possible engine fuel requirements and must progress smoothly from one state to another.

When the driver switches on the ignition, the electric fuel pump mounted in the trunk sends fuel to the solenoid injectors in the engine. Injection pressure is constant, and the controller determines the quantity of fuel injected by controlling the time the injector is open. Hence, each word stored in the memory corresponds to a time interval.

On turning over the engine, auxiliary contacts in the distributor cause the solenoid injectors to commence fueling at the correct point in the engine cycle and also provide engine-speed information to the control circuit, selecting the appropriate memory word (Fig. 2). With a cold engine, the fuel supply is increased over the amount a hot engine would need by multiplying the quantity stored in the digital memory by a factor dependent on the engine's temperature sensor. This sensor, which is fitted on the engine block, is tailored to provide easy starting with minimum emissions and thereby function as an automatic choke.

The driver controls the power delivered by the engine by depressing the accelerator pedal, which controls the

throttle aperture in the air intake. The angle of the restricting butterfly valve, in conjunction with the engine speed, measures air flow. Both the driver's demand and the engine's air intake can be measured by coupling a potentiometer to the throttle shaft. As the throttle is depressed, extra air flows into the engine, and simultaneously a new word is addressed in the memory, thus optimizing the amount of fuel injected into the cylinders.

To account for changes in air density due to climatic conditions and radiant heating by the engine of the intake air, an atmospheric pressure sensor and air-inlet temperature sensor are also installed.

Data converted

The throttle angle and engine-speed information both have to be converted into digital form to address the memory. Whenever the combination of throttle angle and engine speed hit a precise point in the memory, the engine's fuel demand is obtained by direct reference. However, when the values of throttle angle and engine speed are between these exact memory sites, the engine fuel demand is calculated by interpolation from the adjacent stored data.

For the throttle signal, a potentiometer output proportional to throttle angle is first shaped to define more closely the changes at the initial low throttle opening. The signal is then converted into digital form by a simple analog-to-digital converter, which uses a feedback resistor network. For signals of equal amplitude, the output from the amplifier is zero, and the digital word-signal feedback from the counter is equal to the input analog signal. When this analog signal increases, the output from the amplifier decreases from zero until the comparator threshold level is reached.

The counter is then allowed to count up the clock pulses, thus changing the digital word until equality of both signals again is achieved. The digital signal remains constant until an error greater than half the least-significant bit occurs, at which point the digital value changes to reduce the error. This particular a-d converter tracks the throttle signal rapidly.

The auxiliary contacts mounted in the distributor provide engine-speed information, which is turned into an analog voltage from the time between contact pulses

EXHAUST POLLUTION EMISSIONS IN EXPERIMENTAL CAR
(grams/mile)

Pollutant	U. S. Federal	California	Achieved on Test Engine*
1971 LEGISLATION[1]			
Carbon Monoxide	23	23	3.5
Hydrocarbons	2.2	2.2	0.8
Nitrogen Oxides	–	4.0	0.8
1975 LEGISLATION[3,4]			
Carbon Monoxide	3.4	12	3.5
Hydrocarbons	0.41	0.5	0.8
Nitrogen Oxides	3.0	1.0	0.8

*7-mode California cycle

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2. State of California Air Resources Board, Nov. 20, 1968
3. Federal Register, Vol. 36, No. 128, Part II, July 2, 1971
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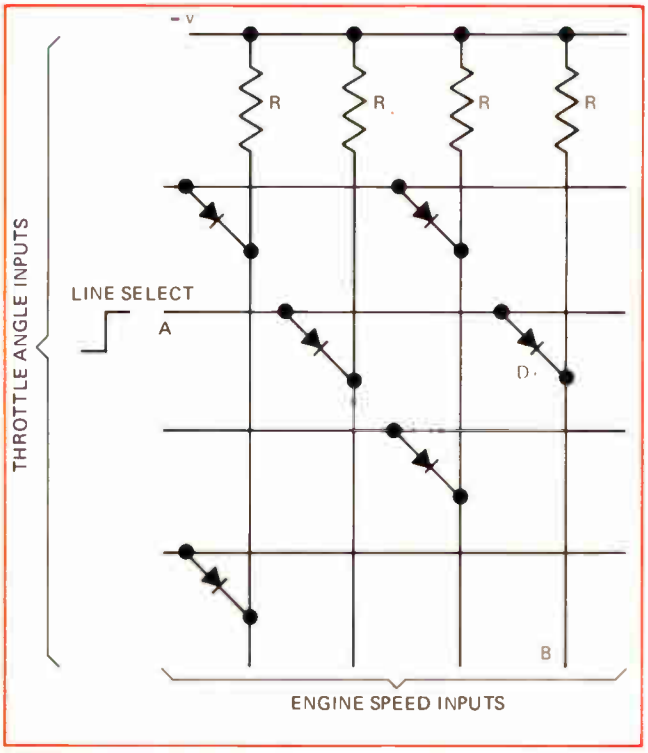
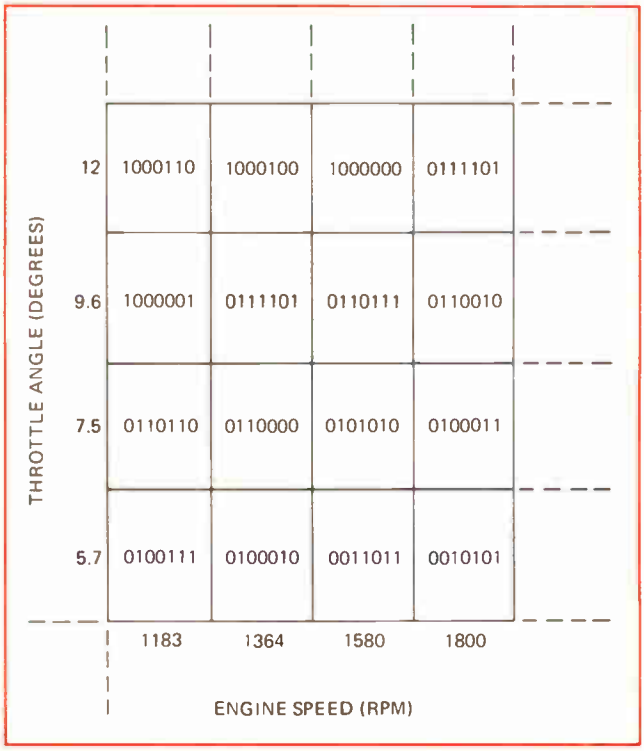


4. Memory lane. Digital words representing throttle angle and engine speed are fed into a decoder circuit, which then selects a programed line in the memory matrix to calculate fuel quantity.



5. Fuel program. Each box in the memory program has a digital code number representing location and proper amount of fuel required for that particular operating condition.

(Fig. 3). On closure of the first contacts, capacitor C1 rapidly charges toward a reference voltage. After about 5 microseconds, S1 opens, and the capacitor decays through a fixed resistor R for the remainder of the engine revolution. When the second distributor contact closes, this voltage is sampled for about 10 μs through switch S2 and is stored on capacitor C2. The voltage follower acts as a buffer to prevent discharge of capacitor C2. This cycle is repeated for every engine revolution.

Another a-d converter changes the analog voltage representing the engine speed to a digital word. The two four-bit digital words—one representing throttle angle, the other representing engine speed—are fed to decoding circuits; each decoder circuit then selects a particular line in the memory matrix (Fig. 4).

Engine-speed conversion

For example, if line A on the throttle input is selected and a positive voltage is impressed on the line, then diode D will conduct. If line B is sensed by the engine-speed decoder, the positive voltage through diode D will be sensed on line B if the particular line sensed has no diode on line . If the particular line sensed has no diode, then a negative voltage would be sensed. So by the presence or absence of a diode, a binary 1 or 0 can be programed for any particular input line.

This example shows a simple memory matrix of 16 one-bit words. To increase the number of bits, separate matrixes should be addressed simultaneously. The digital memory used in the controller consists of 256 words, each of seven bits. MOS transistors are used to form the matrix instead of diodes.

The digital information (Fig. 5) stored in the square corresponding to the intersection of throttle angle 9.6° and engine speed 1,580 rpm is 0110111. The data in the adjacent sites in the memory bear no relation to each other, and whatever the optimum fuel required by the engine at the appropriate site, it can be provided by the control system.

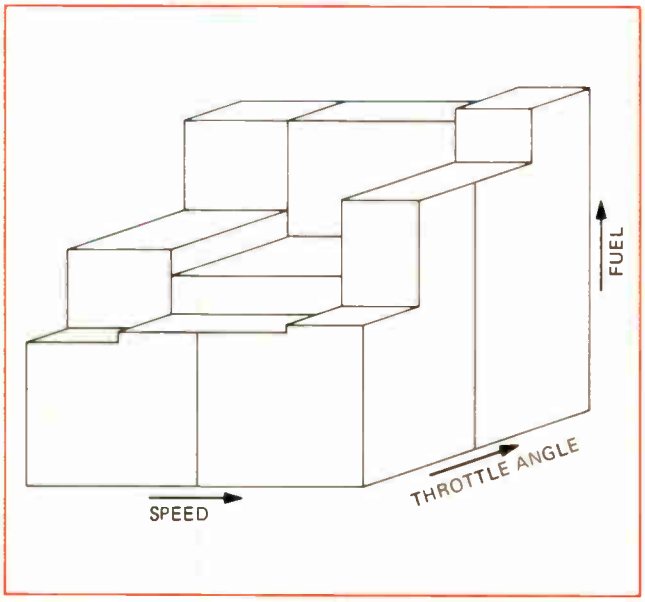
The fuel surface represented by the stored information in the memory would consist of a number of flat planes (Fig. 6), the height being proportional to the fuel quantity to be delivered per engine stroke. However, the required surface cannot have these discrete steps. The control unit achieves a smoothly varying surface by linearly interpolating stored data whenever the combination of the throttle angle and engine speed do not hit an exact memory site (Fig. 7).

Circuits interpolate

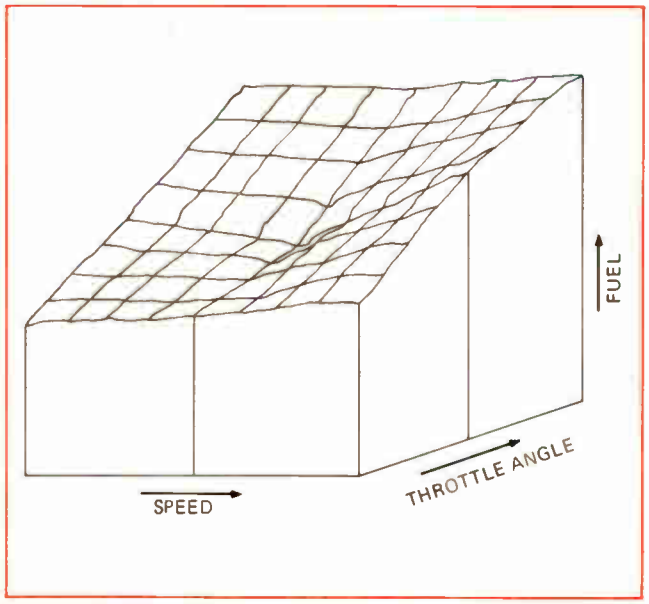
There are two interpolation circuits—one for engine speed and one for throttle angle. Each generates a positive and negative triangular wave of fixed amplitude and frequency. The effect, for each parameter, is to make the memory sites each side of an intermediate point read out alternately for periods proportionate to the distance of the sites from the intermediate point. To do this, the triangulations superimpose on the sensor voltage from the summing amplifier. To distinguish between the two parameters, one wave generator is placed 90° out of phase behind the other.

When a sensor output voltage corresponds exactly to one of the 16 matrix input levels tied to that sensor, the positive and negative triangular oscillators are equal in amplitude, and the running voltage level in the comparator is within the threshold levels identifying that particular matrix line. When the sensor voltage moves slightly, one triangle peak pushes the comparator voltage within the levels identifying the next matrix line for a fraction of the triangle cycle time.

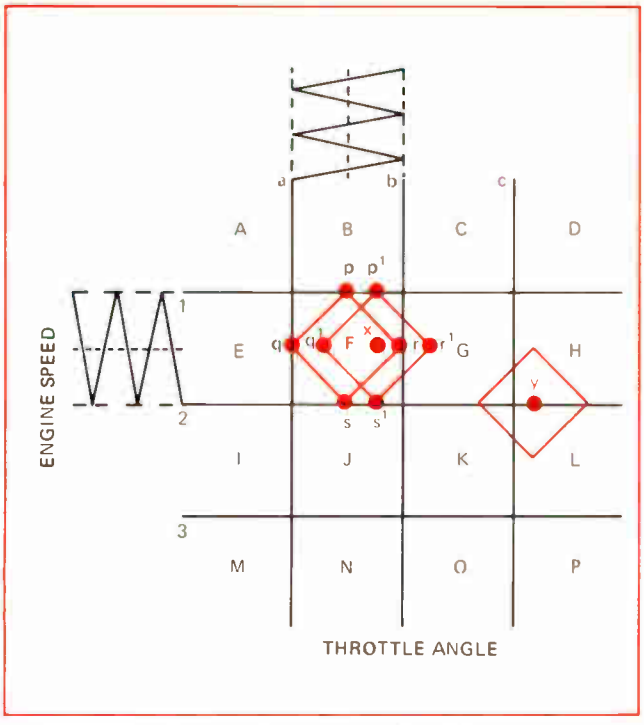
Half-way between the lines, half the triangle extends into the next line level, and so on. To connect voltage levels and matrix lines, each line in each parameter is identified by a four-bit digital word, and an a-d converter translates voltage into word. Hence, two four-bit words act on each of the seven memory planes, identifying in each plane a particular memory site. All seven sites are read out simultaneously, making a seven-bit



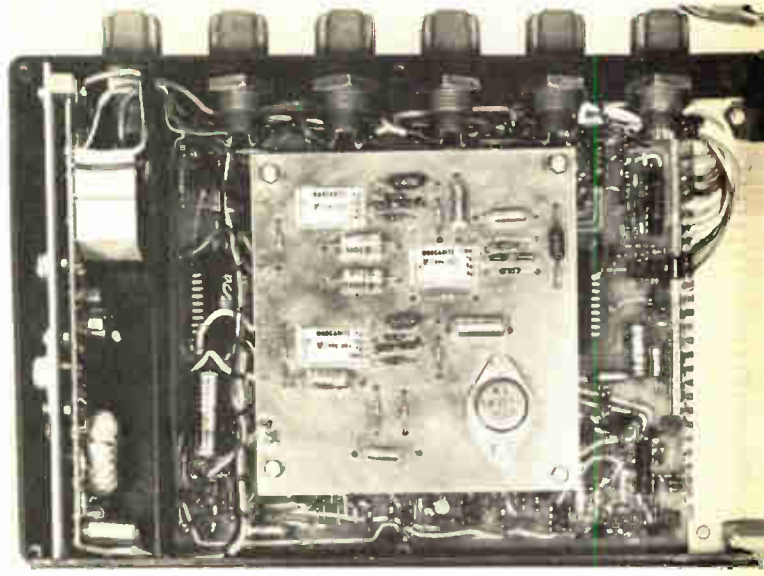
6. Injection plot. Without interpolation, a three-dimensional plot of speed, throttle angle, and fuel amount would look like this series of discrete and flat planes produced by an X-Y plotter.



7. Bumpy road. With interpolation to facilitate continuous engine operation, the surface of an X-Y plot becomes a series of undulations, assuring smoother engineer operation.



8. Gas station. When fuel demand coincides with an exact memory site, the interpolation signal causes only that site to be addressed (point F); but when fuel needs don't correspond to an exact site—which is normally the case—an interpolation of as many as four adjacent word sites may be necessary (point Y).



9. It's a gas. Prototype unit contains both ICs and discrete semiconductors, but follow-on versions will replace analog with digital devices. Protrusions on the top of the unit are power resistors used to set the time-constant of the solenoid fuel injectors.

word identifying an exact injector opening time. Because most throttle and engine-speed selections will be somewhere between exact sites, most of the time the memory output, under the influence of the interpolation circuits, is cycling around four adjacent sites.

Fig. 8 shows the effect of the triangular waves on the memory where the memory sites, alphabetically labelled, represent the engine conditions when the fuel data have been measured. The solid lines represent the decision points where the a–d converter changes from one word to the next, thus selecting a different memory site. When the driver's demand, i.e., throttle angle and the resulting engine speed, are both sent to the same memory site, the interpolation signal causes only that memory site to be addressed. For example, if F is the selected point, the resultant path traveled through the matrix is the square bounded by p, q, r, and s. When the driver demands more power, point x would be selected, and the output from the memory would be alternatively the words stored at memory sites F and G.

As the matrix is swept at a constant velocity, the time for which each word appears at the output of the memory is proportional to the throttle-angle position between F and G. A lag in the summing circuit averages the memory output to give linear interpolation between F and G. With the throttle angle and engine speed set to select the point Y—the typical operating situation—the output from the memory consists of the four adjacent word sites G, H, K, and L in cyclical sequence. These words are averaged to produce a two-dimensional interpolated surface (Fig. 7).

To control the fuel delivered to the engine, auxiliary distributor contacts activate the synchronization circuit, which, by means of the steering circuit, turns on an appropriate group of injectors. At the same time, the voltage-to-time converter commences its timing period.

This period is a direct function of the voltage supplied from the memory, but it's modified, depending on engine temperature, air temperature, and barometric pressure. At the end of the timing period, the steering circuit is reset, and the appropriate group is turned off, cutting the fuel supply to those particular cylinders.

Prototype has standard parts

The prototype unit specifically developed to control the fuel system for the test vehicle (Fig. 9) is 2.25 inches by 6.75 in. by 10.25 in. All the components, as well as some discretes, are readily available ICs; for instance, a standard MOS ROM has been programed with the information pertaining to the Triumph that had been obtained from engine tests. However, in production units, custom-designed integrated circuits would be used exclusively.

Although the system is in the early development phase, it has already shown considerable improvement over currently available fuel-control devices. Development is being continued to assess the full potential of this type of control system. The pollution figures from this unit have fallen short of meeting the new Federal and California requirements for 1975 (see Table 1), although it did perform within the limits of previous legislation. This unit has shown that accurate fueling under both steady-state and transient conditions can reduce pollutants and work in conjection with a total antipollution system.

Current work is aimed at digitizing the analog speed-measurement stage and the analog fuel-measurement stage after the memory. A digital interpolation technique is being devised so that the only analog stage in the system will be throttle-angle sensing. This should mean that all the electronics can be packed on one bipolar IC and one MOS IC. □

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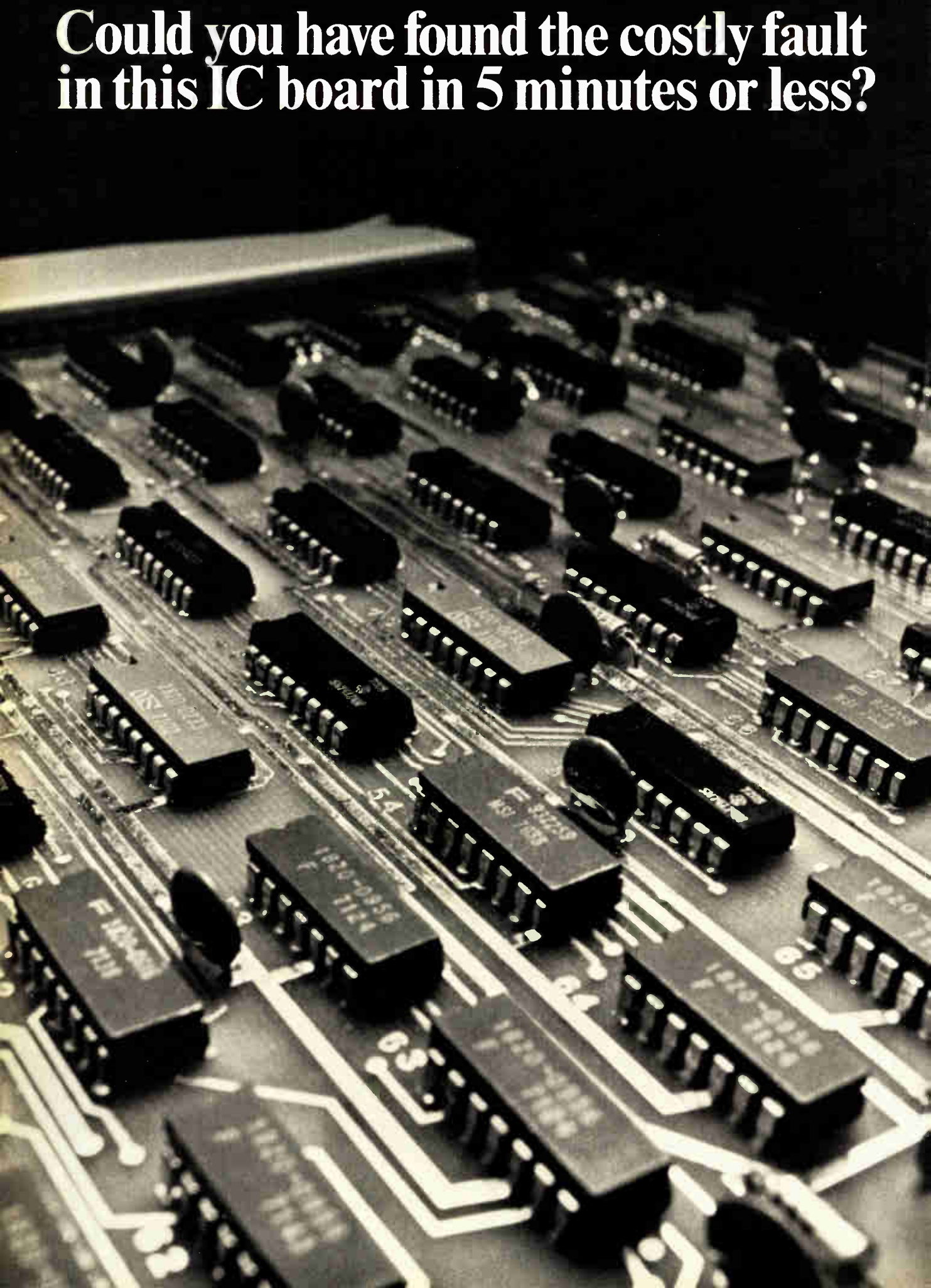

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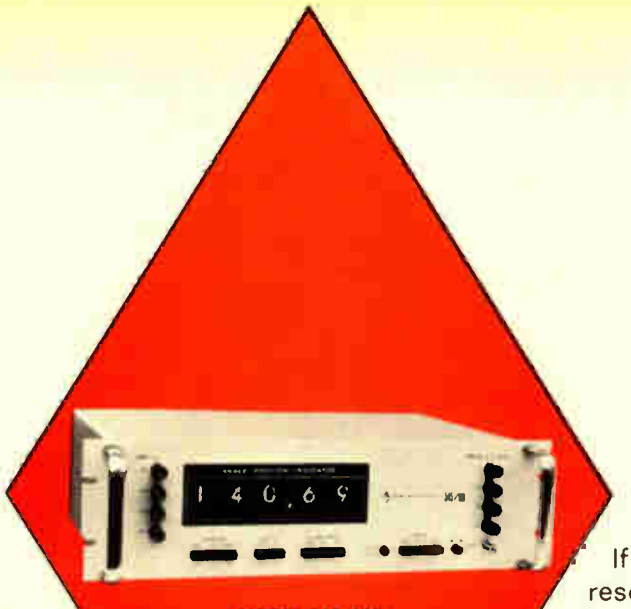

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Finding MOSFET threshold with one measurement

by Amos Wilnai
Monolithic Memories Inc., Sunnyvale, Calif.

Measuring the threshold voltage of a MOS field-effect transistor is not simply a matter of finding the gate-to-source voltage that results in a certain drain current. Although direct, this method only approximates the threshold voltage and depends on both MOSFET geometry and test-current value.

At least two readings must be taken at two different current levels to determine the actual threshold voltage. Here's a technique that accomplishes this automatically and finds the threshold voltage directly, with no need for graphic extrapolation.

Usually, when two V_{GS}–I_D data readings are taken, they are plotted on a graph of V_{GS} versus $I_D^{1/2}$. The threshold voltage (V_T) is then extrapolated by determining the point at which the straight line connecting the two readings intersects the V_{GS} axis, where $I_D = 0$. This method is time-consuming and requires experience.

The test circuit in the diagram, however, offers an easy way to measure the threshold voltage automatically. To understand the principle on which the measurement is based, first consider the MOSFET's transfer characteristic in the saturation region:

$$I_D = k(V_{GS} - V_T)^2$$

where k is a constant. This equation can be rewritten as:

$$I_D^{1/2} = k^{1/2}(V_{GS} - V_T)$$

For two data readings:

$$(I_{D1}/I_{D2})^{1/2} = (V_{GS1} - V_T)/(V_{GS2} - V_T)$$

Solving for the threshold voltage yields:

$$V_T = [V_{GS2}(I_{D1}/I_{D2})^{1/2} - V_{GS1}]/[(I_{D1}/I_{D2})^{1/2} - 1]$$

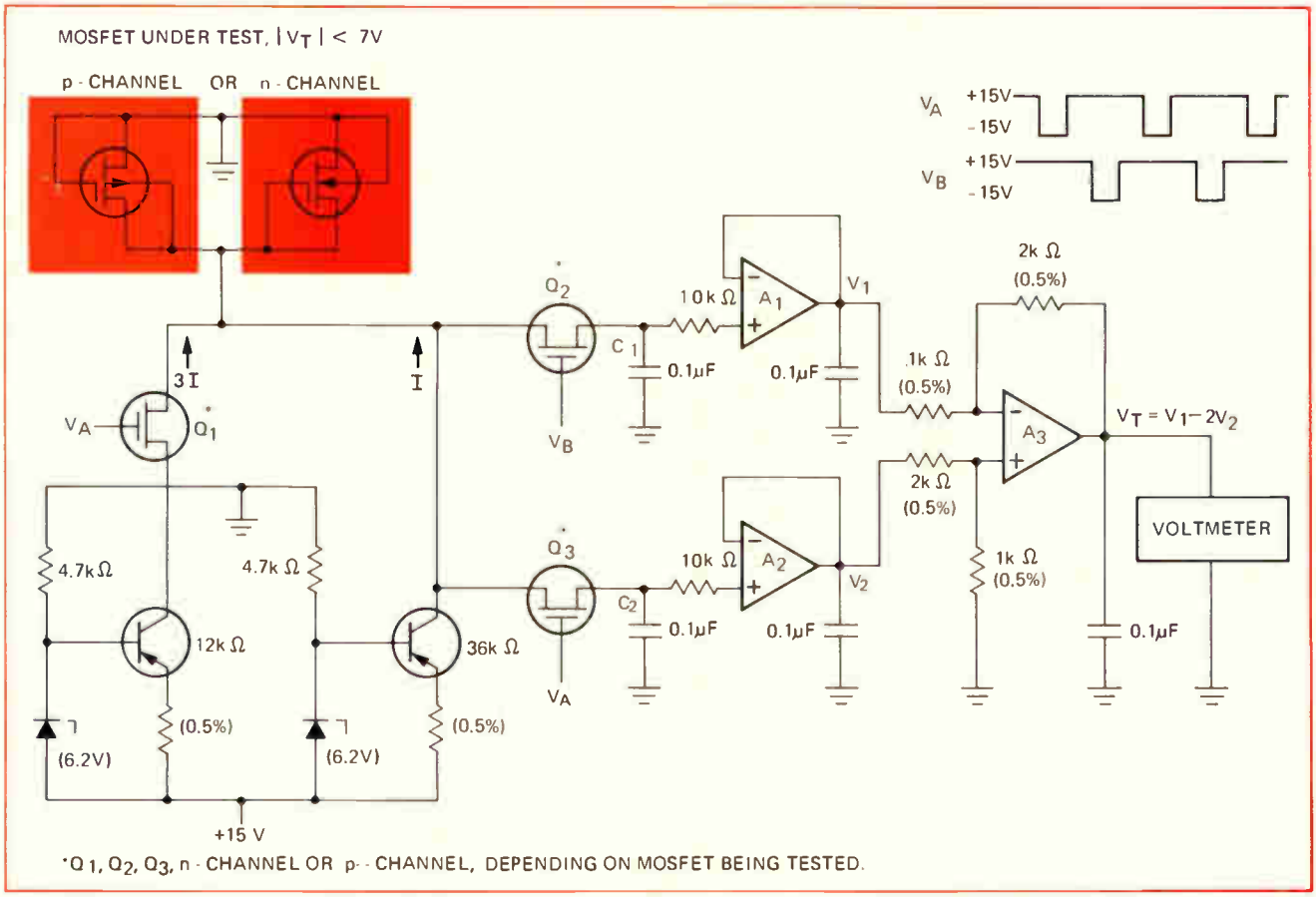
Selecting levels of $I_{D1} = 4I_{D2}$ reduces this equation to:

$$V_T = 2V_{GS2} - V_{GS1}$$

Now the threshold voltage can be found from two data readings by a simple subtraction.

In the test circuit, currents I and 4I are alternately supplied by separate current sources to the MOSFET under test. The device's drain-source voltage drop is sampled and held on capacitor C_1 and C_2. Voltage-followers A_1 and A_2 isolate the capacitors and provide a low-impedance output for driving subtractor A_3. The output voltage of A_3 is the extrapolated threshold voltage and can be measured with any voltmeter. □

Circuit alternately drives test MOSFET with different currents so that output threshold voltage reading is based on different data points.



Graphic aids simplify low-pass filter design

by Robert B. Cowdell
ITT Gilfillan, Van Nuys, Calif.

Designing single-element low-pass interference filters for matched or mismatched systems can be reduced to the use of a few graphs and some simple equations. With this design technique, even the degrading effect of capacitor lead length on filter insertion loss can be easily determined.

The extent to which lead inductance influences filter insertion loss depends on the type of capacitor used. Since dry Mylar capacitors are used in approximately 75% of all filter applications, they will be characterized here. Their popularity can be attributed to their ruggedness, low cost, and small size for the capacitance values of interest (0.1 microfarad to 5 μF).

Both ideal and practical low-pass capacitor filters are shown in Fig. 1. The practical version, of course, includes a series inductance to account for capacitor lead length. Letting:

$F = f/f_o$ = normalized frequency ratio

where f is the frequency of interest (in hertz) and f_o is the filter cutoff frequency (also in hertz), and:

$A = R_L/R_S$ = mismatch ratio

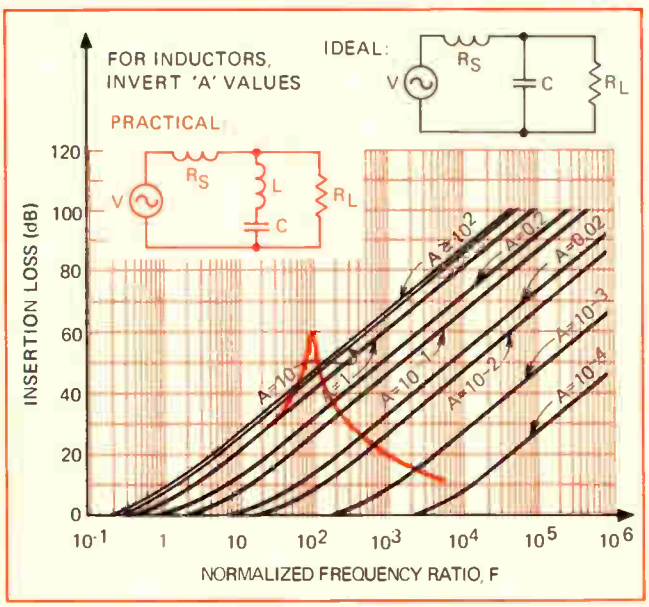
where R_L is the load resistance, and R_S is the source resistance, the insertion loss for the ideal capacitor filter can be written as:

$$I.L. = 10 \log[1 + F^2(4A^2/(1+A)^2)]$$

For an ideal low-pass inductor filter, the equation for insertion loss is:

$$I.L. = 10 \log[1 + F^2(4/(1+A)^2)]$$

1. Only ideal capacitor filters follow insertion-loss curves plotted for several values of mismatch ratio A. Self-resonant frequency curve (color) corrects for lead and internal-foil winding inductances. Ideal curves can also be used for ideal inductor filters.



Capacitor radian cutoff frequency can be expressed as:

$$\omega_o = 2/R_SC$$

For inductors, this equation is:

$$\omega_o = 2R_S/L$$

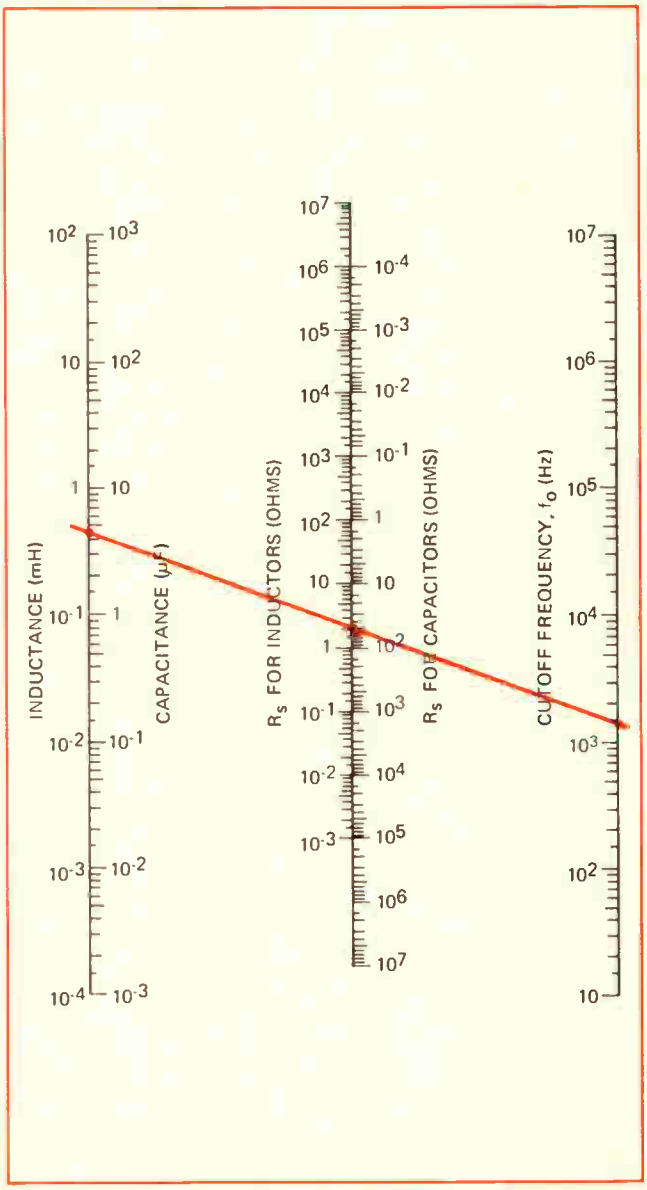
Insertion loss curves (black lines) for the ideal capacitor filter can be plotted over a range of normalized frequencies for several values of mismatch ratio A, as is done in Fig. 1. The same curves will be obtained for an ideal inductor filter, but the values of A must be inverted. A nomograph (Fig. 2) can solve both radian cutoff frequency equations.

The insertion loss of the practical capacitor filter can be computed from:

$$I.L. = 10 \log[1 + (F^2/(1 - F_r^2)^2)(4A^2/(1+A)^2)]$$

where normalized resonant frequency $F_r = f/f_r$ and self-resonant frequency $f_r = 1/(2\pi\sqrt{LC})$. The equations for the practical and ideal cases differ only by the term, $(1 - F_r^2)^2$, which is, by definition, the universal reso-

2. Low-pass cutoff frequency f_o, source resistance R_S, and L or C value can be found with straight-edge. Nomograph solves two radian cutoff frequency equations: $\omega_o = 2/R_SC$ and $\omega_o = 2R_S/L$.



nance correction factor. For frequencies beyond cutoff, the practical insertion loss can be expressed as:

$$I.L. = 10 \log[F^2(4A^2)/(1+A)^2] - 20 \log(1 - F_r^2),$$

permitting the correction factor to be added to or subtracted from the insertion loss of the ideal filter.

Plotting this last equation yields the universal resonance curve shown in Fig. 1. The departure of this curve from the ideal curves is the same for any value of capacitance and under any mismatch condition.

Although the curve's shape is always the same, its frequency location shifts with the value of capacitor self-resonant frequency f_r, and the curve's peak always occurs at f_r. Therefore, the practical filter's insertion loss follows one of the ideal curves (depending on mismatch ratio) until the self-resonance condition begins to dominate; then filter insertion loss follows the resonance curve.

A graph of the self-resonant frequency of dry Mylar capacitors is shown in Fig. 3 for various lead lengths and capacitance values. The shape of a capacitor, as well as its voltage rating (which dictates its size), alters capacitor internal inductance, but produces only a slight shift in f_r. Typically, as lead length increases from 0.1 inch to 3 inches, the self-resonant frequency of a 1-μF metallized polycarbonate capacitor shifts from 1.3 megahertz to 530 kilohertz for a 50-volt device, and from 1 MHz to 530 kHz for a 400-V device.

A design example illustrates how to use the graphs and equations. Suppose a low-pass capacitor filter were needed to reduce the conducted noise level on a matched 50-ohm line by 57 dB at 1 MHz. First, mismatch ratio A must be found:

$$A = R_L/R_S = 50\ \Omega/50\ \Omega = 1$$

From Fig. 1, the intersection of the A = 1 curve and the 57-dB loss line yields the normalized frequency ratio, F = 700; from this, the filter cutoff frequency is easily computed:

$$f_o = f/F = 1\ MHz/700 = 1.4\ kHz$$

The required capacitor value is found with Fig. 2 by placing a straightedge through the points f_o = 1.4 kHz and R_S = 50 ohms, which yields a value of C = 4.5 μF.

The ideal-insertion-loss curve of interest is now obtained by overlaying a piece of transparent paper on Fig. 1 and aligning cutoff frequency f_o = 1.4 kHz with F = 1 on Fig. 2. (Normalized frequency F = 1 should always be aligned with the desired filter cutoff frequency.) Trace the curve for A = 1 on the work paper to obtain the response of an ideal 4.5-μF capacitor in a 50-ohm system (see Fig. 4).

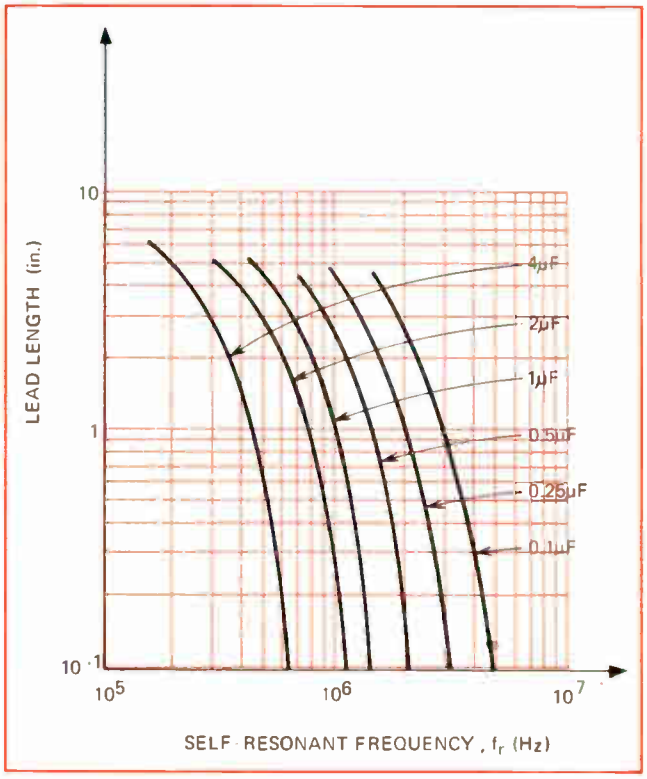
This ideal curve now must be modified to account for capacitor lead length. For illustration purposes, three different lead lengths will be considered—0.1 inch, 2 inches, and 4 inches. Using the curve for a 4-μF capacitance from Fig. 3 gives self-resonant frequency values of 640 kHz, 350 kHz, and 245 kHz, respectively.

All the data needed to sketch the practical-insertion-loss curve is now available. Again, overlay the same work paper on Fig. 1 and set the peak of the resonance curve at the first value of self-resonant frequency (640 kHz), making sure that the slopes of the two ideal curves coincide. Sketch the resonance curve for the first f_r value, as well as the other two, as shown in Fig. 4.

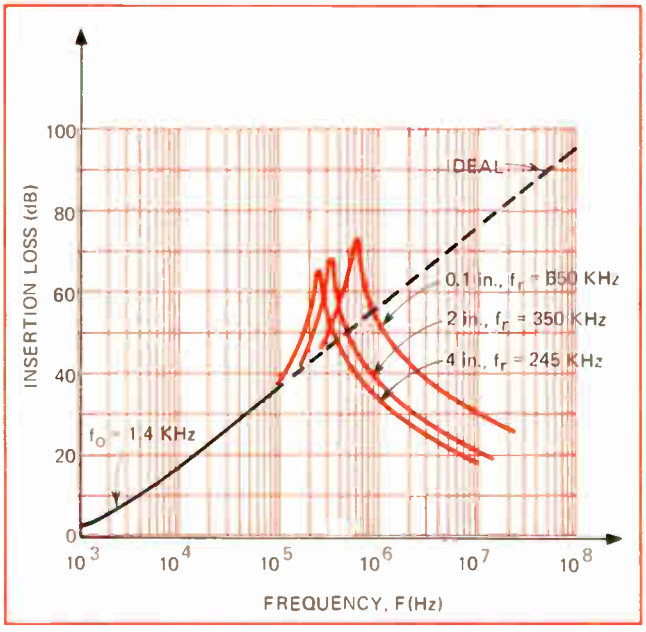
Measured data for the 0.1-inch lead length curve agrees very closely with the computed results from 50 kHz to 2.5 MHz. For higher frequencies, computed insertion loss is inaccurate because of reactance effects. □

■ *Self-resonant frequency curves for other capacitors will appear shortly in Engineer's notebook.*

3. Self-resonant frequency varies with capacitor type, as well as lead length. Curves shown are for dry Mylar capacitors.



4. Design graph is generated by drawing appropriate ideal insertion-loss curve from Fig. 1. Self-resonance curve (color) can also be drawn, once correct self-resonant frequency is found with Fig. 3.



Engineer's Notebook is a regular feature in Electronics. We invite readers to submit original design, applications, and measurement ideas. We'll pay $50 for each item published.

NEW EL-MENCO Transmitting Dipped Micas take only 1/6 the space, yet cost less than conventional types.

Typical TDM43 Capacitor, actual size

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Check the table below for representative values among the many standard TDM43 units available ... or call or write Electro Motive if you have a special application or one in which pulse conditions are present. Technical literature available on request.

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Typical Values Available—TDM43 Transmitting Dipped Mica Capacitors

Capacitance Value in pF	60 Hz Peak W.V.	Characteristic	Rated Current in amps. at Freq. of 3.0 MHz	1.0 MHz	0.3 MHz	0.1 MHz	Max. Dimens. in Inches L	W	T
47		C	0.50	0.10	0.07	0.03	2.010	.850	.220
1200	1500	F	4.90	3.80	1.20	0.42	2.010	.850	.230
2700		F	5.90	5.80	2.20	0.90	2.010	.850	.230
3300		F	6.10	6.20	2.60	1.10	2.010	.850	.230
5600	1000	F	6.50	7.30	4.10	1.80	2.010	.850	.240
9100		F	6.80	8.10	5.50	2.40	2.020	.860	.260
10,000		F	6.90	8.40	6.40	2.70	2.020	.860	.260
15,000	750	F	7.00	8.90	7.80	3.30	2.030	.870	.280
20,000		F	7.10	9.20	8.30	3.50	2.040	.880	.310
22,000		F	7.20	9.40	8.80	3.70	2.030	.870	.300
30,000	500	F	7.20	9.60	9.30	3.90	2.040	.880	.320
36,000		F	7.30	9.80	9.70	4.10	2.040	.890	.340
39,000		F	7.30	9.90	10.0	4.20	2.050	.890	.350
68,000	250	F	7.40	10.3	10.9	4.50	2.050	.900	.370
100,000		F	7.40	10.5	11.5	4.70	2.070	.910	.440

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Engineer's newsletter

Power line monitor from the Navy

Tired of wondering what your power line is doing, or for that matter, isn't doing? **If so, you may be interested in a low-cost 3-phase power line monitor that keeps an eye on the output of such supplies.** The monitor checks for both over- and under-voltage and frequency, and positive or negative pulse transients from 50 to 600 volts of pulse durations of from 1 microsecond to 16 microseconds. The Naval Civil Engineering Labs has made the results of this research and development effort available; for further information write: Utilization Officer, L02, Naval Civil Engineering Laboratory, Port Hueneme, Calif. 93043.

Book examines technology's effect on copyright

Civil libertarians and design engineers sometimes find themselves on opposite sides in arguments over technology vs individual rights. **A book to be published in October should make it easier for both sides to marshal their facts.** The book is called "Technology and Copyright: Annotated Bibliography and Source Materials," edited by George P. Bush, professor emeritus at the American University in Washington, D.C. Published by Lomond Systems Inc., of Mt. Airy, Md. 21771, the 400-page volume is a reference work on the effects of technology—xerography, microforms, computers, facsimile—on copyright. Hard copy is $14.50, microfiche, $9.50.

Sign of the times: engineering schools merge

As if to underscore all the rhetoric of the past few years about hard times in the engineering professions, **one of the oldest engineering schools in the East has been forced by economic conditions to close down.** New York University's School of Engineering and Science has been absorbed by the Polytechnic Institute of Brooklyn. But there is one bit of silver lining the cloud: all of NYU's faculty members have been offered appointments at Poly.

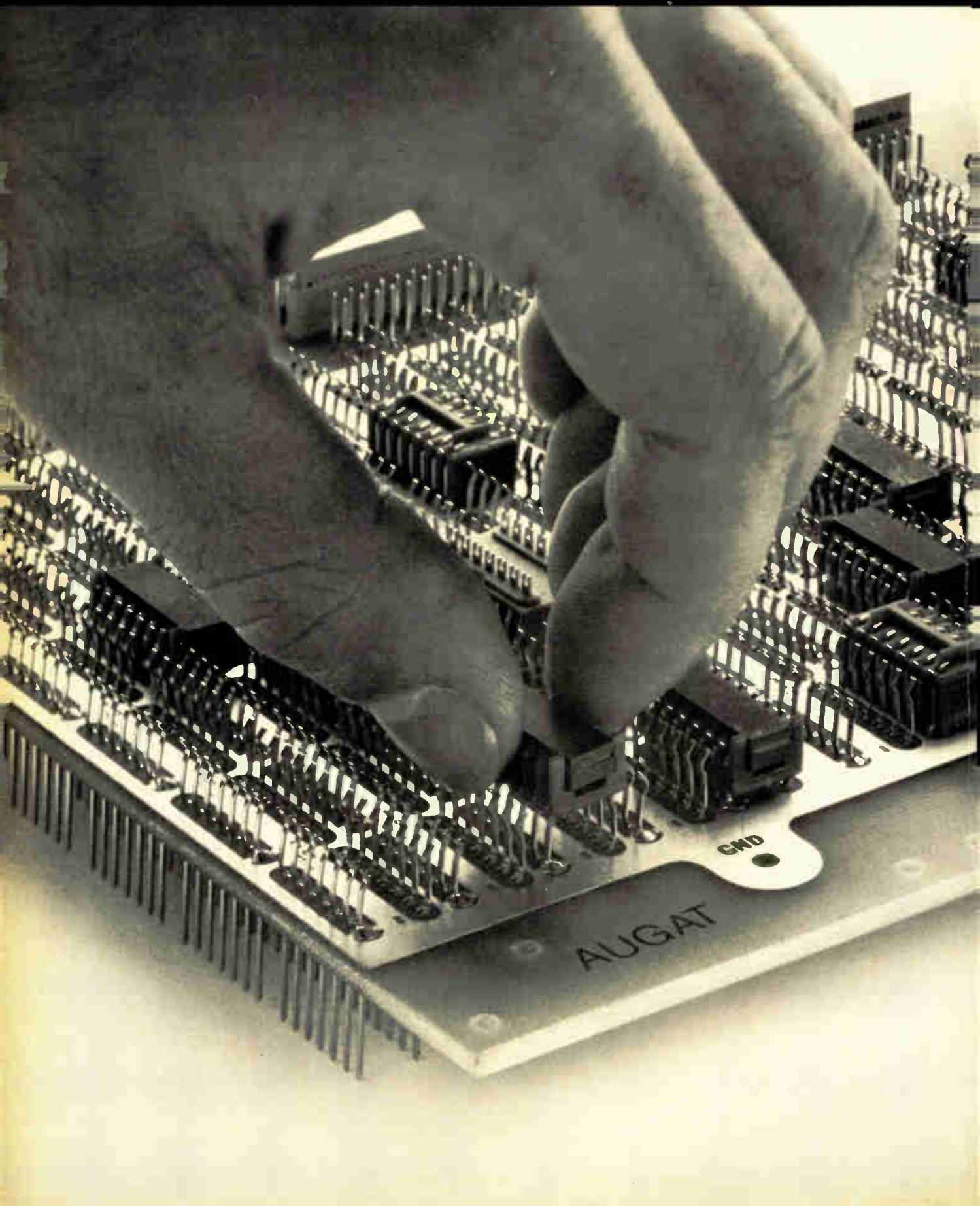
Bulletin offered on IC multipliers

Anyone whose design plans include using a general-purpose analog multiplier ought to get a copy of Intersil's new "Applications Bulletin A011—A Precision Four-Quadrant Multiplier." **It contains a particularly good general discussion on transconductance multiplication,** and the multiplier background is extremely informative. And, if you're thinking of using Intersil's multiplier, several block diagrams detail just how to hook it up to perform various mathematical functions, as well as performing as a variable-gain amplifier. The bulletin is available from Intersil Inc., 10900 North Tantau Ave., Cupertino, Calif. 95014.

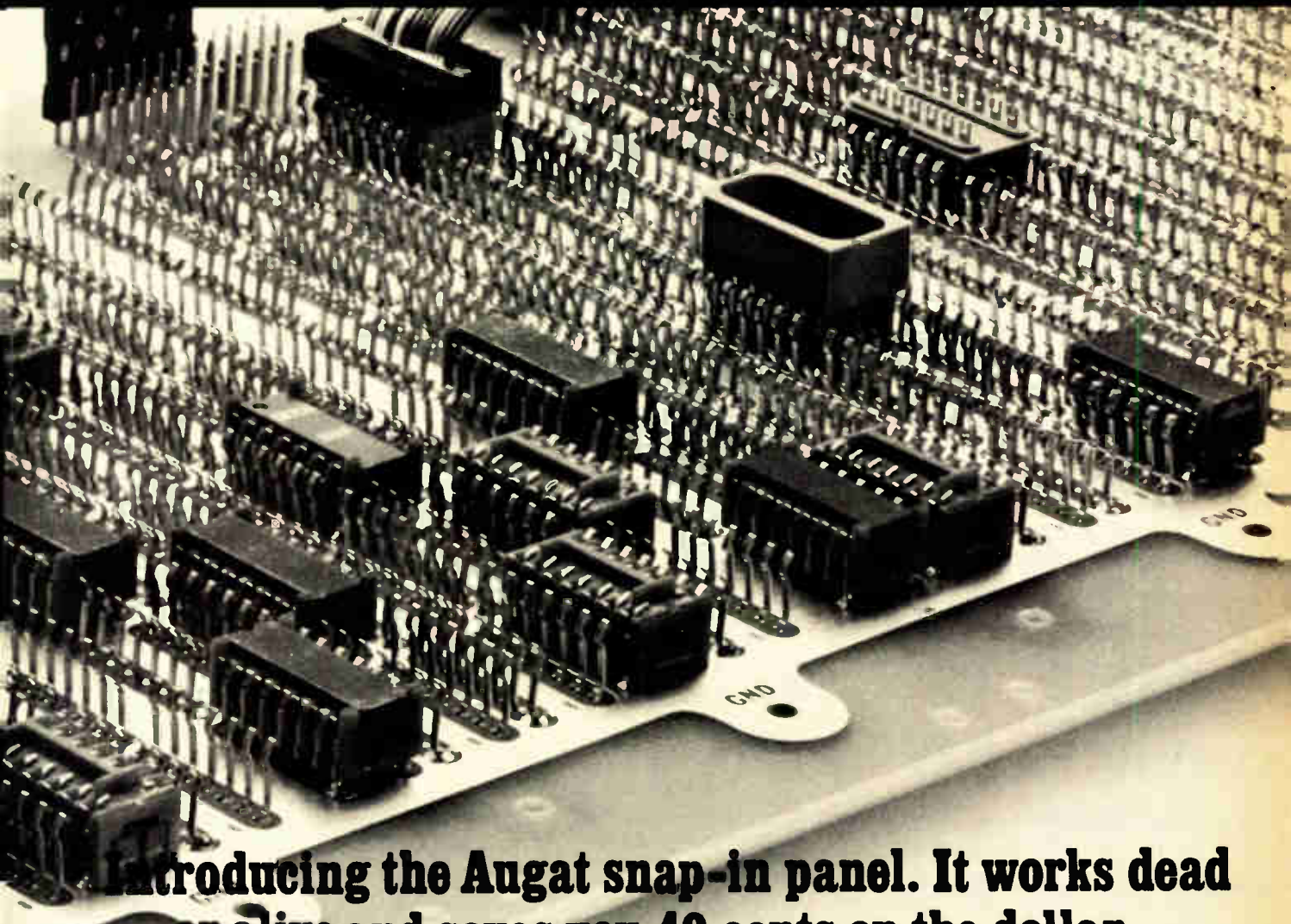
Addenda

If you've noted a drastic increase in SCR leakage current when it's triggered, you may be interested in the latest Westinghouse "Tech Tip," **which cautions against using a positive gate bias while the SCR is in a reverse-blocking mode.** For a copy of "Tech Tips 3-2" write J.L. DeFazio, Westinghouse Electric Corp., Semiconductor division, Youngwood, Pa. 15697. . . . The RCA Solid State division has a new 12-page application note called "Application Considerations for Hybrid Series Voltage Regulators." It covers high-current models that supply 5, 12, or 15 volts. The address is Route 202, Somerville, N.J. 08876.

SNAP. SNAP. SN



P.SNAP.SNAP.

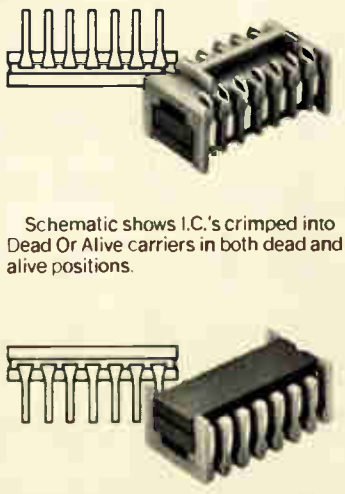


Introducing the Augat snap-in panel. It works dead or alive and saves you 40 cents on the dollar.

Augat calls it "Dead Or Alive"™. It's a brand-new way to make a panel. And now you can save up to 40% over other "plug-in" packages. Why? Because this new snap-in system uses post contacts and special carriers rather than machined sockets. And you save the difference. You get more flexibility too. More than other plug-in panels, and, of course, far more flexibility than rigid soldered printed circuit boards.

In either the alive position (IC legs down) or dead position (IC legs up), you can move or replace components freely. Just pull out and snap in. If you require soldering or conformal coating, components can be soldered in the dead position. Dead or alive, you still have the flexibility of back-of-panel wire-wrapping.

The positive action post contacts hold components snugly, virtually immune to vibrations, shock and other environmental conditions. What's more, the dead or alive carriers protect I.C. leads from damage during handling, insertion, and withdrawal.



Schematic shows I.C.'s crimped into Dead Or Alive carriers in both dead and alive positions.

(Patent Pending)

The panel's offset pin design maintains .100" grid centers. Together with perfect pin alignment, it provides for accurate and dependable automatic wire-wrapping.

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Communications Hardware, Just Price List.

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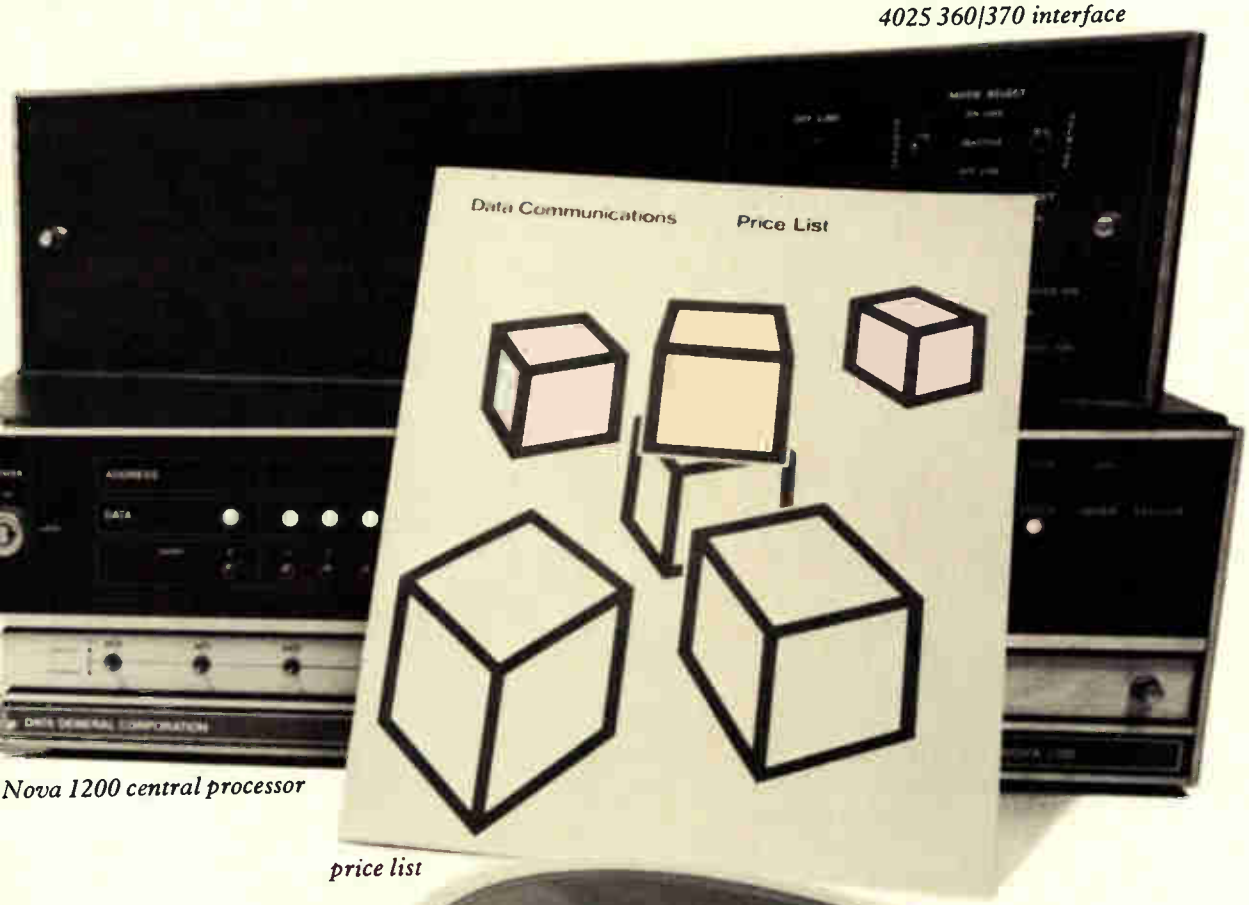
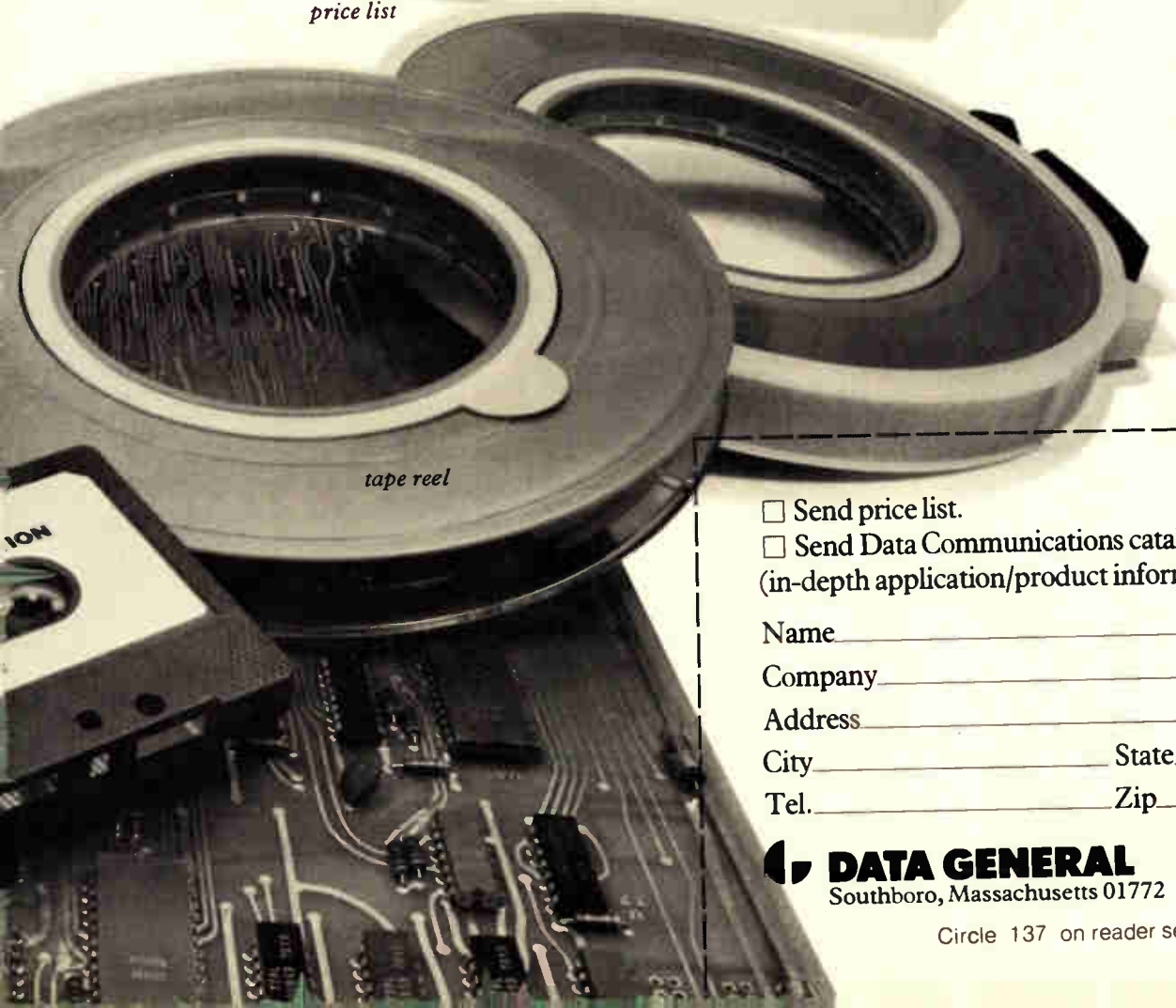


Nova 1200 central processor

price list



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☐ Send Data Communications catalog (in-depth application/product information).

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Wescon '72: the lure of broader markets

"We'll join you," the recruiting slogan of the new Army, might well be the merchandising theme of exhibitors when the Western Electronic Show and Convention takes over the Convention Center in Los Angeles, Sept. 19-22. Visitors will find that most exhibitors are looking this year for broader markets and are anxious to "join" with customers who can open new market areas, particularly in non-aerospace and non-electronics segments of industry. Instruments and components will dominate the exhibits, as usual, and there will also be a strong showing of data conversion equipment, peripherals, and other products associated with the data communications boom.

In the pages that follow are some of the more significant products that will be introduced at Wescon.

Solid-state vhf generator is quiet

Designed to replace the venerable model 608, Hewlett-Packard's new vhf signal generator has a wider frequency range, plus a high-quality output signal and modulation versatility. And it's only about as noisy as the best vacuum-tube generators, despite the fact that it's all solid state.

Unlike the older instrument, which spans only 10 to 480 megahertz, the model 8640 covers from 450 kilohertz to 550 MHz, to include both the rf and i-f frequencies of virtually all vhf receivers. Dynamic range is wide—+19 to -147 dBm—through a continuously variable calibrated attenuator. Pulse and calibrated frequency modulation are provided along with a-m and simultaneous calibrated a-m/fm.

Low noise. But noise performance is the new generator's star asset. Harmonics are at least 35 decibels below the carrier up to 128 MHz, and at least 30 dB down up to 512 MHz. Subharmonics and non-harmonic spurious signals are at least 100 dB down.

Single-sideband noise in a 1-kHz bandwidth 20 kHz from a 400-MHz carrier is at least 126 dB below the carrier, with a typical level of -133 dB. Broadband SSB noise is specified at least 140 dB/Hz below the carrier, with a typical figure of -145 dB/Hz.

Residual a-m is at least 78 dB down, and residual fm is less than 0.04 ppm for cw and low-index fm signals.

Two models. Frequency drift and accuracy depend upon which of the two model 8640s is under consideration. The 8640A, at $3,100, is a straightforward cavity oscillator with a slide-rule dial and a maximum frequency error of 0.5%. Its total drift over time, including warm-up drift, is typically less than 500 ppm. After a two-hour warm-up, its drift is less than 10 ppm/10 min.

The model 8640B, at $4,450, includes a built-in frequency counter with a crystal-controlled time base, a 6-digit LED display, and a phase-

lock circuit for locking the generator to the counter's time base. Spectral purity is preserved in the locked mode by the phase-locked loop's maximum bandwidth of 5 hertz.

The maximum frequency error of the 8640B is the sum of the time-base, resolution, and crystal-aging errors. The time-base error is 1 ppm from 15 to 35°C (typically 3 ppm from 0 to 55°C). Resolution error is ±1 count, and the crystal-aging error is less than 2 ppm/year.

Total drift of the locked unit works out at less than 2 ppm. Drift after warm-up is less than 0.05 ppm/hour.

Convenient. In addition to a carefully calibrated meter for measuring percentage modulation on a-m and peak deviation on fm, the 8640 has a number of warning lights that ensure its proper use without the aid of external equipment. For example, if the a-m modulation level and rf output level are both set so high that the maximum output power capability is exceeded, the generator won't simply clip the top off the output signal, it will light an annunciator saying Reduce Peak Power. Similar annunciators are used to warn of conditions leading to excessive fm deviation.

The standard models both include internal modulating signals of 400 and 1,000 Hz. In addition, an internal 20-Hz to 600 kHz oscillator is available as a $150 option. Its calibrated output can supply from 1 millivolt to 3 volts into a 600-ohm external load.

Inquiries Manager, Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. 94304 [363]

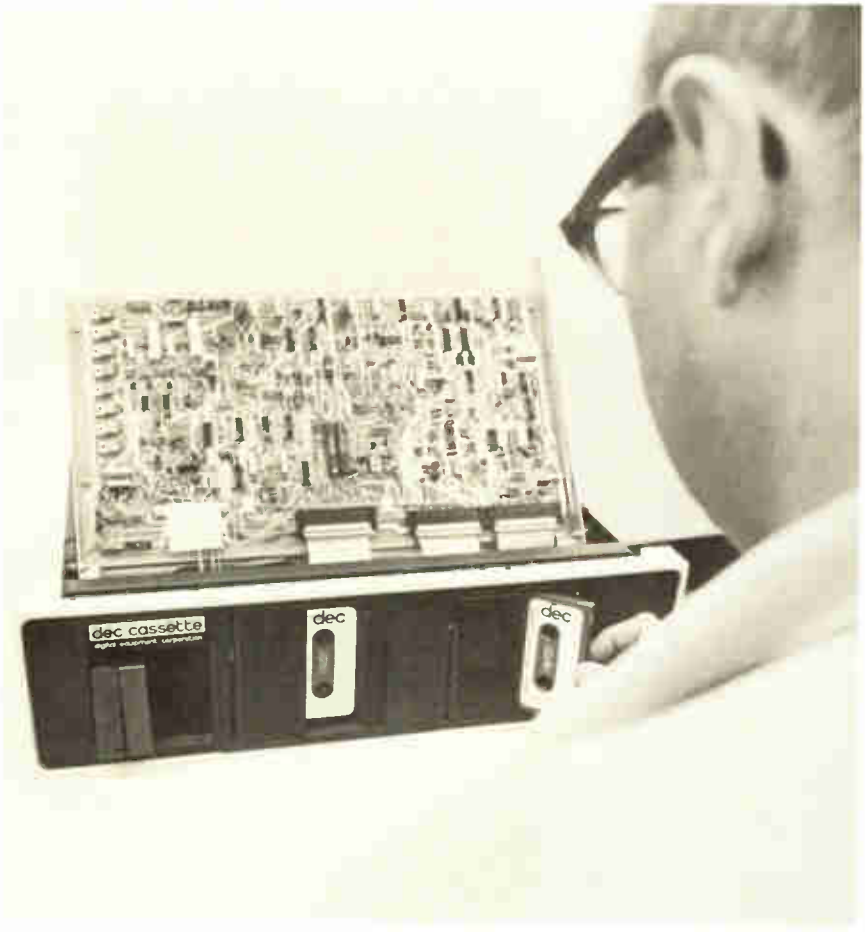
Cassettes crowd in on paper tape

As an input and output medium for computers, paper tape has so far survived all challenges from new media that were faster or less expensive on a character-by-character basis. But now paper-tape equipment seems to be seriously threatened by increasing use of magnetic tape cassettes, which can perform similar tasks at similar data rates and, by and large, for less cost. At the same time, they're reusable, and they eliminate the messy chads—the little circles that are punched out of some tapes to make the holes.

Digital Equipment Corp. is joining the parade of cassette-drive suppliers with a unit aimed at replacing paper-tape equipment. For a long time, DEC may have felt that it didn't need cassettes, because paper tape did well in low-performance applications, and the familiar DECtapes—small magnetic-tape systems using 4-inch reels of ½-inch-wide tape—were supplied for the faster machines. But DECtape is, in the words of one DEC spokesman, a "linear disk." Data on DECtape is block-addressable, under control of executive software. DEC's cassettes, to be aimed at another market, will be low-cost, high-reliability data-storage devices not intended for high performance or large storage capacity.

DEC's cassette drive is a reel-to-reel machine without a capstan, so that the speed varies widely because the motor speed is constant, while reel size varies as the tape winds and unwinds. Data is phase-encoded across the full width of the tape in a single track; the encoding method is self-clocking. The company plans to manufacture the mechanical and electronic portions of the drive, but to buy magnetic tape and hubs made to its specifications for the cassettes. An outside supplier will wind the magnetic tape on the hubs and assemble the cassettes, which in general will follow the widely used Philips pattern.

Meanwhile, DEC's rival, Data General Corp., has brought out its



the light fantastic

New gallium phosphide LEDs from Microsystems International —in red and green.

That's right, a line of red and green LEDs offering low, low operating current levels of 5mA—10mA, I.C. compatibility and bright (the brightest you've ever seen) with wide viewing angles of 90° each side of normal. All this made possible by Microsystems' gallium phosphide technology and unique optical designs.

At the top of the line, our panel-mount MA2300 series (the one in the foreground of the photo), with its built in lens/reflector system produces a sparkling 2.0mcd luminous intensity at $I_F = 5mA$. On its left is the MA2200 series, the same lamp, but with axial leads.

Just behind the MA2300, is the MA2400 series in the industry accepted panel-mount package. It produces a glowing 1.5mcd at 10mA—compare this with other standard lamps. At the far right is the MA2500 series in a standard TO-18 header, and putting out 0.4mcd at 10mA.

For the colour conscious designer there are optional: clear, clear diffused, tinted clear, or tinted diffused epoxy packages. Just about any colour and package combination for your signal and indicator lamp applications—and they're available now at competitive prices.

Seeing is believing, so why not drop around to any of the Microsystems outlets listed below and see our LEDs. Or give us a call and we'll bring our demo unit to show you—the Light Fantastic.

gallium phosphide LEDs from the performance leader

microsystems international

microsystems international limited, box 3529 station c, ottawa, canada — montreal, ottawa, toronto, brussels, stuttgart, london, palo alto, Philadelphia.

For further information — call or write your nearest Microsystems sales office or distributor.

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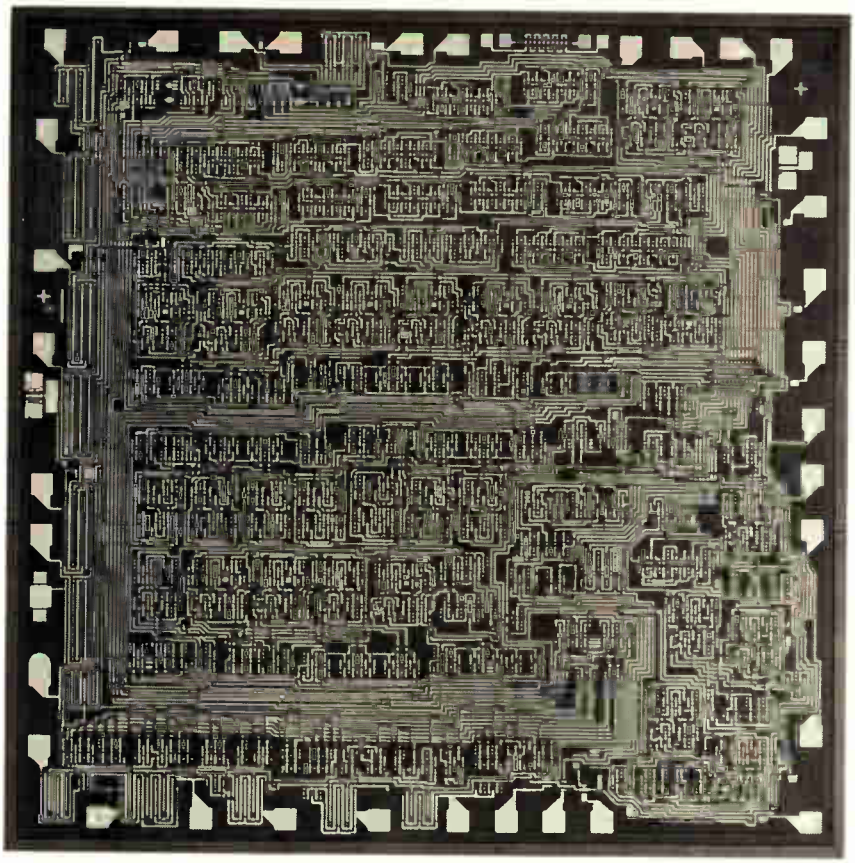
Chip

off the old breadboard.



RCA put 1,238 devices on a 150 mil COS/MOS chip. What are your LSI requirements?

The move is toward LSI. And RCA is ready now to develop custom COS/MOS circuits to your most demanding requirements.

For example, the 149 x 150 mil timing circuit above was integrated from a breadboard containing 1,238 discrete devices. Just one of many custom chips designed with RCA's unique silicon interconnect process to provide high packaging density.

RCA maintains a staff of systems engineers who are experienced in the development of complex micropower arrays. They are backed by extensive facilities to speed the process of IC design and development.

These facilities consist of computers for logic simulation, artwork digitizer-plotter systems that can cut turnaround time by 33% in typical circuits, Mann Pattern Generator facilities to speed mask preparation, and Teradyne Model J-283 digital IC systems which functionally evaluate complex arrays.

Put RCA's COS/MOS team to work to help reduce package count, cut assembly costs, and achieve excellent cost effectiveness in your systems.

When it comes to COS/MOS LSI, come to RCA.

Contact your local RCA Representative or RCA Distributor, or write RCA Solid State Division, Section 70 I-11, Box 3200, Somerville, New Jersey 08876.

International: RCA, Sunbury-on-Thames, U. K., or Fuji Building, 7-4 Kasumigaseki, 3-Chome, Chiyoda-Ku, Tokyo, Japan. In Canada: RCA Limited, Ste. Anne de Bellevue 810, Canada.

RCA Solid State

products that make products pay off

own cassette drive, the Nova Cassette. Data General also is aiming at the paper-tape market with a low-cost, high-reliability unit recording in a single self-clocking track. Data General, however, is using a ratio-recording method somewhat similar to pulse-width encoding; the binary data is defined as a positive-going magnetic state on the tape, either one-third or two-thirds the length of a bit cell, depending on whether the data is a 1 or a 0. Data General is buying its mechanical drives from Redactron Corp., a Long Island manufacturer of editing typewriters that also supplies peripheral equipment to several OEM customers. Data General adds the electronic circuitry to the Redactron mechanical assembly and puts the whole thing in a cabinet for rack mounting.

Digital Equipment Corp., 146 Main Street, Maynard, Mass. 01754 [413]

Data General Corp., Southboro, Mass., 01772 [364]

Counter measures to 12 GHz automatically

Sophistication exists in some electronic counters, and ruggedness in others. But at Wescon, Systron-Donner Corp., Concord, Calif., is unveiling a counter that has both features.

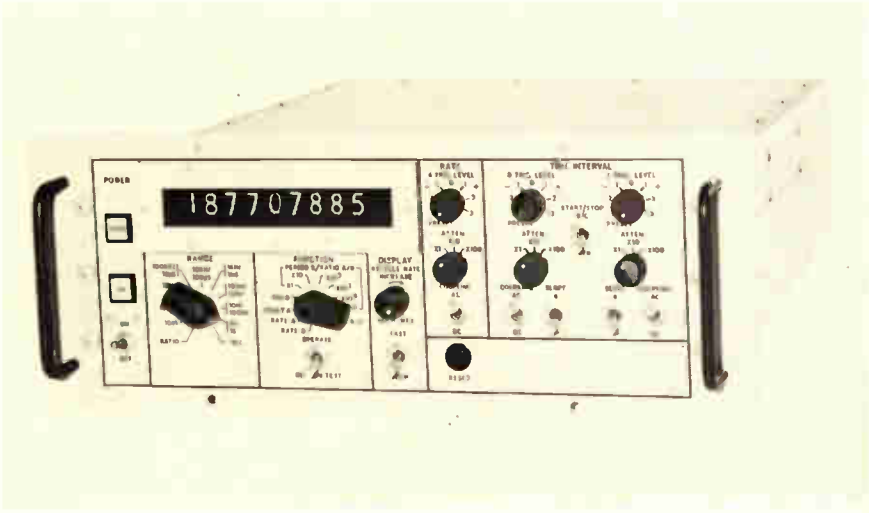
The model 6154 combines automatic direct readout of frequencies up to 12 gigahertz with full counter-timer functions, and has built-in full systems capability, including remote control and programing. Moreover, the instrument meets all military specifications for quality control, high and low temperatures, altitude, humidity, vibration, shock, and electromagnetic interference and compatibility. "It is designed for all those applications requiring built-in, failure-free protection against environmental hazards," says Noel Kelley, product marketing manager.

The instrument is essentially two counters in a single frame. One operates from dc to 200 MHz, and the other from 200 MHz to 12.4 GHz. In the time interval and period measurement mode, the 6154 has a resolution of 10 nanoseconds. Input sensitivity is 100 millivolts on the basic 200 MHz counter and is also 100 millivolts on the 200 MHz to 12.4 GHz input. The low-frequency input is 1 megohm shunted by about 75 picofarads. The high frequency input is a nominal 50 ohms.

Besides continuous frequency measurement from zero to 12 GHz, the 6154 offers time interval, period, ratio, totalize, and scaling functions. The standard time base has a crystal frequency of 10 megahertz, and the aging rate is ±3 parts in 10^8 per month.

The short-term stability is ±5 parts in 10^{10} rms for 1 second at constant environment and line voltage. Temperature stability is 2 parts in 10^{10} from 0° to +55°C. If more stability is required, an external 1-MHz source may be connected at the rear panel. Other features are a nine-digit display and an internal digital-to-analog converter for variable trigger-level control. The 6154 will sell for about $10,000, depending on specific requirements and quantity.

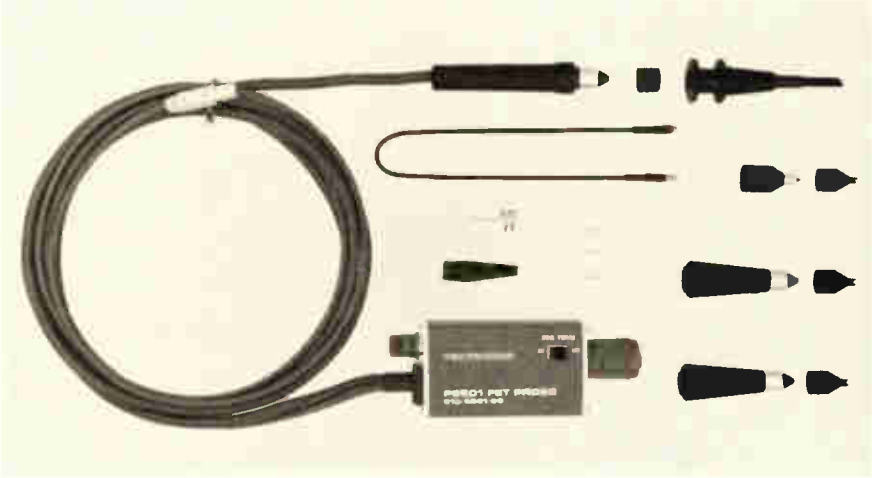
Systron-Donner Corp., 10 Systron Dr. Concord, Calif. 94520 [400]



Scope probe provides 900-MHz bandwidth

Next best thing to increasing scope bandwidth is to help engineers get full use out of the presently available bandwidth. That's the thinking benind Tektronix' new non-attenuating scope probe, called the P6201, which offers a unity-gain bandwidth of from dc to 900 megahertz.

The low input capacitance of the field-effect-transistor probe—on the order of 3 picofarads—permits coupling of high-frequency signals to a scope input with minimum loading on the circuit under test. Input resistance is 100 kilohms, but this can be increased by plug-on attentuator heads (each is 1 megohm shunted by 1.5 pF that simultaneously reduce the input capacitance. Without the attenuator heads, the effective dc offset range for the P6201 is a minimum of −5.5 volts to +5.5 V with respect to the probe tip. With the attenuator heads, the effective offset is extended to 10 times and 100 times.



Designed primarily for use with Tektronix 7700 and 7900 series mainframes, the P6201 can also be used with the company's new model 475 and 485 portable scopes, and with 50-ohm sampling instruments and conventional scopes having 1 megohm inputs. With the Tektronix products, the active probe receives its power from the mainframe. With older Tek scopes and instruments made by other companies, it needs the accessory power supply that is available, and an internal 50-ohm termination may be switched in or out to adapt the probe output to either 1-megohm or 50-ohm inputs.

The probe includes a locking-type BNC connector, which provides automatic scale factor readout information to instruments having this capability. The 10× and 100× attenuator heads also couple readout information to the instruments by means of the output connector. Other specs for the new probe include a rise time of 0.4 nanosecond, and a dynamic signal range of at least ±600 millivolts.

The probe is priced at $375.

Tektronix Inc., Box 500, Beaverton, Ore. 97995 [414]

Generators permit wide choice

A-m/fm capability has been added to more conventional function-generator features in two models, the F35 and F36, developed by Interstate Electronics Corp. The company says that the F36 is the first such instrument to provide trigger, gate and variable width pulses, as well. Otherwise, the generators are similar, with frequency ranges of 0.03 hertz to 3 megahertz (6 MHz for sine waves), and sine, square, and triangular output waveforms. They also have adjustable dc-level output, and 1,000:1 deviation with voltage for frequency modulation.

A five-step, 50-decibel attenuator is used for high-output resolution and high signal-to-noise ratio, especially for low signal levels. The generator modulation system differs from standard a-m generators in that either can be disconnected to allow the generator to produce a pure output waveform. As marketing manager Hal Stitt explains, "If the modulator isn't disabled, it tends to exaggerate waveform distortion and degrade the rise and fall times of the wave output produced by the generator. We felt that if the operator doesn't need the a-m in an application, he should be able to switch the modulator out and go directly to the output port."

The modulation technique can supply both conventional amplitude modulation and double-sideband suppressed-carrier modulation. An internal 400-hertz sine-wave source can provide a-m or fm of the output, eliminating the need for a second signal generator.

IEC has paid special attention to

Table Travel Speed: 400 ipm each axis.

High-torque, high-speed, low inertia servo motor driven by General Automation computer provides *instant* acceleration for unmatched production.

Drill Hit Rate: 200/min.

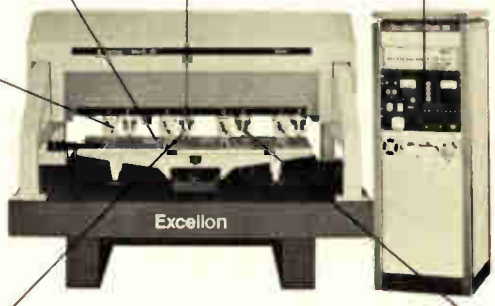
Quality holes on 0.25-inch movement with 3-high stacks and .002 chip load.

Spindle Motor Speed: 45,000-80,000 rpm.

Air-bearing, AC variable-frequency motor exceeds practical limits of ball bearing motors.

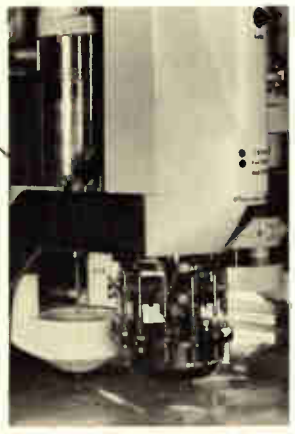
Spindle Feed Rate: 20-250 ipm.

Constant feed rate accuracy to within 2.0% of setting. Stroke limit adjustable in 0.001-inch increments.



Computer-directed NC utilizing General Automation SPC-12/15.

Step and repeat, mirror image, automatic rewind. Handles variety of code formats and is plug-compatible with central computer.



Automatic Drill Changer.

Selects from 12 drill sizes on computer command. No drilling area sacrificed.

Excellon marks a new era in p.c. drilling. Mark III

We've had more than our share of advancements over the years.

Like the first multiple-spindle manual drilling machine, the Quad-Drill. That was in 1963.

In 1965, we introduced the Quadramatic tape machine. It was the first to use a granite base and a unique, 2-position shuttle plate.

We introduced the Accumatic, with the first granite ways and free-floating granite table, in 1968. It increased the going spindle rates from 21,000 rpm to 80,000 rpm. It increased hit rates from about 45 per minute to 120 per minute.

The fact is, when we added up the knowledge we'd gained from our successes, (and failures), we had all the makings of a major breakthrough.

The Mark III, controlled by General Automation's SPC-12/15.

Compare its performance with any other drilling machine made. We think you'll agree it makes 1972 the beginning of a new era.

And while you're at it, investigate Excellon's world-wide drilling industry supply and service capability.

Call or write Dick Hogan, Sales Manager. His number is (213) 325-8000.

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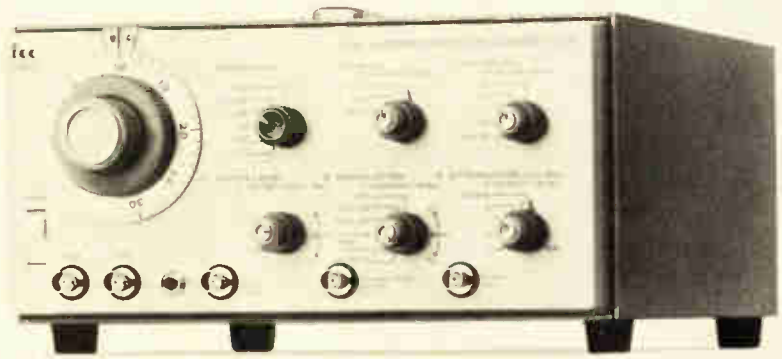
user maintenance, and a manual test/check program included with schematics shows ideal waveforms at readily identified test points. Plug-in ICs simplify servicing, and the entire instrument package can be removed from the case after two rear panel screws are removed.

Price of the F35 is $595, and of the F36, $645.

Interstate Electronics Corp., 707 East Vermont Ave., Anaheim, Calif. 92803 [415]



16-bit converter is compact

It wasn't too long ago that engineers who needed a 16-bit analog-to-digital converter had either to buy large and expensive units or build their own. But both size and price have been coming down—Datel Systems' new ADC-HR16B, a successive-approximation unit, is priced at $895.

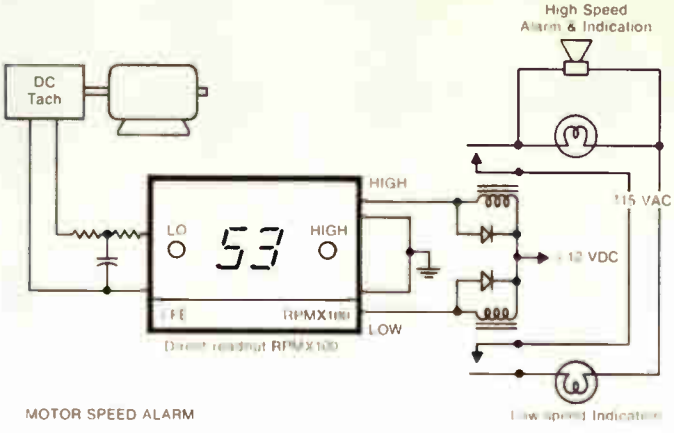
Instead of building the device around one of its existing digital-to-analog converters, Datel designed the HR16B from the ground up, using a two-chip LSI programer and a new d-a converter component. That is how the company was able to fit the complete converter into a plastic-encapsulated module that measures 2 by 4 by 0.8 inches. Although the height is nearly double that of competing packages, the over-all volume is much lower. Pin spacings are compatible with dual in-line packages.

Settling time of the HR16B is only 100 nanoseconds, and total conversion time is only 50 microseconds, making possible a throughput rate of 20 kilohertz. To attain this speed, Datel has shortened the settling time by omitting the input buffer amplifier. "In most applications, people know the source impedance," says John H. Gallagher, marketing manager, "so in many cases you don't need 100 megohms impedance. If the source impedance is fixed, you can take it into account when calculating accuracy."

Output resolution is one part in 65,000, true 16-bit resolution with a 96.3-decibel range, and linearity error is ±0.0015%. System accuracy is within ±0.005% of full scale, and long-term stability is to within ±0.001% per year.

The temperature coefficient is kept to an unusually low 5 ppm/°C

DIGITAL CONTROL METERS



MOTOR SPEED ALARM

Now: set, read and control with digital precision!

These totally new **api** Digital Control Meters control and display your temperature, flow, voltage, or current in brilliant blue-green 7-segment digits one-half inch high. If either set point is exceeded, a LED indicator lights and a reed relay switches for precise, quick control.

Set point adjustment is also fast, easy and positive: simply depress and rotate the control knob to obtain the desired high or low limit. The **api** Digital Control Meter displays the set point value during setting, reverts to displaying the controlled variable as soon as the knob is released.

Two models are available: **api** Model 4350-K displays 2½-digits, has ½% accuracy and resolution, accepts voltage or current inputs. **api** Model 4354-K extends the range to 2¾-digits, the accuracy to 0.2%, handles temperature and resistance in addition to current and voltage.

LFE, Process Control Division, 1601 Trapelo Road, Waltham, Mass. 02154
Tel. (617) 890-2000.

CORPORATION

Process Control Division

Circle 147 on reader service card

over an operating range of 0 to 70°C by using a precision ladder network that tracks to within 0.5 ppm/°C and an oven-controlled zener reference.

Speed is fixed by an internal clock, which can be used for system control or can be slaved for external system timing. The unit offers both parallel and serial NRZ data outputs, capable of driving up to six TTL loads. Output digital coding can be straight binary, offset binary, or twos complement with word lengths of 14 to 16 binary bits.

Full-scale input can be either unipolar (0 to +10 volts) or bipolar (±5 volts or ±10 volts), at an input impedance of 5 kilohms, requiring a source current of 2 microamperes.

Unit price of the converter is $895, with discounts of 25% available in 100-unit lots. Delivery time is 4 weeks.

Datel Systems Inc., 1020 Turnpike St., Canton, mass. 02021 [383]

Converter works with TTL, C-MOS

Measuring only 1.7 by 0.875 by 0.26 inches, a 12-bit, ac-reference multiplying digital-to-analog converter is said by its manufacturer, Micro Networks Corp., Worcester, Mass., to be the smallest of its type on the market.

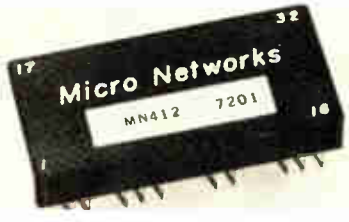
Hybrid switches are used in the converter, called the MN412, to increase packing density; and the 12-bit precision ladder network, a thin-film device, fits in a single flatpack. Despite its size, performance characteristics are respectable—switching time is a maximum of 2 microseconds, and over-all settling time for small steps is 5 μs maximum. Total throughput rate is a relatively slow maximum of 10 kilohertz.

Micro Networks doesn't specify temperature coefficient, says Robert J. Lane, president, "because the engineer still has to figure out the accuracy at a specific temperature." Instead, the company specifies accuracy of one bit over the full operating range of 0°C to 70°C.

The MN412 accepts a broad range of reference voltages, from +13 volts to −13 volts. Output voltage is proportional to the product of the digital input and the reference voltage. Total power consumption is less than 750 milliwatts. And besides being TTL-compatible, the 412 is also C-MOS-compatible, an unusual feature because of the high voltages required. The 412 has standard 6-mil pin spacing, which allows it to plug directly into a pc board and makes testing easy.

Micro Networks expects the 412 to find a market in simulators and display applications, including ramp generation and simulation of aircraft functions and of controls, such as at atomic power plants. Price of the MN412 is $245 each in quantities of 1 to 24, and $195 in quantities of 25 to 99.

Micro Networks Corp., 5 Barbara Lane, Worcester, Mass. 01604 [362]

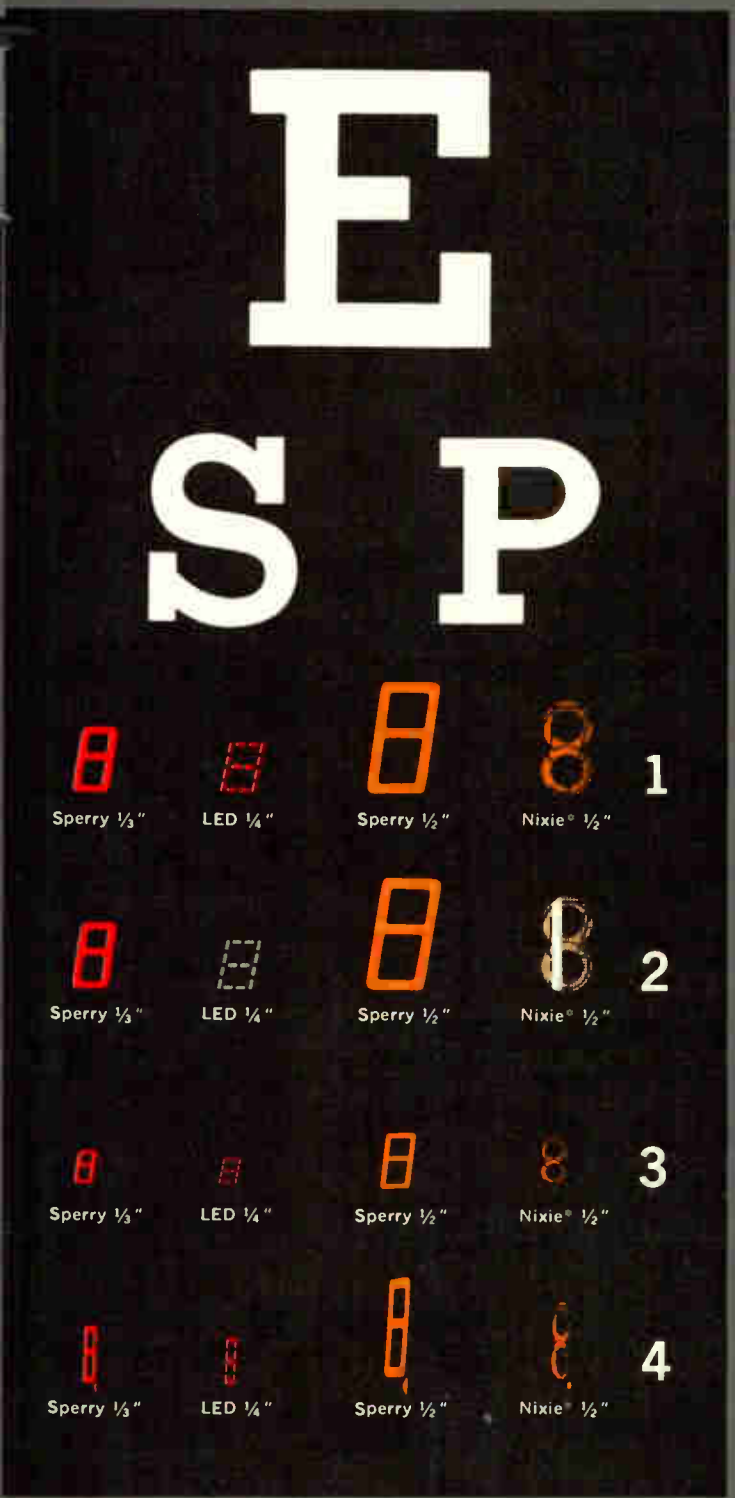


8-bit converter is low-priced

A technique that needs only half the components required by the successive-approximation method has enabled Hybrid Systems Corp. to pack an eight-bit analog-to-digital converter into an unusually small space for an unusually low price. Fitting into a mere 2 by 2 by 0.4 inches, the ADC590-8 is described by the company as the smallest and, at $59, one of the lowest-priced commercially available.

In Hybrid Systems' basic-counting technique, an eight-bit counter

The Sperry eye test for display equipment buyers



The above is a printed interpretation of the appearance of the more popular displays. You are encouraged to make the same comparison with actual devices.

The old saying "what you see is what you get" certainly applies to the purchase of equipment incorporating displays — panel meters, DVM's, multimeters, counters, instruments, calculators and other equipment. If you can't clearly and easily read the information being displayed then you're not getting full product value. And, you're obviously not getting equipment supplied with advanced Sperry planar displays†.

How do you tell if they're Sperry displays? Simply take the Sperry eye test.

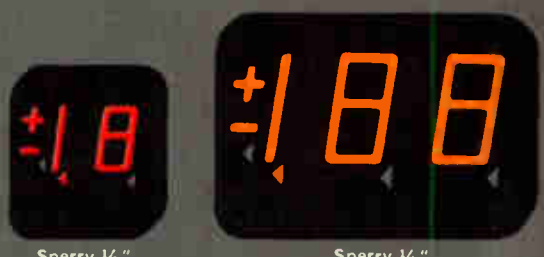
1. **Do the displays appear as uniformly bright, continuous characters with no irritating gaps or filaments and screens to reduce readability?**
   ☐ YES ☐ NO
2. **Do the displays remain bright and clearly legible with no glare or appreciable fading even under direct sunlight conditions?**
   ☐ YES ☐ NO
3. **Can you quickly, easily and accurately read the displays from 20 to 40 feet away?**
   ☐ YES ☐ NO
4. **When the unit is positioned within a 130° viewing angle, can you still clearly read the displayed characters?**
   ☐ YES ☐ NO

If you answered YES to all four questions, you already have your eyes on equipment featuring preferred Sperry displays.

If you answered NO to any of the questions, you owe it to yourself to take a comparison look at products equipped with superior Sperry displays.

FREE BUYER'S GUIDE —
To help you make the right equipment selection, Sperry offers the handy "Buyer's Guide for Equipment featuring Electronic Displays". It's your's for the asking. Order your copy today by checking the reader service card or phone or write: Sperry Information Displays Divison, P.O. Box 3579, Scottsdale, Arizona 85257, telephone (602) 947-8371.

SPERRY
INFORMATION DISPLAYS



units are available for use with red filters

It's a whole new ball game in displays!

†Patents Pending
*NIXIE is the registered trademark of The Burroughs Corporation.

SPERRY RAND

Circle 149 on reader service card

driving the d-a converter increases the converter's output voltage one count at a time. When the output signal equals the input, the counter is stopped, and the value in it corresponds to the input voltage.

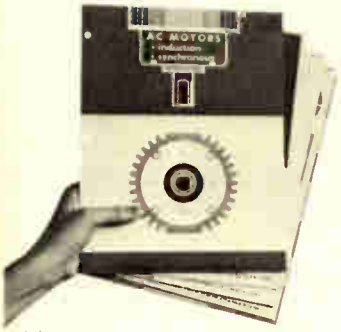
However, this is much slower than successive approximation, because what the method saves in space is sacrificed in speed: total conversion time is 200 microseconds. A-d converters twice the size of the ADC590-8 can convert eight bits in 50 microseconds. To help compensate for the slowness of this counting technique, Hybrid Systems uses a high-speed a-d converter in the unit.

Though the price is low, Hybrid Systems uses thin-film resistors and all-hermetic active components that have been burned in for 72 hours to ensure reliability. Accuracy is to within 0.25%, and temperature coefficient is 50 parts per million/°C. The input voltage range of −5 to +5 V or 0 to +10 V is determined by simple pin interconnections. The unit has its own internal references, with an over-all power-supply sensitivity of 0.05%.

Potential applications include medical instrumentation, process-control, and remote signal-monitoring instruments. Because of the ADC590-8's low price and ease of use, Hybrid Systems says users can put one at every sensor of a system, rather than time-sharing one or more.

In quantities of 100, the price of

Everything you always wanted to know about Drive Motors.



Into these five booklets we've crammed 156 pages of the latest information on Kearfott's line of Drive Motors.

Kearfott, as you probably already know, is a primary supplier of drive motors. And has a reputation for quality, service and on-time delivery.

We can furnish you with drive motors in individual units or in packages to fit any of your aerospace or industrial applications. From counters to computers. From business machines to printers and tape readers.

Let's take a look at the type and range of motors we're talking about.

DC TACHOMETERS

Kearfott Tachometers are designed specifically for precision speed sensing and as rate generators to help velocity servos achieve fast response.

Features include: outputs to 100V dc/1000rpm; minimum ripple at high commutation frequency; high linearity; low friction torque.

These are ideal for computer tape transports where efficient data retrieval is a must. And for business machine and numerical control machine tools.

DC TORQUERS

You can get sizes 12 through 42, uncased for gimbal mount applications and cased for direct drive torque motor positioning.

Kearfott can also supply them with a variety of integral feedback elements such as potentiometers, synchros and tachometers—in a single housing.

You've a choice of standard design, inverted construction (inner member is magnetic and transfers power to an outer armature) and brushless Limited Rotation design.

DC MOTORS

These are Moving Coil Motors used for high-response DC servos such as High-Speed Printer and Capatan drives.

One of their unique features is that they need less cooling than equivalent competitive units. The reason: low internal impedance which allows a high cooling flow rate at low developed pressures.

Permanent magnet and wound-field types are available for standard aerospace and industrial applications, including high acceleration motors with integral tachometers for terminal printers.

AC MOTORS

Kearfott induction or synchronous motors of the hysterisis or reluctance type come in a broad range of frame sizes. And from sub-fractional power to 15 HP.

We can furnish motors that run on up to 440 volts ac, single, 2 or 3 phase. Induction motors that operate on 2, 4, 6, 8 or 12 pole design. And dual speed motors such as needed for driving memory discs in large computers.

You can also get: high-slip motors for aircraft requirements at 400 cps; synchronous motors for constant rotating speeds with varying loads; gear motors for extremely low speeds or speeds incompatible with the power supply frequency.

STEPPER MOTORS

If you want precision control—for example for small peripheral devices, small line printers and tape readers—Kearfott Steppers provide it via discreet steps and high slew rates. And in a wide choice of stepping rates and torque levels.

Typical Kearfott units have 15° stepping angles, compatible with all 24-tooth sprockets. They give high holding torque, high stepping speed and fast response.

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Plug and patch components cut design and maintenance costs.

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the ADC590-8 converter drops to $50.
Hybrid Systems Corp., 95 Terrace Hall Ave., Burlington, Mass. 01803 [354]

Modular tester

"We've finally had enough complaints, so we've developed a system that answers everyone's needs." That's how William C.W. Mow, president of Macrodata Corp., describes the firm's new MD-500 test system designed for 10-megahertz testing of all ICs—bipolar and MOS, random logic, RAMs, ROMs, and shift registers. The system, which is modular so that it may be configured for testing many types of devices, can do the work of the earlier MD-200 and MD-150 systems.

The system consists of a number of basic "macromodules"—computer, parametric test system, clock source, power supplies—a number of which are "micromodular," with the provision for expansion to 13 power supplies, for example.

The heart of the MD-500 is its choice of different program sources for testing different types of LSI. The system includes: Macrodata's pattern-generation testing, which Mow says is most suitable for RAMs and shift registers; an optional shift-expandable register buffer for random logic; and a RAM buffer for ROMs and such single-chip devices as calculators and central processing units.

The reason, he says, is, "The concept of test has changed, and the reason for this is that LSI devices have changed." Among the changes is what Macrodata calls its initial-vector-compare technique for single-chip parts. "We don't test the logic, but the operation of the chip. We simulate a keyboard, looking for the correct output response for each input move." The system can also functionally test universal asynchronous receive-transmit chips and devices for such rapidly mushrooming markets as clocks and watches.

The system has as many as 64 pins, although Macrodata can supply 128. Four test stations can be

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multiplexed, and a separate program-compiler station can be used for program development while the others are testing. All programs can be modified at the console through hardware, often faster and easier than software changes, and the software can incorporate changes.

Programs are compiled on-line without the need for paper tape or personality cards. The operating software from each station is contained fully in core.

The MD-500 price is dependent on configuration, but the cost will generally be from $100,000 to $250,000.

Macrodata Co., 20440 Corisco St., Chatsworth, Calif. 91311 [468]

8-channel recorder

Preamplifiers are built into an eight-channel general-purpose recorder developed by the Instrument Systems division of Gould Inc. Designated the Brush 481, the recorder has a measurement range from 1 millivolt per division to 500 v full-scale (there are 50 divisions across each 40-millimeter-wide channel). The unit can be used in portable or bench applications.

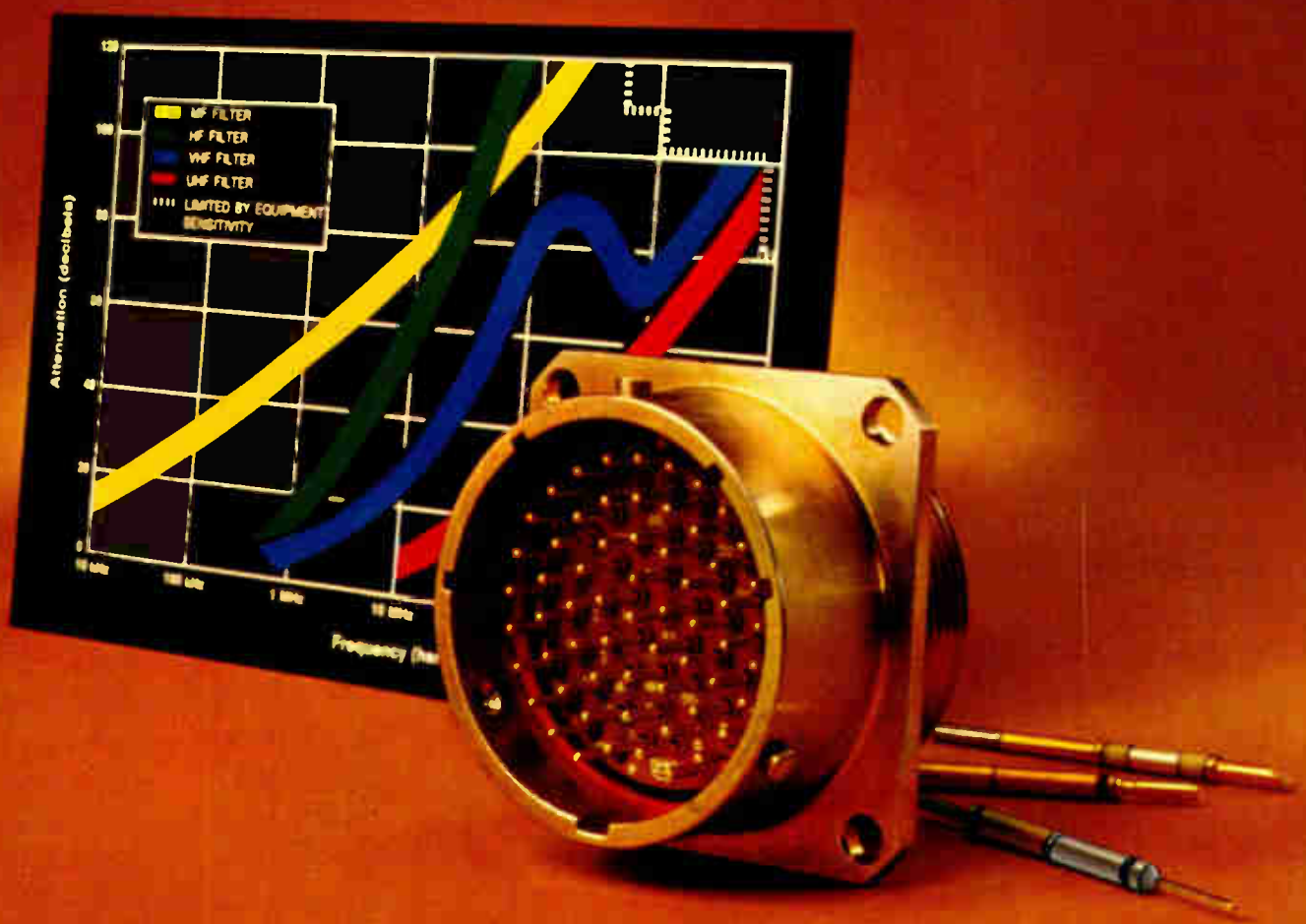
The preamplifiers have differential, floating, balanced-to-guard inputs that are isolated from each other, from the chassis, and from the output. They accept signal sources of any configuration without affecting accuracy or creating system noise.

Features of the Brush 481 also include pressurized-ink writing for clear, smudge-proof traces, rectilinear trace presentation; 99.5% linearity enforced by a servo pen-positioning system; 40-hertz response at 50 divisions; and electronic signal limiters to protect pens from off-scale overloads.

Twelve chart speeds from 0.05 to 200 millimeters per second are selected by pushbutton.

Marketing Services, Gould Inc., Instrument Systems Division, 3631 Perkins Ave., Cleveland, Ohio 44114

Are you getting static?



Our filter connectors are designed to eliminate interference from your circuits. See those attenuation curves? They are just a part of our selection. We can mix and match filters to solve your low pass filtering requirements. Small wonder Bendix filter connectors are first choice in the fight against electronic noise pollution.

Bendix filters come packaged in connectors intermateable with MIL-C-26482, MIL-C-83723, MIL-C-38999 and MIL-C-5015 connectors. In addition, filter contacts can be packaged to mate with other popular connector types including rectangular in military, industrial and commercial applications. There's sure to be one to meet your attenuation and frequency requirements.

You'll like the price, too.

Delivery? We won't give you any static there, either. Write for our brochure. The Bendix Corporation, Electrical Components Division, Sidney, New York 13838.

Bendix

Circle 156 on reader service card

Microprogramed logic shrinks computer

Miniaturized medium-scale machine provides a microcontrolled central processor, byte parity checks throughout, automatic logic verification

by James Brinton, Boston bureau manager

The first product of the newly formed Prime Computer Inc., Natick, Mass., is not the first to use microprograming, but designers of the small computer claim to have wrung more out of the technique than has been accomplished in any but the largest mainframe systems. The 16-bit machine, designated the P-200, is priced at $7,100 for a single unit with 8,192 words of memory.

Prime's spokesmen say the machine is

- the first to fully apply the new three-state logic,
- the first in its price range to use efficient horizontal-type microprograming instead of the slower vertical microprograming, and
- the first commercial computer to include micro-interrupts to verify correct logic operation, as does the NASA lunar lander computer, and to offer automatic trouble-shooting down to the individual IC.

The P-200 is also possibly the first to perform byte parity checks on every data path.

The basic machine has 8,192 words of Intel MOS memory on a single circuit board, easily expanded to 30,000 words. Moreover, the P-200's direct address field reaches out to 256,000 words. Cycle time is 750 nanoseconds. While this may seem slow to a few potential users, it is offset by the machine's 48 addressable hardware registers, direct-index multilevel indirect addressing, and other performance-enhancing features.

The P-200 may be ahead of all other small general-purpose computers in having microprogram-controlled logic throughout. It makes the interconnections of all blocks within its arithmetic logic unit (ALU) dependent on a 64-bit-wide microinstruction. About half of these 64 bits are designated data control bits and in effect restructure the architecture of the ALU each time they are called up. For example, an LSI adder in the ALU has four mode-select lines which decide whether it will perform addition, subtraction, or the logic functions exclusive-OR, or AND. Four bits out of 64 are set aside to control this adder.

The second half of the 64-bit control word is divided into two fields, one for clock control and the other for microprogram control. This last field includes the location of the next control word, and the conditions under which the system should fetch it or jump to one out of sequence.

In other small machines that use microprograming, the words are much shorter, and several are needed to align these computers. But with the 64-bit instruction, "we can go right into the ALU without having to fetch other instructions, or decoding those we are using," says William Poduska, vice president.

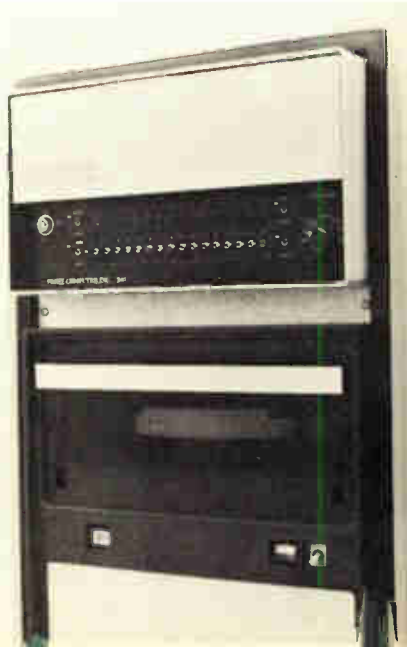
Even apart from the good noise immunity and speed of the three-level logic, the P-200 already is designed for faster logic. It's packaged onto large printed-circuit boards with strip transmission line construction—a ground plane in the middle of the sandwich controls impedance over all data paths.

As for the P-200's trouble-shooting capability, the parity check of each byte of data occurs every time it moves from any node in the machine to another. (While some machines offer parity check in and out of memory, no other in this price class follows each byte through the ALU.) Whenever the parity check shows an error, a microcontrol interrupt is triggered and calls up a logic verification routine to see whether the error is due to parts failure, software, or perhaps a poor memory readout. If the problem is a faulty memory readout, a new readout is substituted for the old, and the machine continues to compute. If the fault is in the mainframe electronics, the machine stops, and points out the location of the failure.

Moreover, the entire checking process is not just automatic—the programer may control it if he wants to. For instance, when the computations being made are critical, he might request a validity check after each step, or call up the routines at set intervals.

The microinterrupts, as usual, also are triggered by input/output controllers. When the P-200 is put in the input/output mode, data flows through the I/O bus while the ALU continues processing.

The microprogramed store that makes this possible is continued in



New products

16 packages of 256-by-4-bit read-only memory, or 256 words at 64 bits. But because it expands to as much as 4,096 words, features like decimal and double precision arithmetic, floating-point processing, and character masking, can be easily added at a fraction of the cost of such additions to non-microprogramed machines. Typically, the floating-point capability costs about a seventh of the price of hard-wired modules offered for other machines.

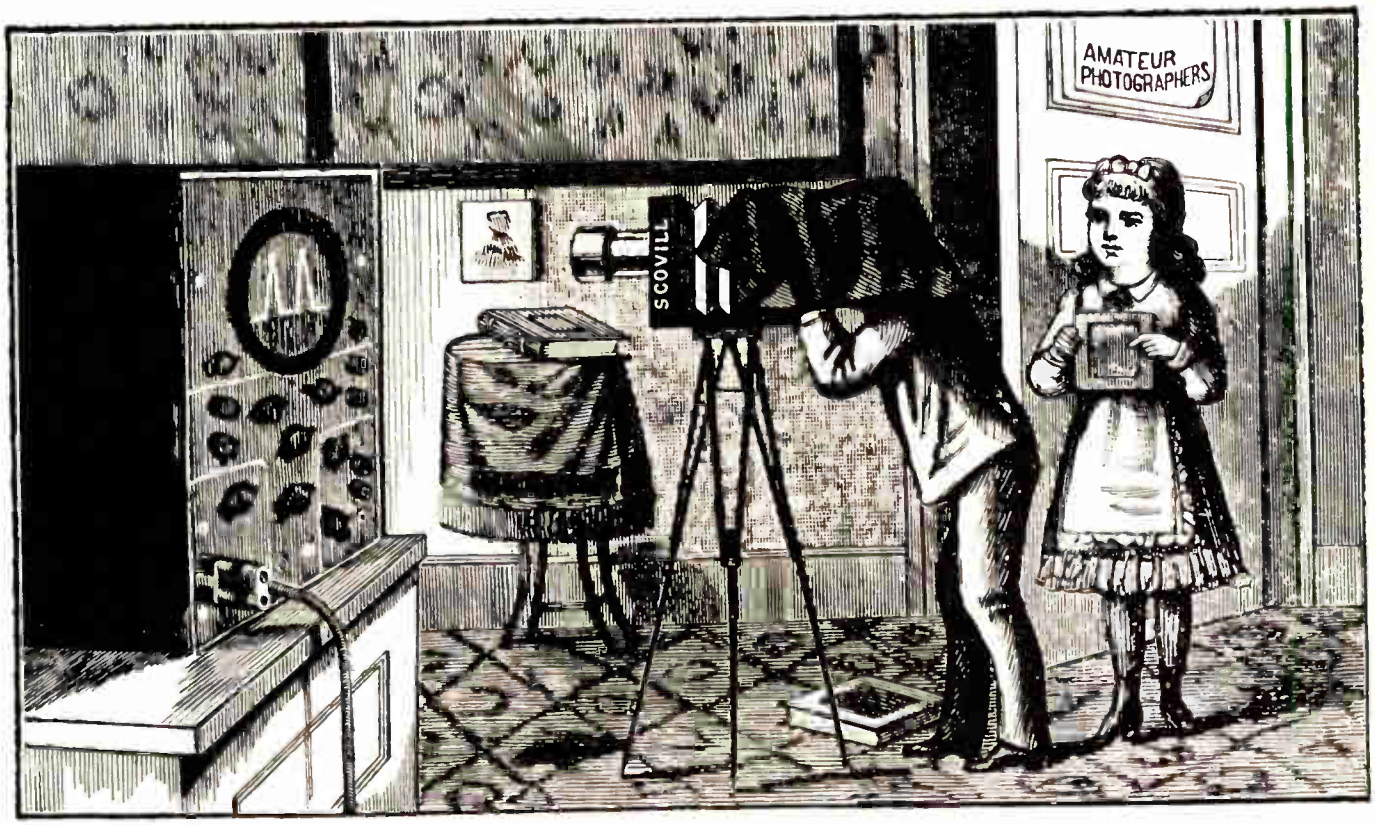
The P-200 is to be delivered complete with full software, comprising a Fortran IV package with a one-path compiler, a macro-assembler, I/O control, a desectorized link-editor, and several run-time packages. Among its operating systems, the P-200 will have a stand-alone system, a disk operating system, a real-time executive, text-edit and debug, and its hardware verification and diagnostic routines. Microprogram simulation should also make the machine compatible with most Honeywell series 516 software. The reason for that stems from Poduska's former job as head of a software development effort at the NASA Electronics Research Center before it closed. Out of the program grew the basis for more than 75% of the software in Prime's library, and since the software was written for H-516 machines, Poduska found it simplest to rewrite it for the Prime 200, emulating some of the 516's features. Later, naturally, other machines may also be emulated, giving P-200 users a chance to adopt unique machine capabilities without changing mainframes.

The company states that discounts will be competitive with the Digital Equipment Corp.'s, adding, however, that although 20 or so typical system configurations price out at about the cost of similar systems built around the PDP-11/20, the P-200's performance is in the medium-scale computer class.

First deliveries will take place in October. List price for an 8,192-word unit without teletypewriter is $7,100, while a 4,096-word model costs $5,900.

Prime Computer Inc., 17 Strathmore Rd., Natick, Mass. 01760 [473]

Some people still use old-fashioned ways to stop 1-time signals.



Tape deck, strip chart, conventional scope and camera — the old ways die hard.

And yet there *is* a better way — with one of our waveform recorders.

These are perhaps the world's only instruments ideally suited to measuring non-repetitive (or repetitive) signals. They are ideal for electronic trouble-shooting, shock and vibration studies, explosives testing, kinetic energy and plasma physics analysis, sonar applications, and many more.

They let you capture the signal, digitize it at rates up to 100 MHz, store it in memory, then transmit it in digital form, or reproduce it as a repetitive analog signal.

You can observe the stored waveform on a scope, make permanent records on a strip chart recorder, or feed the digital data directly to your computer for analysis. You can even record the data preceding your trigger signal for cause-effect or "leading edge" studies.

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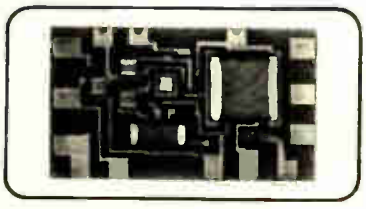
Circle 159 on reader service card

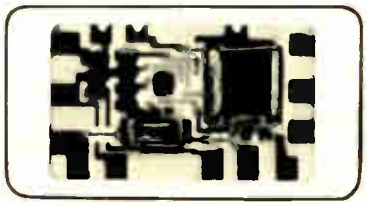
The Micaply Ohmega™ circuits at the left save up to 500% over the conventional circuits at the right



Micaply Ohmega Hybrid
Frequency Circuit
Manufacturing cost
excluding chips and wires:

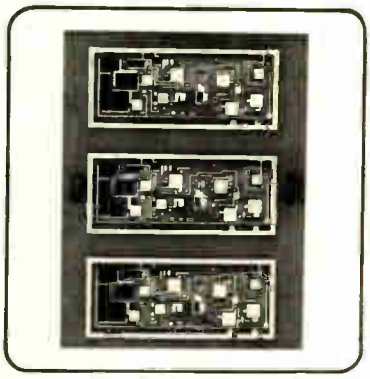
25¢

VS



Thick Film Hybrid
Frequency Circuit
Manufacturing cost
excluding chips and wires:

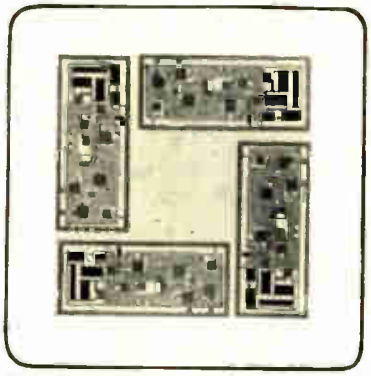
$1.25



Micaply Ohmega Hybrid
Demultiplexer Circuit
Manufacturing cost
excluding chips and wires:

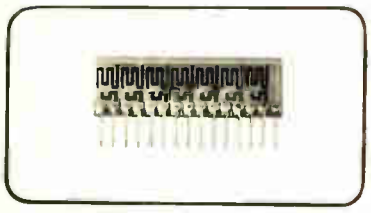
50¢
per circuit.

VS



Thin Film Hybrid
Demultiplexer Circuit
Manufacturing cost
excluding chips and wires:

$2.00
per circuit.



Micaply Ohmega Resistor
Array Circuit
Manufacturing cost
excluding connector:

15¢

VS

Discrete Resistor
Array Circuit
Manufacturing cost
excluding connector:

46¢

This dramatic saving is due to Micaply Ohmega's unique properties which make it possible to eliminate many costly parts, materials, procedures and equipment needed for conventional thick film, thin film and printed circuits.

Micaply Ohmega is an epoxy glass substrate completely covered on one or both sides with a bi-layer cladding. The layer against the substrate is resistive, the top layer is copper. Using conventional printed circuit production procedures patterns of conductors and resistors can be etched on 10" x 36" sheets to produce complete resistor-conductor circuits. The entire process is subtractive so no expensive screening, firing or vacuum equipment and materials are required!

Now hybrid microcircuits can be made on 10" x 36" sheets, drilled, plated-thru and even multilayered! And discrete resistor circuits can be replaced with less expensive and more reliable etched resistor circuits!

Micaply Ohmega provides these additional advantages:

For thick and thin film applications
95% yields. 5% etched resistors that can be trimmed if desired. Accurate etching down to 6 mil lines and spaces. Availability of 10" x 36" substrate as thin as .0025" for step and repeat processing. Elimination of expensive noble inks and metalized substrates.

For printed circuit applications
Board size is reduced because resistors can be multilayered inside and put on the bottom of the board. Resistor cost, handling and insertion is eliminated. Reliability improves because solder joints are eliminated. Cooling is better because fewer components interrupt the airflow.

The design and cost saving possibilities are endless with Micaply Ohmega. Call or write today for a prompt evaluation of your requirements or complete descriptive literature.

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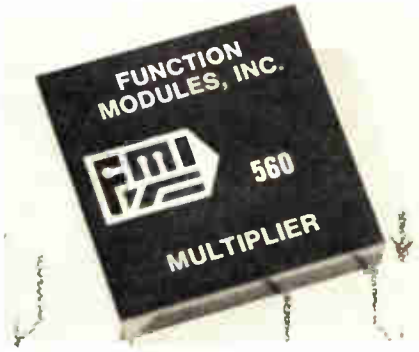
Components

Multiplier holds error to ±0.1%

High-accuracy module uses transconductance technique to bring price down to $139

Like operational amplifiers and data converters, multipliers are rapidly gaining acceptance as building-block components. But the precision units, those having an accuracy to within ±0.1%, are usually relatively high-cost items, with price tags of around $200, because they employ a sophisticated circuit technique called pulse-height/pulse-width analysis. The simpler and less expensive transconductance multiplier, which uses transistor currents to find the product of two inputs, has been limited to an accuracy of within ±0.2% to ±0.5%.

However, Function Modules of



Irvine, Calif., is introducing a four-quadrant transconductance multiplier that boasts a maximum full-scale accuracy of within ±0.1% and that costs only $139 in quantities of 1 to 9. The accuracy figure applies to operation in any quadrant and over the full input voltage range of ±10 volts. Moreover, since all linearity, gain, and offset errors are accounted for in the accuracy specification, the unit's nonlinearity is held to a mere ±0.04%.

The new multiplier, model 560, also minimizes temperature drift. Internal compensation permits the unit to hold drift error to a maximum of ±0.01%/°C. Like the accuracy callout, this figure is a full-scale specification that includes all linearity, gain, and offset errors.

Although it's a precision unit, the model 560 is a small modular package, measuring just 2 by 2 by 0.4 inches. In addition to multiplying, it can be used for dividing, squaring, and finding square roots.

The unit's frequency response is impressive, better than that of several other precision multipliers. Its small-signal 3-decibel bandwidth is 25 kilohertz, and its amplitude response remains flat to within 1% out to 500 hertz. The full-power response extends out to 5 kHz.

Both the X and Y inputs have an impedance of 100 kilohms and can accept signals of up to ±16 v maximum. Slew rate is 300 millivolts per microsecond, while settling time to rated accuracy for a 20-v step input is 80-μs. Output voltage can swing ±10 v at ±5 milliamperes; output impedance is only 1 ohm.

Function Modules Inc., 2441 Campus Dr., Irvine, Calif. 92664 [341]

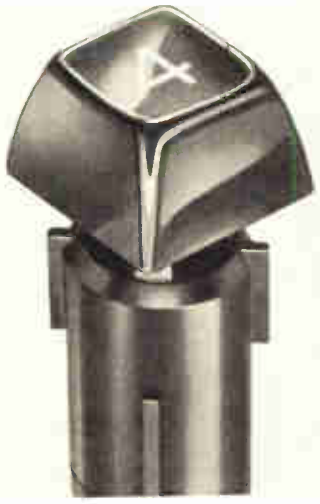
Low-priced accelerometers require no amplification

A series of accelerometers is available in one-, two-, or three-axis configurations. All feature full-range outputs up to 50 millivolts per volt. The units do not require amplification because they avoid external signal conditioning, and they are designed for a variety of applications, including aerospace engineering, dynamic simulation, and industrial-control systems. Other features are shock endurance of 100 g, and high linearity. Price ranges from $195 to $295, depending on axis.

DSC Inc., 8490 Perimeter Rd. South, Seattle, Wash. 98108 [344]

Reed switch operates without metal contacts

A keyboard-type reed switch called the 2700 series can be panel-mounted or soldered to a circuit. The switch features a low-friction mechanism that has no metal-to-metal contact. An internal magnet is positioned so that reed action is positive, and no magnetic interference is generated between



switches. Contact bounce is limited to 0.4 millisecond, and resistance to 200 milliohms maximum. The unit will handle up to 500 milliamperes in dc-resistive applications.

Maxi-Switch Co., 3121 Washington Ave. North, Minneapolis, Minn. 55411 [345]

Coaxial attenuator can be controlled by a computer

A frequency range of dc to 100 megahertz, usable to 300 MHz, is offered by a programable rf coaxial attenuator. The unit, which can be remotely controlled by a computer or other conventional means, accepts a six-bit parallel binary input that switches the attenuation over a

range of 0 to 63 decibels in 1-dB steps. The device is available in STEPS. The device is available in 50- or 75-ohm versions, and features a maximum current rating of 90 milliamperes.

Matrix Systems Corp., 20426 Corisco St., Chatsworth, Calif. 91311 [346]

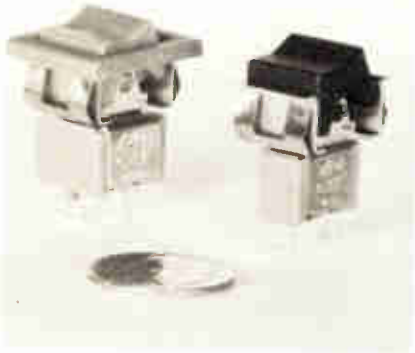
Trimmer measures 0.15 inch in height

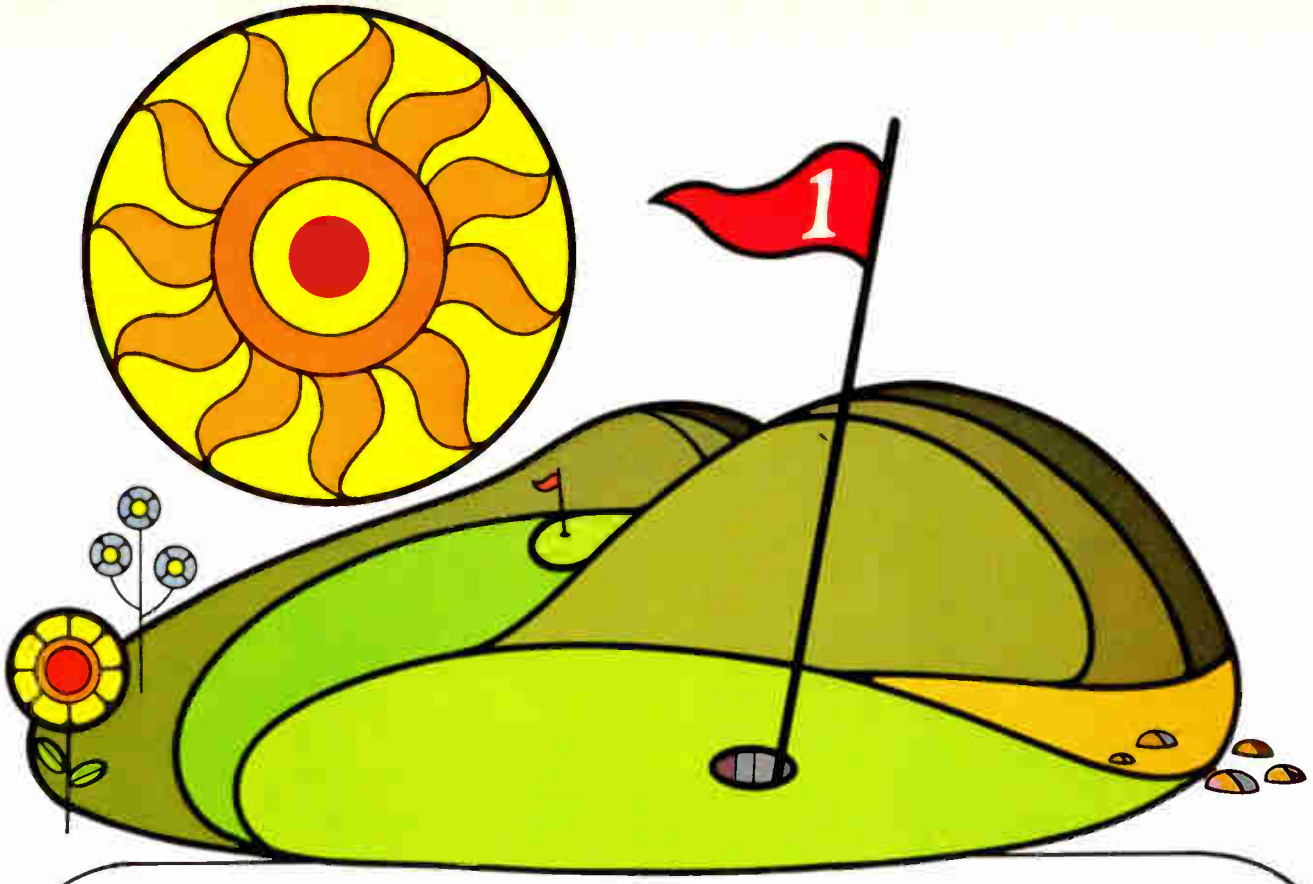
A trimming potentiometer, 0.15 inch high, is designated the model 82. The unit has built-in standoffs to permit board-washing without adding to the over-all mounting height. Also offered are infinite resolution and a rate of resistance change typically less than 0.5% during the first 1,000 hours of operation. Temperature coefficient in all resistance values is a maximum of ±100 ppm/°C over the full operating temperature range. Price is $1.40 in quantities less than 10.

Beckman Instruments Inc., Helipot Division, P.O. Box 11866, Santa Ana, Calif. 92711 [347]

Snap-in rocker switch has a low profile

The model J-50 subminiature snap-in rocker switch stands 17/32 inch above the panel surface and has an over-all length of 0.715 inch. The unit, available in over 30 versions, offers 100,000 make-and-break cycles and can be specified in 1-, 2-, 3-, and 4-pole double-throw config-





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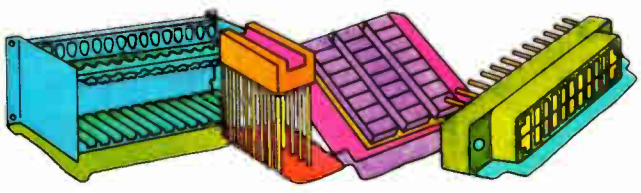

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Whichever method you choose, we can supply the components for you to assemble yourself. Or, we'll pick the parts, do the assembly, and let you do the wiring. Or, we'll provide everything: components, assembly, and Wire-Wrap®. So, just call us in . . . and you go out golfing!

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Circle 163 on reader service card 163

New products

urations. Contact is made on the opposite side from the depressed position of the rocker.

C&K Components Inc., 103 Morse St., Watertown, Maine 02172 [348]

Pushbutton switch offers multifunction operation

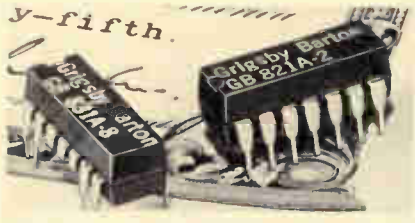
A lighted pushbutton switch offers low-power, multifunction operation. The series 300 is designed to replace single-button lighted pushbutton

switches with high-power requirements that designers have often been forced to use in low-power situations. Applications include bank terminals, calculators, and copiers. Price is $1.25 per station, and split-legend models are available at less than $1.60 per station.

Oak Industries Inc., Switch Division, Crystal Lake, Ill. 60014 [349]

Reed relay is available in 14- and 18-pin DIPs

A series of dual-in-line-packaged reed relays includes more than 150 models. The GB820/830 family of 14- and 18-pin units offers a variety of contact configurations and coil voltages. Forms available include Form A, 2 Form A, Form B, and



Form C. Coil voltages of 3, 5, 12 and 24 Vdc interface directly without additional buffering. Prices begin at $1.43 each in 1,000-lots.

Grigsby-Barton Inc., 3800 Industrial Dr., Rolling Meadows, Ill. 60008 [350]

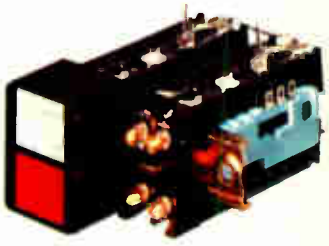
Press here to save on lighted pushbutton switches.

buys all the switch you need.

Oak's Series 300 gives you good looks and a small price-tag in lighted pushbutton switches. Plenty of switching performance for most jobs, without paying a premium. Even the Series 300 Split-Legend/4 Lamp Switch is less than $1.60 (normal latch, 2P2T, glass alkyd insulation, no engraving, less lamps.)

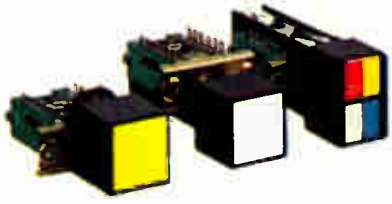
Built to take it.

Series 300 is built for reliable performance and long life. Applications galore—bank terminals, calculators, and copy equipment.



Modular design.

Single-legend/single-lamp, split-legend/4-lamp, and single-legend/redundant lamp switches have snap-on lamp holders. Plus replaceable legend plates, lens caps, and button assemblies. Front-panel relamping, too, without special tools on all types.

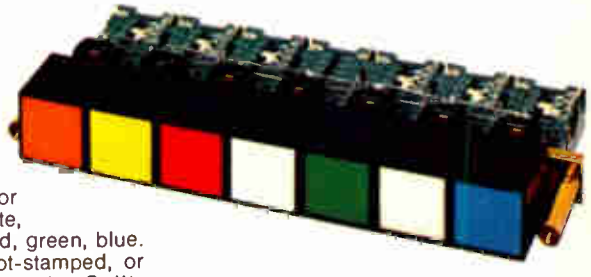


Three versions with switching up to 4P2T.

Choose from single, dual, or four lamp display as well as non-lighted type. One to twelve station, momentary, interlock, alternate action, or any combination available on the same switch bank. Lockout feature available for all types. Power Module 3A125VAC. Lighted indicators are identical in size and appearance, but without switching.

Gang them up by the dozen.

Order up to 12 switching stations on a single channel, any switching mix, with convenient panel-mounting studs. Color selection: white, lunar white, yellow, amber, orange, red, green, blue. Choose silk-screened, hot-stamped, or engraved-and-filled legends. Split-legend switches can be specified with any two, three, or four colors on insertable legend plates.



Write for our Series 300 Brochure

OAK Industries Inc.
SWITCH DIVISION/CRYSTAL LAKE, ILLINOIS 60014
TELEPHONE: 815 • 459 • 5000 ■ TWX: 910 • 634-3353 ■ TELEX: 72 • 2447

Circle 93 on reader service card

The amplifier-per-channel
Neff system 620

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Our good looking Neff System 620 also gives you more than you bargained for. Both in performance *and* economy.

Behind that handsome 7-inch high front panel is a *complete* data acquisition system. 64 field-proven Neff differential amplifiers and active filters — one for each channel. *Plus* a high level FET multiplexer, a gain programmable amplifier, a high speed 14 bit ADC, and TTL control logic. All you supply are the transducers and the computer.

Everyone agrees that for performance, the amplifier-per-channel approach is the way to go. With complete isolation right at the signal source, higher CMR, less crosstalk, lower noise, higher speed, greater accuracy, continuous analog outputs, protection against loss of data on other channels, and filtering *after* amplification, where it belongs.

The price is a happy surprise, too. Less than $150 a channel. And expandable. Just add 3 more boxes for a 256 channel system which prices out at under $40K. Or order the *big* configuration. Up to 2,048 channels!

We're getting orders for System 620 from all over the world. For applications we never knew existed. So send for the complete story on this thrifty beauty that's cooking up a storm in data acquisition circles.

NEFF

1088 East Hamilton Rd., Duarte, California 91010
Telephone (213) 357-2281 TWX 910-585-1833

Circle 166 on reader service card

Instruments

$345 multimeter has autoranging

Second product, a digital panel meter, is thin enough to mount outside panel

Low-cost digital multimeters can't have all features, and autoranging is usually one of the first to be eliminated after the number of digits is set. Most of the inexpensive units have manual range selection; an exception is the new model 8310 from California Instruments Co.

This 3½-digit unit offers automatic ranging, yet is priced at $345. The performance of the 8310—other than the number of gas-discharge digits—isn't limited either: it provides automatic zeroing and automatic polarity selection, plus a wide choice of ranges. Part of the reason for the modest price is that it is manufactured in Japan and sold and serviced in the U.S. by Calico.

William L. Barker, marketing manager, points out that the unit uses standard American-type components, such as MSI devices, for easy servicing. The multimeter, built around a dual-slope integrator, has dc ranges of 2 to 1,000 volts, with accuracy within 0.1% of reading plus one digit. 40 decibels of normal-mode rejection and 80 dB of common-mode rejection at 60 hertz. On ac, the highest voltage displayed is 350 volts, and accuracy is within 0.3% of reading plus two digits on the 2-, 20-, and 200-volt ranges. Frequency range is 45 Hz to 20 kHz.

The 8310 measures resistance to 200 megohms, higher than most low-cost instruments. Accuracy is within 0.5% plus one digit up to 200 kilohms. Maximum source current is 10 milliamperes on the lowest range (to 200 ohms), and drops proportionately on the higher ranges. Accuracy specifications are applicable for 30 days, and reading rate is two per second.

Among the options are current shunts suitable for ac or dc measurements to 2 amperes, high-voltage probes to 26 kilovolts dc, 1 kV ac, and rack-mounting adapter. The instrument operates from 115 Vac. The price of $345 includes carrying case and test leads.

Calico is also marketing what appears to be the first digital panel meter that is so thin it can be mounted on the outside of the panel. The meters, designated as the 8330 series, are not tiny at 2 inches by 4⅛ in., but they are only ⅝ in. thick, so they can be mounted on front panels without the need to cut large holes.

Other features have resulted from the type of mounting chosen. For one thing, a single circuit board is used, eliminating interconnections between boards that are often a source of trouble. There's not even any external connector, just direct wire connections to the circuit board. The 3-½-digit LED display is accurate to within 0.1% ±1 digit. The LEDs fit snugly against the faceplate and cannot be displaced. Life expectancy of the LEDs is given at 250,000 hours by the company, and the viewing angle of the planar numerals is 150°.

One advantage of the outside mounting is that the unit is isolated from heat sources within the cabinet. Temperature range is 0 to 55° C. and a three-step integration technique assures maximum zero and full-scale stability with respect to temperature and time.

The 8330 operates from the same 5-volt supply used by transistor-transistor logic. Various ranges are available: 200 millivolts, and 2, 20, and 200 volts. The display is bipolar, with both plus and minus signs displayed. When the DPM is out of range, the main digits drop to zero and flash on and off. For systems use, the meters have stored DTL/TTL-compatible BCD output. Price of the 8330 series units is $115 in quantities of 1 to 100.

California Instruments Co., 5150 Convoy St., San Diego, Calif. 92111 [351]

Meter pinpoints frequency of a 60-hertz system

Responding instantaneously—within two cycles—to changes in frequency, a digital-display meter is designed to show the exact frequency of a nominally 60-hertz system. Accuracy to within ±0.1 Hz is achieved by digital measurement of each period, using a quartz crystal as a time standard. The range of the meter is 59.00 to 61.00 Hz, and overrange is indicated by a plus or minus sign. A 400-Hz meter is also available. This meter has a range of 395.0 to 405.0 Hz, and accuracy is to within 0.1 Hz.

Herbst Associates Inc., P.O. Box 205 East Hanover, N.J. 07936 [356]

Programable dc amplifier holds gain error to 0.01%

A family of programable dc amplifiers for use in data acquisition and process-control systems is designated the 760 series. The units accept transistor-transistor logic binary commands or 10-line logic controlling up to 10 gain steps. Standard or optional capabilities include a maximum gain error of

New products

0.01%, maximum drift of 1 microvolt per degree Celsius, a common-mode voltage rating of 300 volts, 126-decibel common-mode rejection ratio, active filters, and dual outputs. Prices start at $695.

Ectron Corp, 8133 Engineer Rd., San Diego, Calif. 92111 [357]

Tester checks components at temperatures up to 200°C

The model TP22 Thermospot Jr. system is designed to test components at temperatures above ambient to 200°C. The instrument incorporates low-noise, optically coupled, zero-cross switching control, a mirror-scale thermistor thermometer, overheat and control lights. The presettable temperature is transferred by the tip. The probe (with appropriate adapter) is brought into contact with the component on the tester or on the circuit board and brings it quickly to the desired temperature. Accuracy of the instrument is to within ±1°C. The price is $750.

Temptronix Inc., 591 Hillside Ave., Needham, Mass. 02194 [358]

Low-profile graphic recorder avoids dead-band problems

A high-resolution graphic recorder can be tailored to meet different requirements and installations. The unit, which is only 7 inches high in its tabletop configuration, uses solid-state servo systems and enclosed infinite-resolution slide wires instead of helically wound resistance elements. This insures high precision and eliminates dead-band problems. Many different chart

Adar Associates, Inc.
85 Bolton Street, Cambridge, MA 02140

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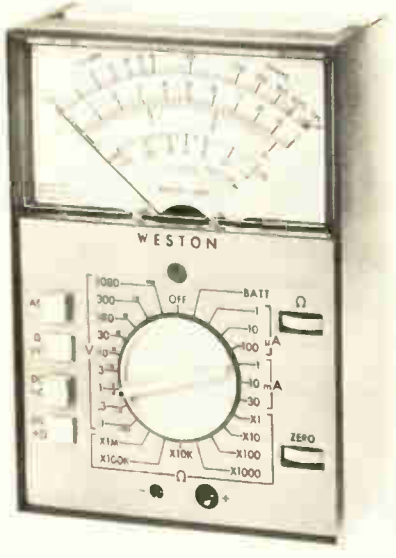
New products

speeds are standard, both by gear selection and transmissions. The unit is designated the Servo/riter II.

Texas Instruments Incorporated, Digital Systems Division, P.O. Box 1444, Houston Texas 77001 [359]

Volt-ohmmeter has FET circuit for 10-MΩ impedance

The model 666 circuit tester is a volt-ohmmeter that offers 12 ranges with a lowest full-scale range of 1 microampere. The unit also provides 18 voltage ranges from 100



millivolts full scale through 1,000 volts, and 14 resistance ranges featuring seven low-power resistance ranges for in-circuit measurements on semiconductors. Other features include a differential FET input circuit providing 10 megohms impedance. This circuit design eliminates the need for frequent battery replacement and assures 400 continuous hours of operation. Price is $132.50.

Weston Instruments Division, Weston Instruments Inc., 614 Frelinghuysen Ave., Newark, N.J. 07114 [360]

our OEM power supply is very big in computers

About a year ago, we introduced our new OEM power supply, a low-cost, off-the-shelf, 4-32 volt, 0.9-36 amp series. We sold a lot of them, especially for computer applications: 5v supplies for IC logic and ±12v and ±15v dual supplies for associated op amp circuitry. The price was right — starting at $57 — and they had the features the industry needed: remote sensing, 0.1% regulation, overcurrent and overvoltage protection, remote programmability, UL approval, 50-60 Hz inputs, modular or rack-mounting capability, and ACDC's "guaranteed forever" performance.

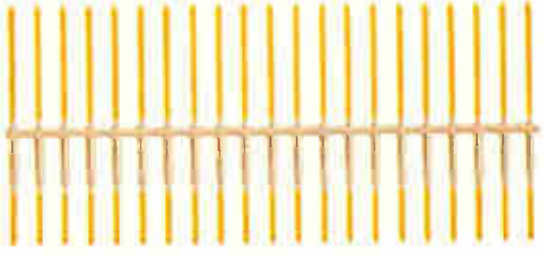
Of course, there were some applications that the OEM series just couldn't handle. But it did open the doors for our specials. Specials with overtemperature or undervoltage protection; with locking fault indicators and interface logic signals for absolute protection of stored data; with dc energy storage for memory retention, on-off sequencing, etc. The point? . . . We make a quality line of standard power supplies — and specials too. So, if you're big in computers, why not talk to the company that's big in computer power supplies?

acdc electronics inc.

Oceanside Industrial Center, Oceanside, California 92054, (714) 757-1880

Circle 171 on reader service card

There's only one good way to solder posts and contacts to a PC board.



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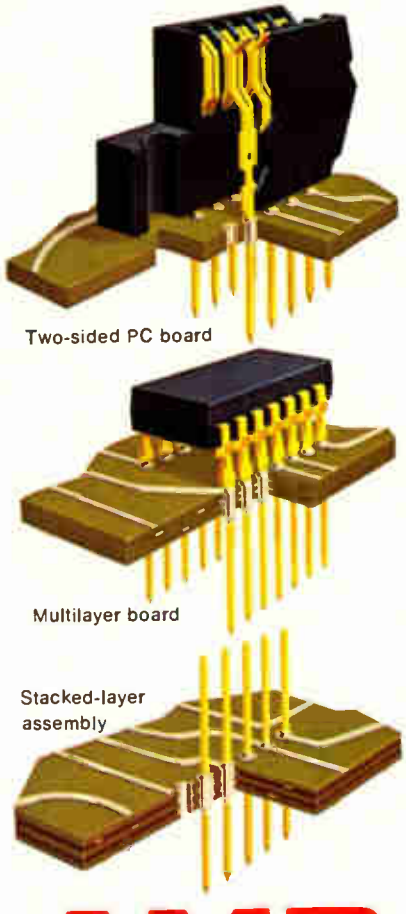

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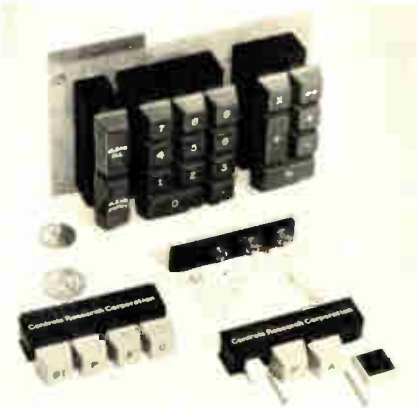
Data handling

Keyboard sells in $50 range

Simplified key switch, calculator market growth help to reduce price

An elegantly simple key switch already being used in most American-made calculators appears to be a major factor in what Controls Research Corp. calls the lowest-cost standard alphanumeric keyboard on the market. The fully decoded 53-key board is priced at $49 each in quantities of 5,000, or $53 in quantities of 1,000. The company also makes conventional reed-relay keyboards.

The Santa Ana, Calif., company developed the basic switching mechanism, Bi-pac, in an effort to make a minimum-cost, reliable product for high-volume calculator applications. The contacts consist of two concentric gold-plated springs, one larger and taller than the other, and ending in a straight section across the diameter of the top. The larger spring is depressed by a plastic keytop, making dual contacts with the inside spring, and the spring action provides both operator feel and return action. The ends of the springs are continued through the mounting plate, where they form the terminals. Only five parts are used, and only three move; typical key switches are made with from six to 12 parts.



Controls Research is supplying the switch in quantity (about 750,000 closures per month) to such calculator companies as Eldorado, Commodore, Master Calculator, and Garrett Comtronics, and to makers of point-of-sale and other nonstandard terminals. The keys are manufactured in modules of four, five, or six switches, and the different modules are staggered in the alphanumeric keyboard for maximum stiffness, compared to keyboards using individual keys. The mechanism has been tested to over 10 million cycles per switch, says Keith A. Sharp, president. The model 7100 keyboard provides four-mode ASCII coding, two-key rollover, low-profile design, dynamically scanned TTL MSI encoding, and standard typewriter keyboard configuration.

James P. Antrim, marketing vice president, attributes the low price of the keyboard to a combination of more than merely a simplified switch. He cites manufacturing economy, including an assembly plant in Tijuana, Mexico, and heavy market penetration by the basic switch.

"The rapid growth of the calculator market is chiefly responsible for the lower-price keyboards," says Antrim. The price of low-cost calculators virtually eliminates reed, solid-state, or other high-price-per-contact key switches. He says that more than 200,000 Bi-pac switch modules and calculator keyboards have already been installed. It's this extensive use that made the low-cost alphanumeric keyboard a profitable venture.

Antrim points out that keyboard prices have dropped significantly in the last few years—from about $195 in 1969 to $95 early this year. "Of course, the possibility of an 8-million-piece keyboard market by 1975 does give an added incentive," comments Antrim. It is estimated that calculators alone will account for about 50 million key switches by 1975. Switches for terminals should reach some 30 million in the same period.

Although there is some confusion regarding market projection, Antrim predicts that, besides calculators, a large portion of market growth will be in traditional data processing equipment—key-to-storage devices, terminals, and data recorders.

Sample delivery of the keyboard is from stock. Special configurations are also available.

Controls Research Corp., 2100 S. Fairview, Santa Ana, Calif. 92704. [361]

Key-to-disk system handles up to 64 stations

Real-time data editing capability is a feature of the model CMC 18 Keyprocessing System that can support up to 64 stations. The unit provides 29 million characters of intermediate disk storage and includes a user language for entry of special data validation problems. Also featured are automatic insertions of

frequently used constants, and conditional data-checking branches. The unit can be configured in a panel display, with a video display, or intermixed. Price is $2,800 a month, plus $70 for each keystation.

Computer Machinery Corp., 2231 Barrington Ave., Los Angeles, Calif. 90064 [365]

Disk/formatter provides random access in 75 ms

A large-capacity data storage/retrieval system for use in small-to-medium-scale data applications is called the Mega-Stor. The combination disk/formatter allows a choice of 12, 16, 24, or 32 sector sizes, and sector data formats are from 32 to 256 words. Disk spindle speeds are 1,500 or 2,400 rpm, and average random data access time is

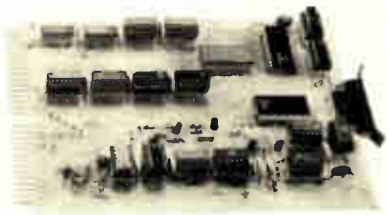
New products

75 milliseconds in this fixed-platter, moving-head disk system. Price is under $6,000.

Xebec Systems Inc., 566 San Xavier Rd., Sunnyvale, Calif. [366]

Plug-in module polls phone numbers

A plug-in module, designated the model 906014, automatically polls telephone numbers, either in sequence upon a single command or individually on a discrete command for each address. Inter-address timing is adjustable to allow various



lengths of transmissions in the sequence mode or may be disabled to wait for a command between addresses. The unit can handle up to 15 14-digit numbers. Price for the polling module is under $100 in small quantities.

G-V Controls, a division of Sola Basic Industries, 101 Okner Parkway, Livingston, N.J. 07039 [367]

Terminal provides phone and telegraph channels

The model 102 telephone-plus-telegraph terminal operates from either a 115/230 volt ac or station dc battery. The unit provides two full-du-

plex 75-baud channels; one telegraph channel in two- or four-wire configuration; and in-band 20-hertz signaling for E and M dial pulses. Combiners are provided for various

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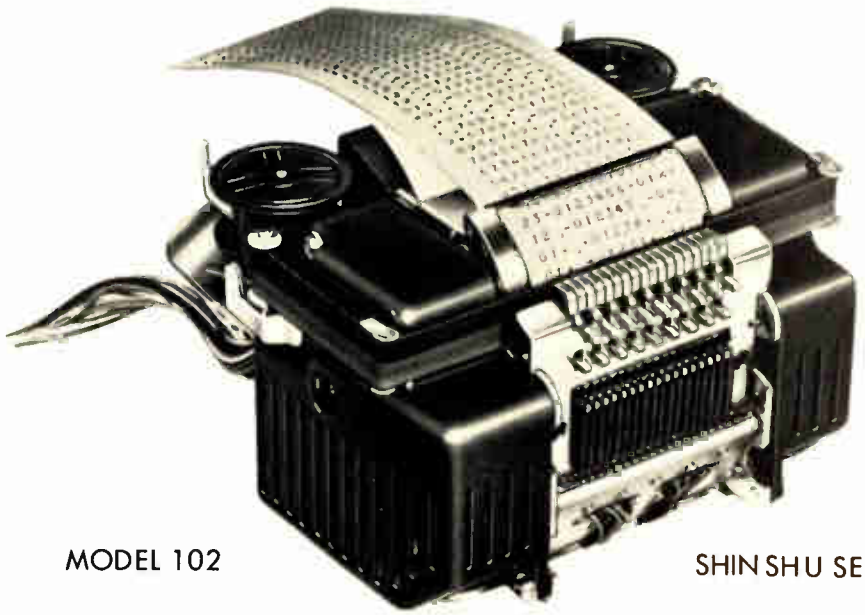

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- Print speed: 3 lines per second
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methods of diversity operation typical of hf radio-telephone circuits.
TM Systems Inc., 682 State St. Ext., Fairfield, Conn. 06430 [368]

Touch-tone receivers aimed at data systems

Two versions of Touch-tone receivers are designated the models TD 112 and 113. Both convert standard two-tone signals into one of 12 TTL-compatible signals, and provide a TTL logic zero and strobe for a valid input signal. The 112 accepts all touch-pad tone pairs when used in private systems with dedicated lines, and the 113 accepts all valid Touch-tone signals over the commercial telephone range or may be used with a touch pad directly in private systems. Applications include data terminals, security systems, mobile communications, and credit systems.
Teletron Co., 40 Elliott St., Melrose, Mass. 02176 [369]

Data entry terminal built for low volume

A new version of the model 88 data entry terminal for low-volume applications rents for $395 per month. The unit provides the user with keypunch-type data entry and IBM 2780 communications capabilities at remote locations without requiring keypunching or batch-terminal facilities. The basic configuration of the model 88-21 consists of a stored program control unit, a storage drive and cartridge, an IBM Selectric typewriter, and an auxiliary 10-key numeric keyboard. The control unit operates in either the entry or communications mode.
Data 100 Corp., 7725 Washington Ave. South, Minneapolis, Minn. 55435 [370]

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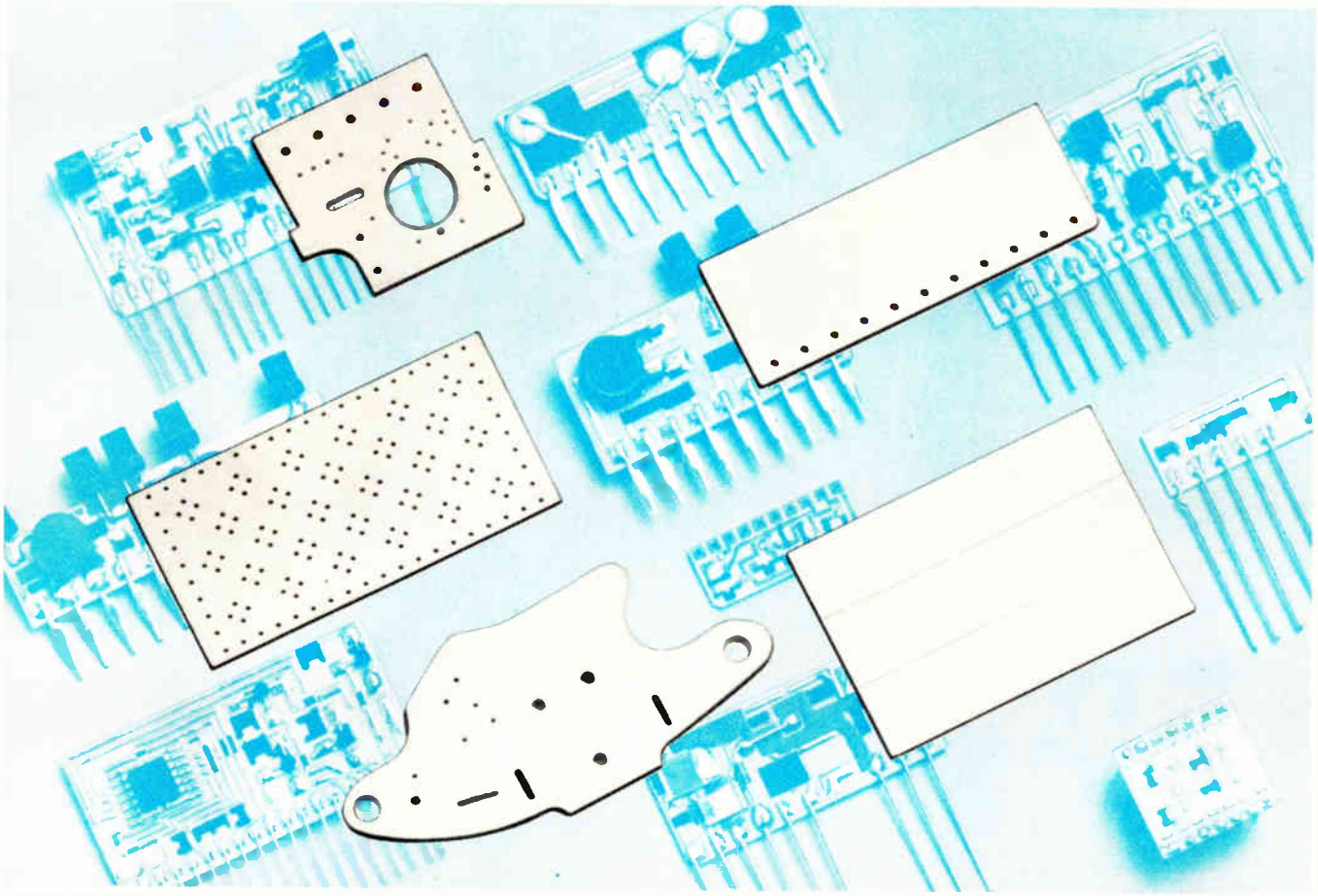
Write Centralab for Bulletin No. 1057TC2



Your first step—your most important

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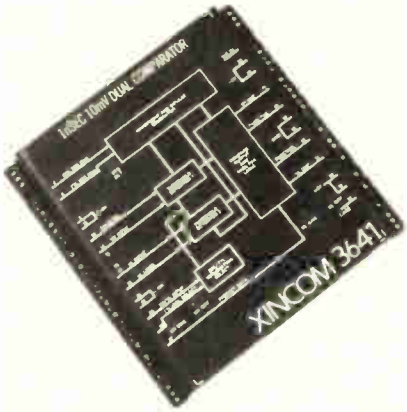
Subassemblies

Comparator runs at 25 MHz

Modular dual unit offers 1-mV resolution, makes pass/fail decision in 1 ns

As operating rates rise in all types of equipment, the widely used operational amplifier analog comparator is hard-pressed to keep up. Operation below a few megahertz has been usual, and the few types of



comparators capable of operating at frequencies higher than 20 MHz have had poor resolution. But along comes Xincom Corp. with what it calls a new approach that can help users who need both resolution and speed.

The result is a modular dual comparator that is capable of making pass/fail decisions in 1 nanosecond with a resolution as low as ±1 millivolt. Brian Sear, the president of Xincom, says that the product should be especially useful in testing new transistor-transistor logic and emitter-coupled logic semiconductor memories that operate at speeds to 25 MHz.

Xincom's 3641 module, priced at $440, uses a strobed design to eliminate comparator indecision and the effects of wideband noise. The effective input window is only 0.5 ns wide, and the strobe can operate at either TTL or ECL level. The input signal is compared to a reference over a ±2-volt common-mode range. The output delay for a TTL-level change indicating pass or fail is 30 ns maximum, and terminated signal lines are required because of the high speed.

Two separate comparators are included—one for high-level input and one for low.

The module, 4 by 4 by 0.55 in., is packaged in Xincom's so-called pinto configuration, used by the company for a range of modules including digital-to-analog and analog-to-digital converters. The comparators feature long terminal pins that are accessible above and below each unit. They can be plugged into circuit boards to form special-purpose conversion and test equipment, or they can be used individually.

The 3641 module, which requires supplies of ±5 V and ±15 V, is priced at $440.

Xincom Corp., Box 648, 20931 Nordhoff St., Chatsworth, Calif. 91311 [381]

Sample-and-hold module settles to 0.005% in 5 μs

The model SHM41 sample-and-hold amplifier is for use with 12-bit medium-speed analog-to-digital converters. The unit has a maximum acquisition and settling time of 4 microseconds for a 10-volt input step and 5 μs for a 20-volt input step. Maximum dynamic transfer nonlinearity does not exceed ±0.005%. maximum aperture time is 40 nanoseconds, and maximum droop is 20 μV/ms. The unit, compatible with TTL, DTL and C-MOS logic, has a dynamic input signal range of ±10 volts. Price for quantities of one to nine is $135 each. A companion model, the SHM40, which is designed for use with eight-

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Stripped for action.

Here's a familiar approach. El Cheapo II. In reality, it's the good old Mod X stripped of all the stuff that made the old Mod X good. Instructions. Memory. I/O facilities. Everything. But it's cheap. It's really cheap. Only the hum remains.

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Here's the same machine in disguise. Now it's hiding behind all the things you have to hang on it to make it work. Like a power supply and a memory and some sort of I/O kluge so your system can talk to it.

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bit and 10-bit converters, is priced at $85.

Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. [384]

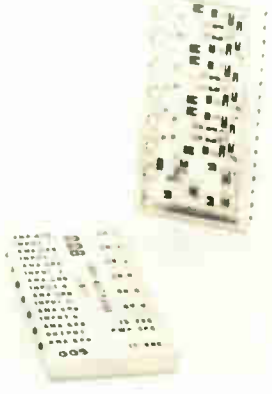
A-d converter offers throughput rate of 500 kHz

A throughput rate of 500 kilohertz is a feature of the model ADC-EH analog-to-digital converter, packaged in a module measuring 2 in. by 2 in. by 0.375 in. The analog input voltage range of the eight-bit converter is digitally programable and can be either unipolar (0 to +10 v full scale) or bipolar (±5 v). Accuracy is to within ±0.2%. Price of the ADC-EH is $85.

Datel Systems Inc., 1020 Turnpike St., Canton, Mass. 02021 [386]

Hybrid video-frequency multiplexer weighs ½ ounce

Occupying less than 1/5 of a cubic inch of space and weighing less than ½ ounce, a six-channel video-frequency multiplexer is compatible with DTL and TTL. The hybrid unit operates over a bandwidth of 15



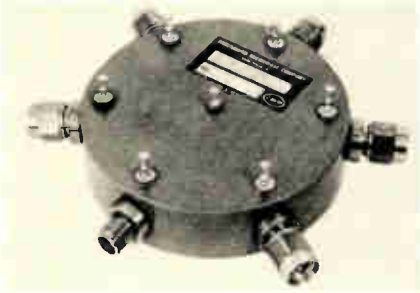
New products

MHz, and input impedance is 10^9 ohms. Capacitance is 15 pF, and channel-to-channel crosstalk is –72 dB. Each of model VMUX's channels is controlled by a separate input line. Channel selection occurs when the control line associated with a given channel is driven to logic 0. FET switches provide break-before-make action to eliminate the possibility of introducing transients back into the signal source. The unit settles to 0.01% of full scale within 100 nanoseconds.

ILC Data Device Corp., 100 Tec St., Hicksville, N.Y. 11801 [385]

I-f diode switches operate in less than 20 nanoseconds

A series of i-f stripline diode switches, designated series 2013, is available in multiple-throw configurations from single-pole single-throw to single-pole 16-throw. Each type covers the frequency range of 20 to 130 megahertz, and each dis-

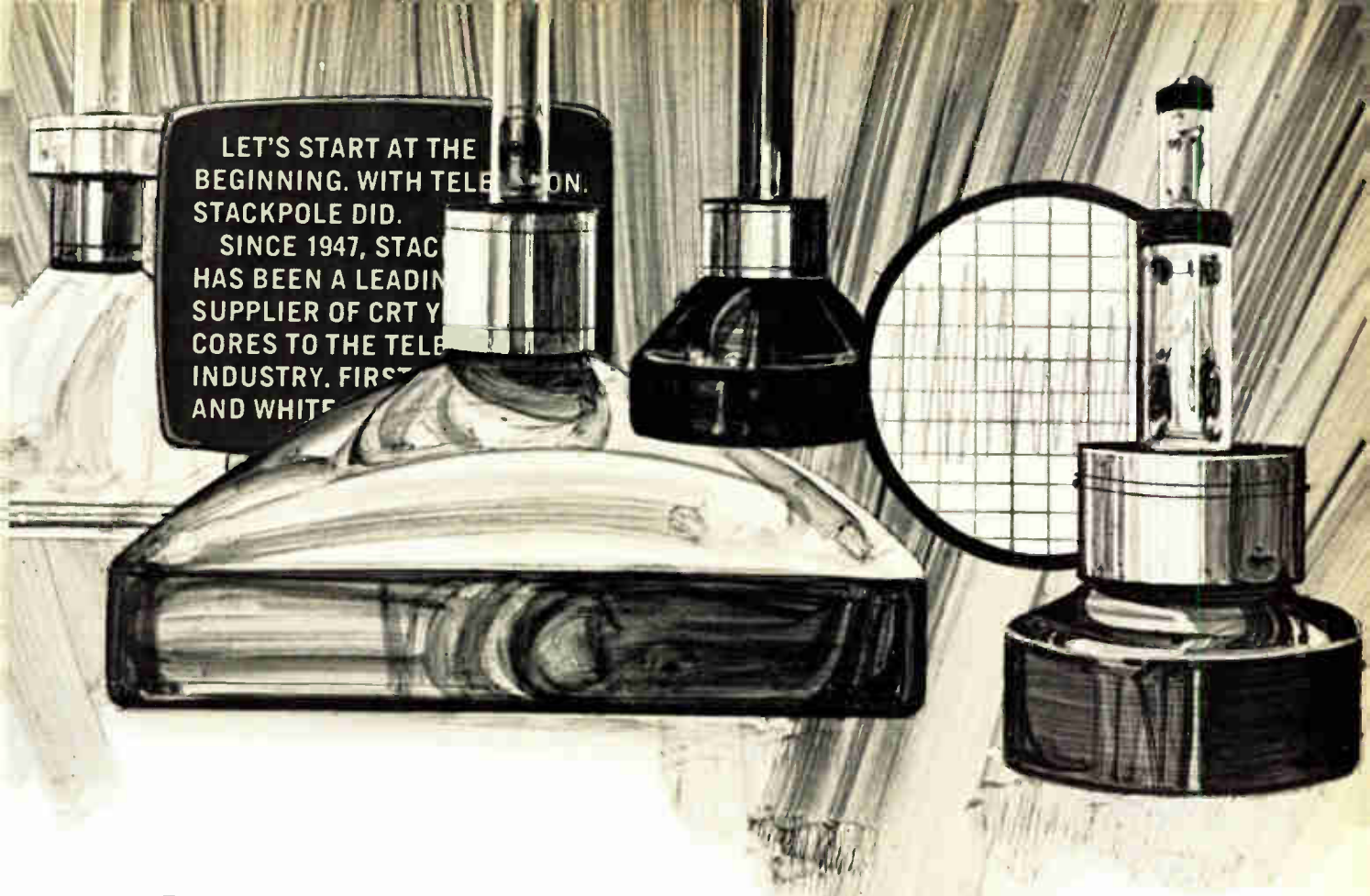


plays greater than 60 dB isolation and typical VSWR of 1.5. Insertion loss is less than 0.5 dB. Switching speed is less than 20 nanoseconds, and phase and amplitude balance are 3° and 0.1 dB respectively. Prices start at $85 without drivers and $115 with drivers.

Engelmann Microwave, Skyline Dr., Montville, N.J. 07045 [387]

Proximity switch handles loads to 1,200 watts

A 15-ampere magnet-actuated proximity switch combines Triac and reed switches in a simple two-wire circuit without an amplifier. The



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Let's start at the beginning. With television. Stackpole did.

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	7B	11	12	24
Initial Permeability	450	125	35	2500
Saturation Flux Density	2600	2550	2400	4500
Residual Flux Density	1650	1420	750	1700
Coercive Force	0.48	2.8	4.7	0.25
Curie Temperature	160	385	450	205

We've been around cathode ray tubes for a long time. Why not take advantage of the technology that can be yours at Stackpole. We may have the answer you've been looking for, or know how to get it. Simply contact: Stackpole Carbon Company, Electronic Components Division, St. Marys, Pa. 15857. Phone: 814-781-8521. TWX: 510-693-4511.

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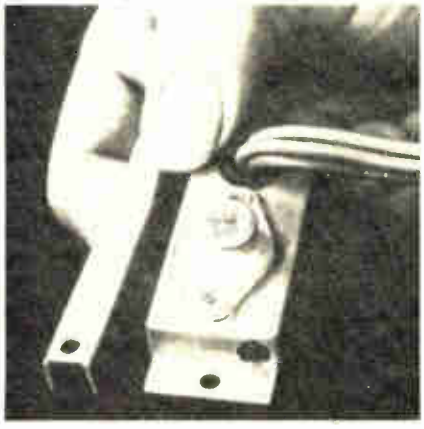
unit handles solenoids, motors up to ½ hp, and light loads to 1,200 watts. It is designed for inductive loads



and has 100-ampere surge protection, 155 F ambient operating temperature, 1,000 v breakdown voltage, microsecond speed, and draws 4 v operating power. Price is from $12 to $15 each, depending on the configuration.

Reed Switch Developments Co., 34 Lincoln Ave., Greenwich, Conn. 06830 [389]

Half-inch digital displays incorporate ion cathodes

Four ½-inch digital displays incorporate "keep-alive" cathodes, internal ion sources that are said to improve the performance of the units in multiplex applications, dark and low-temperature environments,

and where the suppression of blanking zeros is a requirement. Character height is 0.550 in. with centerline spacing of 0.531 in. Four character configurations are offered: the SP-755, a 1½-digit unit; SP-756, 2 digits; SP-757, 3 digits; and the SP-758, 2½ digits.

Sperry Information Displays Division, 350 North Hayden Rd., Scottsdale, Ariz. [390]

Semiconductors

ECL flip-flops at 500 MHz

MECL III stock item competes in speed with custom units; 1-GHz device is planned

To meet the growing demand for more speed by makers of instruments and communications gear, semiconductor manufacturers are expanding their standard products lines to include faster gates and flip-flops. Motorola, a pioneer in fast emitter-coupled logic (the MECL III family), is one of the first to recognize the need for extending standard ECL families beyond the 200-to 300-megahertz range—until now these circuits generally were custom jobs. The first of the new MECL III additions is the MC1690, a master-slave 'D' flip-flop capable of toggle rates over 500 MHz, making this circuit Motorola's fastest standard product. The company plans a 1-gigahertz device in 1973 that will rival any custom logic being sold today.

General-purpose instruments and communications systems will benefit from the MC1690. Prescaling for frequency synthesizers and counters needs fast switching, for example, as also do serial-to-parallel and parallel-to-serial converters, synchronous or ripple counters, shift-register delay-lines for radar, and data compressors or multipliers.

In operation, the data inputs affect only the master portion of the flip-flop when both clock inputs C1 and C2 are in the low state. Data stored in the master is transferred to the slave circuit when C1 OR C2 are taken from a low to a high level. The output state of the flip-flop changes on this positive-going transition of the clock pulse.

Although toggle frequency of the device is guranteed at 500 MHz or more, typical units toggle at about 550 MHz. Setup time is only 0.3 nanosecond (typical), while clock-to-output delay is typically 1.5 ns.

Another plus for the MC1690 is its dc-coupled feature. As such, the device is less sensitive to input edge speeds than ac-coupled flip-flops, and no input waveforming circuits are required.

Output emitter pulldown resistors are not included on the MC1690 chip, since each system has its own termination scheme.

Power dissipation of the device is 200 milliwatts per package, excluding load power dissipation. Two package configurations are offered: a 16-pin black ceramic dual in-line package, and a 14-pin ceramic flat-pack with a stud. Both are hermetically sealed.

The 16-pin version sells at $55 each for 1-24, $50 for 25-99, and $45 for 100-lots. Equivalent prices for the 14-pin package are $60, $55, and $50.

Motorola Semiconductor Products Division, P O Box 20924 Phoenix, Ariz., 85036 [411]

Chip receiver/transmitter is for synchronous data links

A universal synchronous receiver/transmitter is being fabricated on a single chip of silicon by Standard Microsystems Corp. for sale to makers of multiplexers, concentrators, line printers, CRT displays, and other data communications equipment.

The MOS chip replaces a printed-circuit card containing anywhere from 30 to 40 transistor-transistor-logic packages. Even if individual transmitter and receiver packages already on the market were used, a complete system would still require anywhere from 10 to 15 additional TTL packages to perform the functions of Standard Microsystems' chip, says Gerald Gollub, regional marketing manager. In quantities of more than 100, the COM2601 is priced at $20.50, as against the pc board's $60 to $80.

The unit performs all of the synchronous transmit/receive, binary synchronous, bi-sync and interleaved bi-sync functions associated

All cats look the same in the dark.

Heaven help the man who has to choose one, when the "cats" are computer automated test systems. Nailing down the most efficient, least costly system to suit the plant's requirements has been expensive and tough—if not impossible.

Equipment capabilities, system speed, hardware/software flexibility all come into the picture. But the boardroom wants to take a hard-nosed, profit-oriented look at capital outlay, payback periods, overhead, and the impact of cost savings over current test methods.

At last one test system manufacturer, Fairchild Systems, has taken the guesswork out of the selection process. By developing an illuminating computer-based tool that helps you determine the economic feasibility—and the financial justification—of the pre-use testing of semiconductor devices. And matches the results to the level of our equipment you will find most advantageous for all concerned.

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SAVE consists of easy-to-fill in forms which take you step by step through all your applications configurations, number of stations, even the number of daily work shifts. Types and quantities of devices used are considered, with your average rate of untested defectives balanced in.

Your completed forms are fed through Fairchild Systems' SAVE-programmed computer. To deliver hard data on total comparative costs for test equipment replacement, system costs, operating expenses, including payback period and actual net savings realized.

The SAVE read-out is also useful for evaluating alternative system configurations as they relate to the customer's operation, to provide cost-effective solutions. And because SAVE offers in-depth simulation of system test operations, a plant designer can also use this capability to maximize his software/hardware utilization, his operating policies, and to "fine tune" his system for optimum performance.

And finally, the computerized analysis helps you establish the most economical, most productive level of test equipment from our optimized Sentry series—the large-scale Fairchild Systems with unmatched speed, sophistication and flexibility. From MOS to bipolar, from IC's to discretes, or LSI—with software compatible to all, and the lowest throughput costs in the field—the Sentry family offers you total semiconductor testing capability with enormous expansion and adaptability options. And SAVE shows you how to make the most of it.

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Fairchild Systems

New products

with synchronous data communications. It is fully double-buffered, to eliminate the need for precise external timing. And it is fully programable, so that the transmit and receive rates are functions of the clock and independent of each other. Either full or half duplex operation is possible.

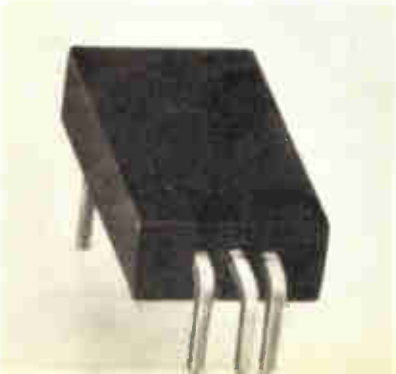
Also independently programable—through the use of such external controls as strapping inputs to combinations of logic levels—are the baud rate, data word length, parity mode, receiver sync character, and transmitter sync character. In addition, the chip internally generates the signals for sync character received and sync character transmitted, permitting an interface with all synchronous peripherals.

There may be 5, 6, 7, or 8 data bits plus an odd/even or no parity bit. All inputs and outputs are directly TTL-compatible. Tri-state data output levels are provided for the bus-structure-oriented signals.

Standard Microsystems Corp., 35 Marcus Blvd., Hauppauge, N.Y. 11787; 1230 Bordeaux Drive, Sunnyvale, Calif. 94086 [412]

Isolator provides minimum current transfer of 40%

For the designer who must electrically isolate low-voltage logic circuits from high-voltage outputs, the model 551-0001 opto-isolator connects two systems by the transmission of light energy, eliminating the need for a common electrical ground. The unit incorporates a gallium arsenide diode that drives a phototransistor, and provides a minimum current transfer of 40% with a 2,500-volt isolation. LED power dissipation at 25°C is 50 mW, LED continuous forward current is 30 mA, detector power dissipation at 25°C is 200 mW, and detector collector-



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One design...9 pin styles

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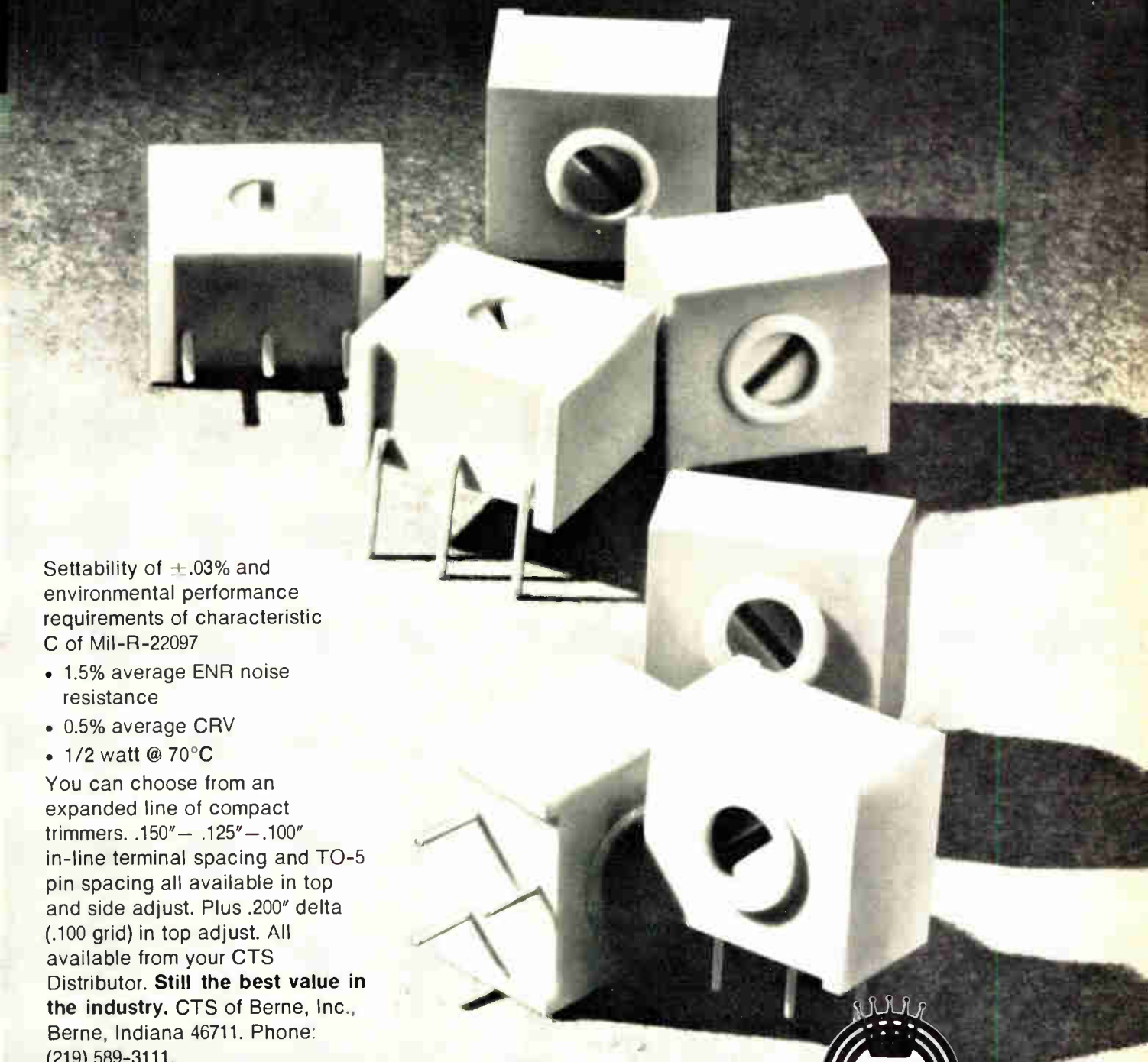

Settability of ±.03% and environmental performance requirements of characteristic C of Mil-R-22097

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- 1/2 watt @ 70°C

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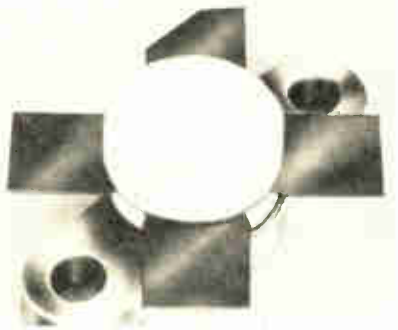
emitter breakdown voltage is 30 v. Price in 1,000-lots is $3.01 each.

Dialight Corp., 60 Stewart Ave., Brooklyn, N.Y. 11237 [416]

Power transistors provide up to 40 W at 12.5 V

A family of very-high-frequency pnp power transistors is designed for power output over the range from 150 to 175 megahertz. The

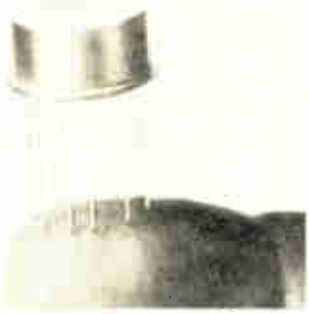


models SD1012, SD1014, SD1016, and SD1279 offer 4.0, 15.0, 30.0 and 40.0 watts respectively at 12.5 volts. The devices are available in a stripline flange package, which increases thermal capability and reduces parasitic induction. Price in quantities of 100 ranges from $5 to $22.

Solid State Scientific Inc., Montgomeryville, Pa. 18936 [417]

Inverting amplifier offers fast settling time

A subminiature inverting amplifier that operates into video frequency ranges, up to 50 MHz, settles to 0.1% of full-scale amplification in 200



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If you're supplying equipment to Navy Standard Hardware Program guidelines, our ingenious new SHP Packaging System will make coming up with the packaging absolutely simplistic and halve your packaging costs at the same time.

No sweat SHP

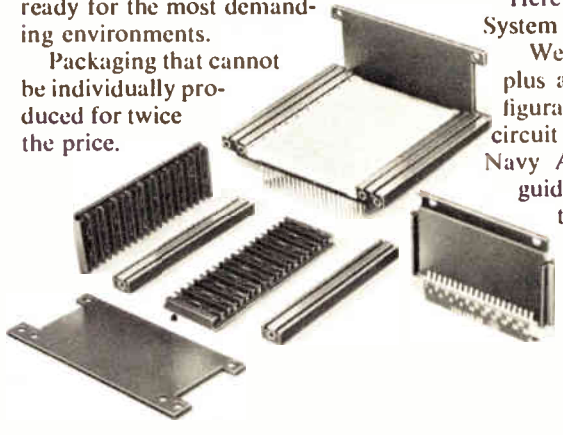
First off, we make designing the packaging so effortless we estimate you'll cut your total design load for the procurement by a third because that's what our first customers are experiencing.

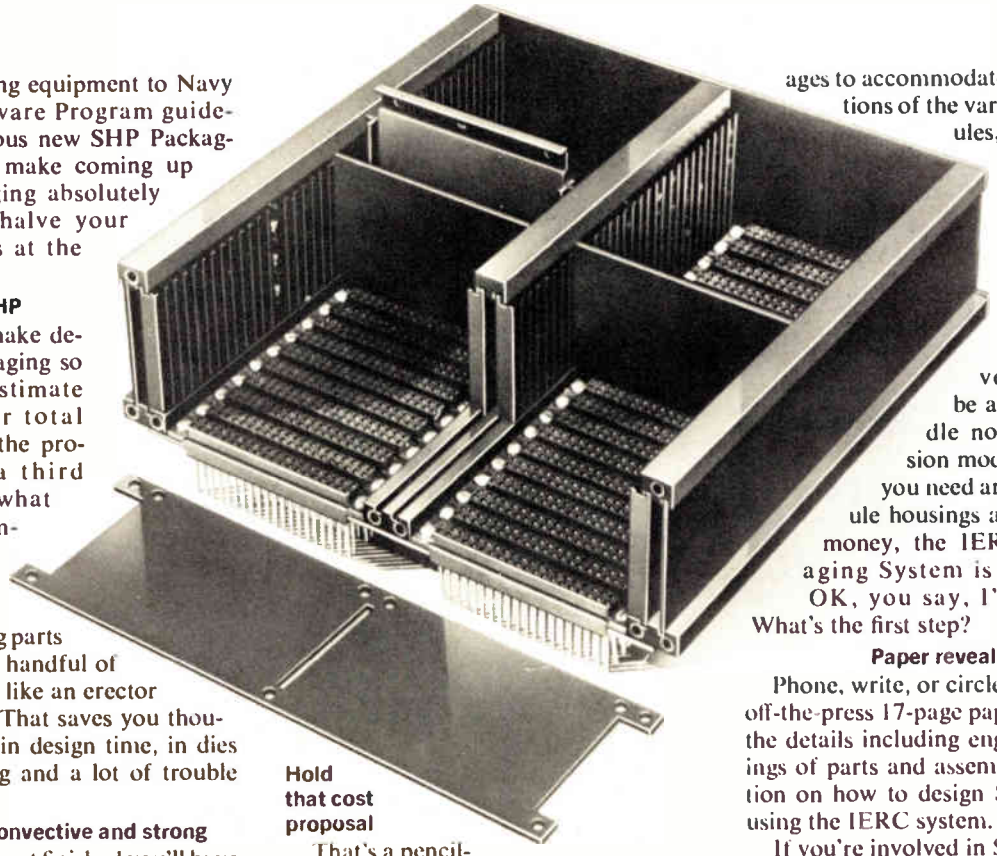
Production consists of putting parts together — just a handful of different kinds — like an erector set. Only easier. That saves you thousands of dollars in design time, in dies and other tooling and a lot of trouble to boot.

Conductive, convective and strong

And when you get finished you'll have packaging for your circuitry with the high order of thermal efficiency you'd expect from industry's leading manufacturer of circuit heat dissipating devices. Plus mechanical integrity that's ready for the most demanding environments.

Packaging that cannot be individually produced for twice the price.





Hold that cost proposal

That's a pencil-sharpening fact you can ill afford to ignore if you're in the middle of preparing a proposal in response to an RFP that calls out SHP — or if you ever expect to bid an SHP program.

Here's how our new SHP Packaging System works:

We've designed six basic parts — plus a few specials for unusual configurations — with which you can build circuit module housings conforming to Navy Avionics Facility, Indianapolis, guidelines and dimensions for any of the common SHP-defined circuit modules using nothing but a screwdriver.

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In fact, our system is so versatile it can be adjusted to handle non-SHP-dimension modules as well. If you need any kind of module housings and like to save money, the IERC SHP Packaging System is for you, too.

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If you're involved in SHP or ever expect to be, get involved with the IERC SHP Packaging System today.

Ask about our SHP module plates including our revolutionary Metal Core Circuit Board plates for extremely high power densities, too. International Electronic Research Corporation, a corporate division of Dynamics Corporation of America, 135 West Magnolia Blvd., Burbank, Calif. 91502. (213) 849-2481.

IERC

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nanoseconds, and to 1.0% in 75 ns. Voltage gain, open-loop dc at a rated load of 500 ohms, is 96 decibels minimum. Slewing rate, as an inverter, is typically 500 V/μs and 400 V/μs minimum, and rated output is ±10 volts. The model HFS-23 is short-circuit-protected and priced at $125 in quantities of one to nine.

ILC Data Device Corp., 100 Tec St., Hicksville, N.Y. 11801 [418]

Varactors have cutoff frequencies to 800 GHz

Developed primarily for operation in cryogenic and uncooled parametric amplifiers, a series of gallium arsenide varactors offers cutoff frequencies to 800 GHz. Other applications include low-loss tuning and millimeter-wave frequency multipliers. The 93 models of the GC-5510 series offer a wide selection of capacitance as well as cutoff frequency ranges. Breakdown voltage is typically 12 volts (10 volts minimum).

GHZ Devices, 16 Maple Rd., Chelmsford, Mass. 01824 [419]

Optical isolators have propagation time of 225 ns

Three optically coupled isolators called the model 5082-4350 series have a propagation time of 225 nanoseconds and a bandwidth of 5 MHz. Each of the three devices is designed for a different purpose. The 5082-4350, with a typical dc current transfer ratio of 11%, is for general-purpose applications; the 5082-4351 is a high-gain unit with current transfer ratio of 22%; and the 5082-4352, with current transfer ratio between 15% and 22%, is designed for critical gain-control applications. All three can be directly coupled to TTL loads at TTL speeds without additional buffers or triggers. Prices are $2 for the 50, $3.40 for the 51, and $5 for the 52 model in quantities of 1,000.

Hewlett-Packard Co., 1601 California Ave., Palo Alto, Calif. 94304 [420]

All you ever wanted to know about your capacitors... immediately, digitally, automatically, accurately.

The Model 275 Digital Capacitance Meter is a fast, simple, compact box that gives you automatic capacitance (both series and parallel) and dissipation measurements with the accuracy of a manually balanced instrument (approximately 0.1% plus one digit).

Designed primarily for production testing—outgoing and incoming—the 275 is simple to operate and features a brightly lit readout of 3½ digits with decimal point. Because of its wide range of capacitance measurements and the high resolution of its D measurements, however, it is also suited for use in developmental laboratories. Its small, half-rack size is another plus for bench work.

Normal mode of operation provides for repetitive measurements tracking at the rate of 4 per second, either C series or C parallel. When D is to be measured, the operator simply pushes the D button and the measurement is instantly displayed. The instrument's reliability is unusually high; circuitry is wholly solid state and mounted on a single, readily accessible, master PC board.

To extend the applications of the Model 275, several options are available. With the companion comparator sorting can be done, by C values *and* D values if desired. If bias measurements are required, an external bias supply can be connected to switch-controlled rear terminals. Holding and sorting fixtures are also available.

If you are making or buying capacitors, the Model 275 Capacitance Bridge will tell you what you need to know before you ship or wire them in. For just about $1200—plus $600 if you want the sorting option. Write or call for the entire story—there's nothing else quite like it.

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"Remember last year, when 1 and 2-MHz test systems were standard, and Macrodata introduced a low-cost, 5-MHz, LSI Tester—the MD-100? Then you won't be surprised to learn that Macrodata has done it again! Now, take a look at the new MD-104 LSI Test System.

"It's the first, true, 10-MHz, LSI test system to offer all these benefits: (1) a high quality, built-in paper tape reader usually found only on higher priced machines; (2) a 10-MHz rep rate that allows the user to test bipolar memories on-line at system operational speeds; (3) a speed that allows the testing of ECL memories; (4) a direct and immediate display of failure conditions, allowing call-up of the exact error condition in both address and data; (5) a 10-MHz rep rate that doubles user throughput as he works with the large bipolar memories coming on the market; (6) a standard, random-access control memory of 64 words by 24 bits wide—expandable to 128 words; (7) an improved instruction set and enhanced subroutine and loop capability, including automatic refresh for dynamic memories; and (8) a GALPAT II test routine capability that is faster than Macrodata's original GALPAT.

"The new MD-104 is compatible with the MD-100 and can use existing personality cards for testing all the most popular RAM's, ROM's, shift registers, and UAR/T at rates up to 5 MHz. Also, the new MD-104 cards will allow the user to test the faster bipolars up to 10 MHz. As a bonus, an option for testing random logics will also be made available.

"With all that going for it, you'd expect a high price tag. But not from Macrodata! Prices start at only $24,950, including the built-in paper tape reader and basic firmware.

"And that boys and girls, is Chapter Five of the Macrodata Story—another exciting chapter in their march to leadership. For your copy of the new MD-104 brochure, use the reader service card; and if you'ready to do business now, just call us directly."

Chapter Five. The Macrodata Story.

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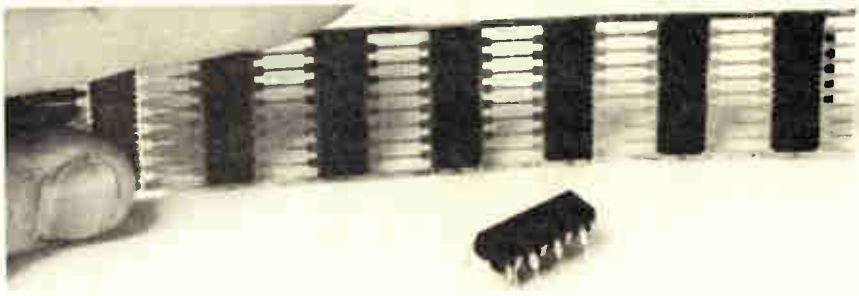

An epoxy compound for the encapsulation of various electronic devices is called Plaskon Epiall MX-300. The material withstands high temperatures and excessive moisture, and features a low ionic contamination level. Cure time is from 1.5 to 2.5 minutes, preheat temperature is from 200 to 220°F and mold temperature is from 325 to 350°F. The material has a long shelf life and good batch-to-batch uniformity.

Allied Chemical, Plastics Div., P.O. Box 2365R, Morristown, N.J. 07960 [480]

Cerama-Dip 538 is a single-component thixotropic alumina-base ceramic coating with a temperature resistance to 3,200°F. It is used to coat rf heating coils, can be brushed or dipped on, and offers high heat resistance and a dielectric strength of 150 v per mil. In high-production rf heating work, the material prevents arcing, and requires a cure at 200°F. Cerama-Dip 538 is available in one-quart kits, including both the base material and a thinner, at $40 per kit.

Aremco Products Inc., P.O. Box 145, Briarcliff Manor, N.Y. 10510 [476]

A line of laminates clad with thin-foil copper is designed to yield greater uniformity in the fabrication of printed-circuit boards. The ½-ounce foil is less wasteful to etch than 1-, 2-, or 3-oz copper foil laminates. The material is pattern-plated by the fabricator to the desired circuit trace thickness. After plate-up of the desired circuitry, the ½-oz copper is etched away with half the etchant consumption in half the time needed for a 1-oz copper-clad board.

Fortin Laminating Corp., 1323 Truman St., San Fernando, Calif. 91340 [377]

A one-component, 100% solid, pure-silver-filled epoxy adhesive is intended for microelectronic chip bonding. Designated material 20-1, the adhesive contains no fluorides and comes as a soft smooth paste that can be applied either by silk screening or by automatic die-bonding dispensers. When cured for one hour at 250°F or half an hour at 300°F, it attains a volume resistivity of 0.0003 ohm-cm. Low resistivity is retained at temperatures to 750°F. The material does not produce resin bleed on gold substrates during the cure process and exhibits low outgassing after cure.

Ablestik Laboratories, 833 W. 182nd St., Gardena, Calif. [477]

An ambient-temperature electroplating process called Alametek deposits pure aluminum on electronic components. The coating has good bond strength to most alloys, including titanium, yields a dense continuous layer of high-purity aluminum, and provides corrosion protection and electrical and thermal conductivity. Coating thickness can be controlled from microinches to several mils.

Ametek, Applied Materials, Station Square Two, Paoli, Pa. 19301 [478]

Silicone Semi-Gel, a transparent potting material, cures to a soft elastomer gel material that provides mechanical cushioning, vibration damping, and protective coating of sensitive microelectronic devices. The physical properties are intermediate between true gel and elastomeric compounds. The material has a low viscosity in the uncured state so that it can be used for encapsulation. Cure is at 100°C and operating temperature range is −75° to +250°C. Price is $12 per pound

New products/materials

for Semi-Gel, which is particularly recommended for use in thick-film and thin-film circuits.

Transene Co., Route 1, Rowley, Mass. 01969 [479]

A medium-viscosity liquid silicone adhesive-sealant called CON/RTV-Ni cures within 24 hours at room temperature after addition of its catalyst, with maximum cure after seven days. The resulting bond is flexible, resilient and conductive with a nominal volume resistivity of 0.1 ohm-cm. Price is $1.06 per ounce in 100-ounce containers. Delivery is from stock.

Technical Wire Products Inc., 129 Dermody St., Cranford, N J. 07016 [376]

Kester Formula 197 is a rosin flux, nearly as active as the highly activated fluxes, which far exceeds Mil-4-14256 specifications. Its high fluxing ability is due to a special activating agent. This is added to the rosin flux in such quantities that a high water extract resistivity of 200,000 ohm-cm results. The material is formulated for foam-fluxing, dipping, brushing, and spraying.

Kester Solder Division, Litton Industries, 4201 Wrightwood Ave., Chicago, Ill. 60639 [338]

Electroding inks. An extensive line of precious-metal capacitor-electroding inks is custom-formulated, and can be made compatible with every known ceramic capacitor system. Tests are conducted to match greenware acceptance, ink drying and vehicle burnout to specified systems. Single-element metals as well as binary and ternary systems are used to provide a wide range of materials.

Electronic Materials Group, Matthey Bishop Inc., Malvern Pa. 19355 [339]

Fiber optics. Plastic optical monofibers are available in five standard diameters in spool lengths ranging from 1,000 to 100,000 feet. Diameters are 0.005, 0.010, 0.020, 0.040, and 0.060 inch. A sampling kit that is suitable for evaluation purposes is priced at $15.

Dolan-Jenner Industries Inc., 200 Ingalls Ct., Melrose, Mass. [340]

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New literature

Magnetic shielding foils. A two-page data sheet has been issued by Advance Magnetics Inc., 226 E. Seventh St., Rochester, Ind. 46975, detailing technical data on high-and low-permeability magnetic shielding coils. Circle 421 on reader service card.

CO_2 laser. A data sheet on the model XF series of low-cost, flowing-gas CO_2 laser systems is available from Apollo Lasers Inc., 6365 Arizona Circle, Los Angeles, Calif. 90045. [422]

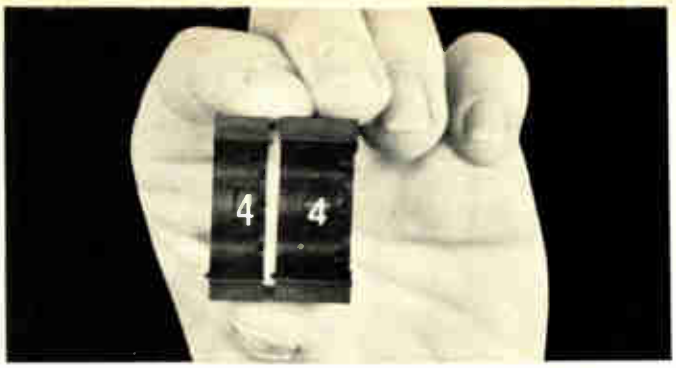
Keystation. Computer Machinery Corp., 2231 Barrington Ave., Los Angeles, Calif. 90064, has published a four-page brochure describing a video display keystation for use with the company's KeyProcessing Systems. Operational and display features are given, along with specifications. [423]

Teflon terminals. Sealectro Corp., Mamaroneck, N.Y., has available a 16-page catalog of press-fit Teflon-insulated terminals and hardware. Information is given on installation, insertion tools, specifications, and how to order. [424]

Data-processing glossary. Microdata Corp., 644 East Young Ave., Santa Ana, Calif. 92705. A microprograming handbook has been revised and now includes an expanded glossary of data-processing terms. More than 200 commonly used definitions are listed. The handbook also contains descriptions of the latest peripheral systems and communications interfaces offered by the company, [425]

Products catalog. A commercial products catalof hs been published by the Semiconductor division of International Rectifier Corp., El Segundo, Calif. 90245. The 32-page catalog contains details on a range of products from replacement components for home-entertainment and industrial electronic equipment to components for hobbyists. [426]

Thyristors. Westinghouse Electric Corp., Box 2278, Pittsburgh, Pa.



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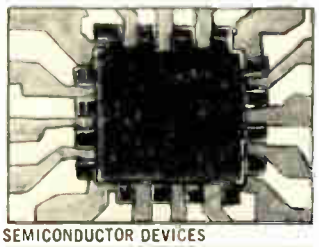
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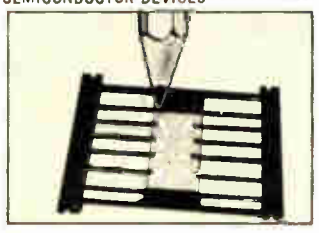
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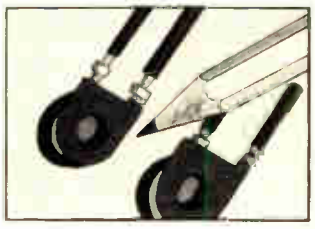
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Circle 117 on reader service card

New literature

15230, has available a booklet presenting frequency ratings for six designs of fast-switching dynamic-gate silicon-controlled rectifiers. The 130-page booklet describes units used in high-frequency, inverter, and dc chopper equipment. [427]

Semiconductor testing. Computest Corp., 3 Computer Dr., Cherry Hill, N.J. 08002. An eight-page catalog and price list describes product lines in three areas of semiconductor testing: digital linear parametric and/or functional benchtop testers, integrated-circuit handlers for IC packages with handling speeds from 3,600 to 7,200 devices per hour, and real-time 10-MHz semiconductor memory test systems. [428]

Terminal blocks. Underwriters Safety Device Co., Dept. EC-2, 4332 N. Kedzie Ave., Chicago, Ill. 60618. Detailed specifications are provided on a line of quick-connect terminal blocks. [429]

C-MOS data. Solid State Scientific Inc., Montgomeryville Industrial Park, Montgomeryville, Pa. 18936, is offering a 100-page data book on C-MOS integrated circuitry. The book includes information on design and operating considerations, technical introduction, package descriptions, and a discussion of chip preparation. [430]

Resistor networks. A brochure featuring two dual in-line resistor networks in standard 14- and 16-pin packages is available from the Helipot division, Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634. The four-page catalog provides specifications, outline drawings, and applications information. [431]

Shielding. Knitted wire mesh for electronic shielding is discussed in a four-page catalog available from Radcon Corp., 246 Columbus Ave., Roselle, N.J. 07203. Characteristics, specifications and applications are given. [432]

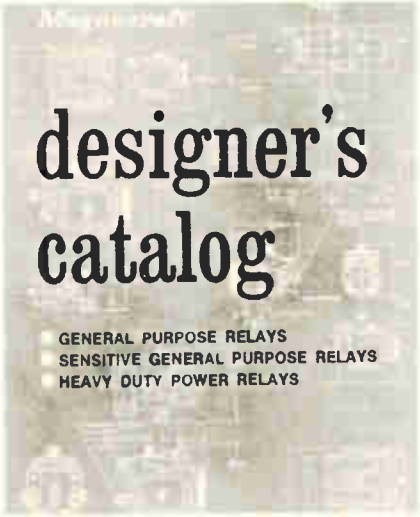
Keyboards. Electronic data-entry keyboards for computer terminal

New literature

applications are described in a four-page brochure being offered by Cherry Electrical Products Corp., P.O. Box 718, Waukegan, Ill. 60085. [433]

Signal processors. A six-page short-form catalog is available from Rockland Systems Corp., 230 West Nyack Rd., W. Nyack, N.Y. The catalog provides condensed specifications on the product line of signal processors and synthesizers, including analog and digital filters, and frequency and speech synthesizers. [434]

Relays. Magnecraft Electric Co., 5575 North Lynch Av., Chicago, Ill. 60630. A 36-page catalog describes various relays available from the company. These include general-



purpose, sensitive general-purpose, heavy duty power, and plug-in general-purpose relays. Also included are special features, accessories, enclosures dimensional line drawings, and specifications. [435]

Danish trade directory. The official trade directory of the Danish electronics industry is available from the Consulate General of Denmark, 280 Park Ave., New York, New York 10017 [436]

Trimmers. CTS Corp., Elkhart, Indiana, has available an eight-page catalog describing the characteristics of a line of products stocked through the company's industrial distributor network. The products

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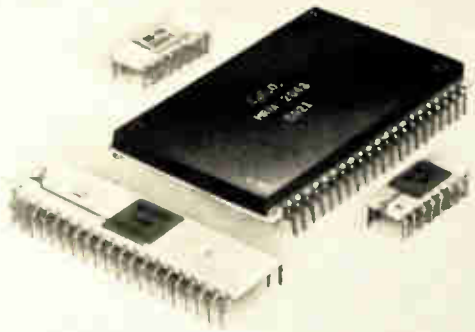

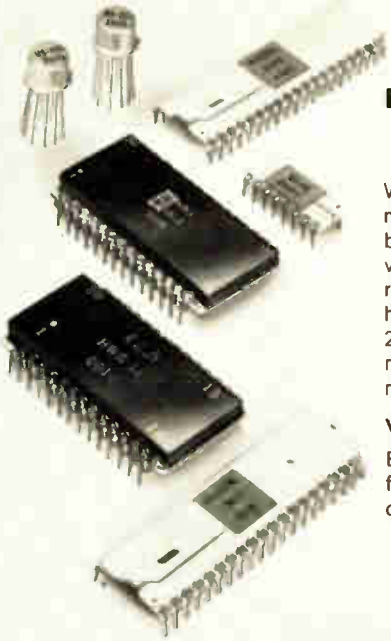

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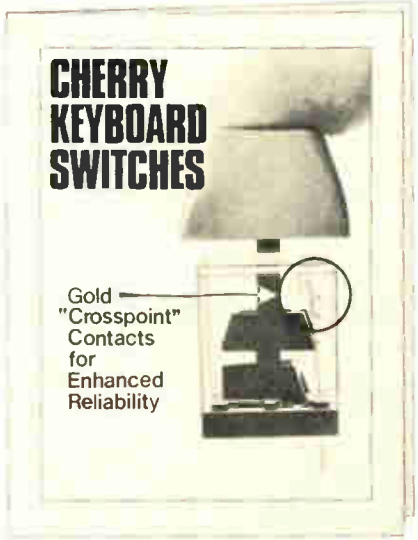
New literature

include trimmers and pots as well as resistor networks and rotary selector switches. [437]

Circuit board guides. Unitrack Div., Calabro Plastics Inc., 8738 West Chester Pike, Upper Darby, Pa. 19082. A catalog sheet on the series PB1000 metal printed-circuit card guides for grounding pc boards to chassis and dissipating heat from boards to chassis includes dimensions and prices. [438]

Keyboard switches. Cherry Electrical Products Corp., 3600 Sunset Ave., Waukegan, Ill. 60085. A com-



plete line of keyboard switches is shown in a four-page brochure that also includes cutaway views and specifications. [439]

Trimming pots. A series of wirewound and infinite-resolution trimming potentiometers is described in a 56-page catalog available from Amphenol Connector Div., Controls Operations, Janesville, Wis. [440]

Thyristors. Westinghouse Electric Corp., Semiconductor Div., Youngwood, Pa. 15697. Three technical sheets give full rating information, curves and ordering instructions for three versions of a stud-mounted thyristor that is typically used in motor control circuits or in power supplies.

Encoder. An application report on

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New literature

the TRN-104 dual-channel encoder describes the logic needed to perform direction sensing, pulse multiplying, and mechanical-noise cancellation. The brochure is available from Trump-Ross Industrial Controls Inc., 265 Boston Rd., North Billerica, Mass. 01862 [378]

Attenuator. Hyletronics Corp., Newtown Rd., Littleton, Mass. 01460, has published a package of attenuator literature for designers of microwave systems. The literature includes information on current-controlled, linear voltage-controlled and digitally controlled attenuators. [379]

Oscillators. A four-page oscillator catalog has been prepared by Texscan Corp., 2446 N. Shadeland Ave., Indianapolis, Inc. The catalog describes mechanically tuned, voltage-tuned, transistorized, and Gunn units, which provide coverage from 4 MHz to 40 GHz. [380]

CRT terminal. A data sheet published by Ann Arbor Terminals Inc., 6107 Jackson Rd., Ann Arbor, Mich. 48103, describes the application of the series 200 video display controller to industrial process and control systems. [391]

Automated drafting system. A four-color brochure from Applicon Inc., 22 Third Ave., Burlington, Mass. 01803, describes a turnkey, automated drafting system that produces graphical and manufacturing information from digital or freehand input. Included in the six-page brochure are descriptions of system operations, applications, and user benefits. [398]

Technical journal. Subscriptions to Test and Measuring Notes, published by N.V. Philips of Holland, are available to U.S. engineers who write on their company letterheads to Test and Measuring Instruments Inc., 224 Duffy Ave., Hicksville, N.Y. 11802. The quarterly presents information on applications of Philips instruments and microwave devices and surveys products as they are added to the Philips line. [399]

New books

Theory and Analysis of Phased Array Antennas. Noach Amitay, Victor Galindo, and Chen Pang Wu, John Wiley & Sons Inc., 437 pp., $22.50.

This book summarizes some of the research activities of three Ph.D.s, presumably during Bell Laboratories' overseership of the Safeguard antiballistic missile radar defense system.

Chapter 1 introduces the terminology and concepts of phased arrays, and it reviews various approaches to analyzing array designs, such as the dependence of the array properties on mutual coupling.

The remainder of the book gets mathematically rigorous, with the emphasis on how to determine the effectiveness of uniformly and closely spaced open-ended waveguide elements. The effects of mutual coupling between elements and edge effects in finite arrays are well covered.

There is little, however, to relate the mathematical analysis to a number of practical applications, such as adaptive arrays, thinned-element arrays, and arrays using dipole elements. A wealth of numerical data on both dielectric-free and dielectrically loaded waveguides supplements the text.

The book is intended for those actively interested in phased arrays and antennas. Familiarity with Maxwell's equations, guided-wave theory, and elementary antenna theory is assumed.

The Theory and Design of Cycloconverters, William McMurray, MIT Press, 165 pp., $12.50

Minicomputers in Data Processing and Simulation, Branko Soucek, Wiley-Interscience, 467 pp., $19.95

Solid State Electronic Devices, Ben G. Streetman, Prentice-Hall Inc., 463 pp., $13.95

Fundamentals of Pattern Recognition. Edward A. Patrick, Prentice-Hall Inc., 504 pp., $18.00

Systems Programming, John J. Donovan, McGraw-Hill Book Co., 488 pp., $13.95

Some engineers are practically extinct at 35.

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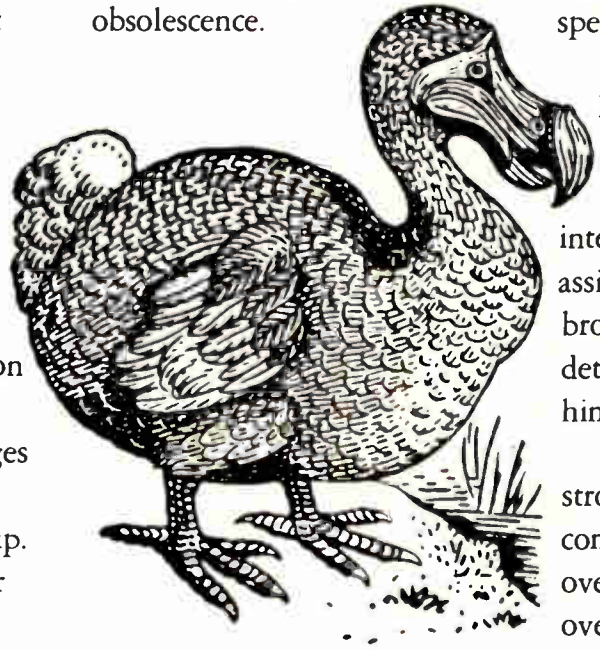

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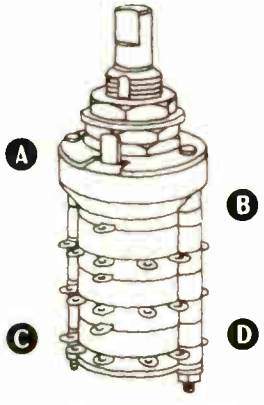

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