JANUARY 9, 1975

Troubled economy furrows executive brows/65

U.S. equipment and components market forecast chart/97

What designers should know about C/MOS specifications/103

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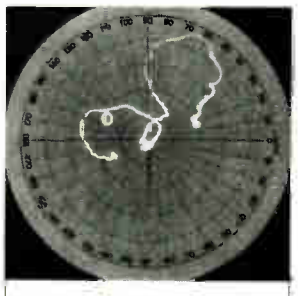

Reflection plot of broadband circulator, 2-18 GHz. (Full scale, $\rho = 1.0$)

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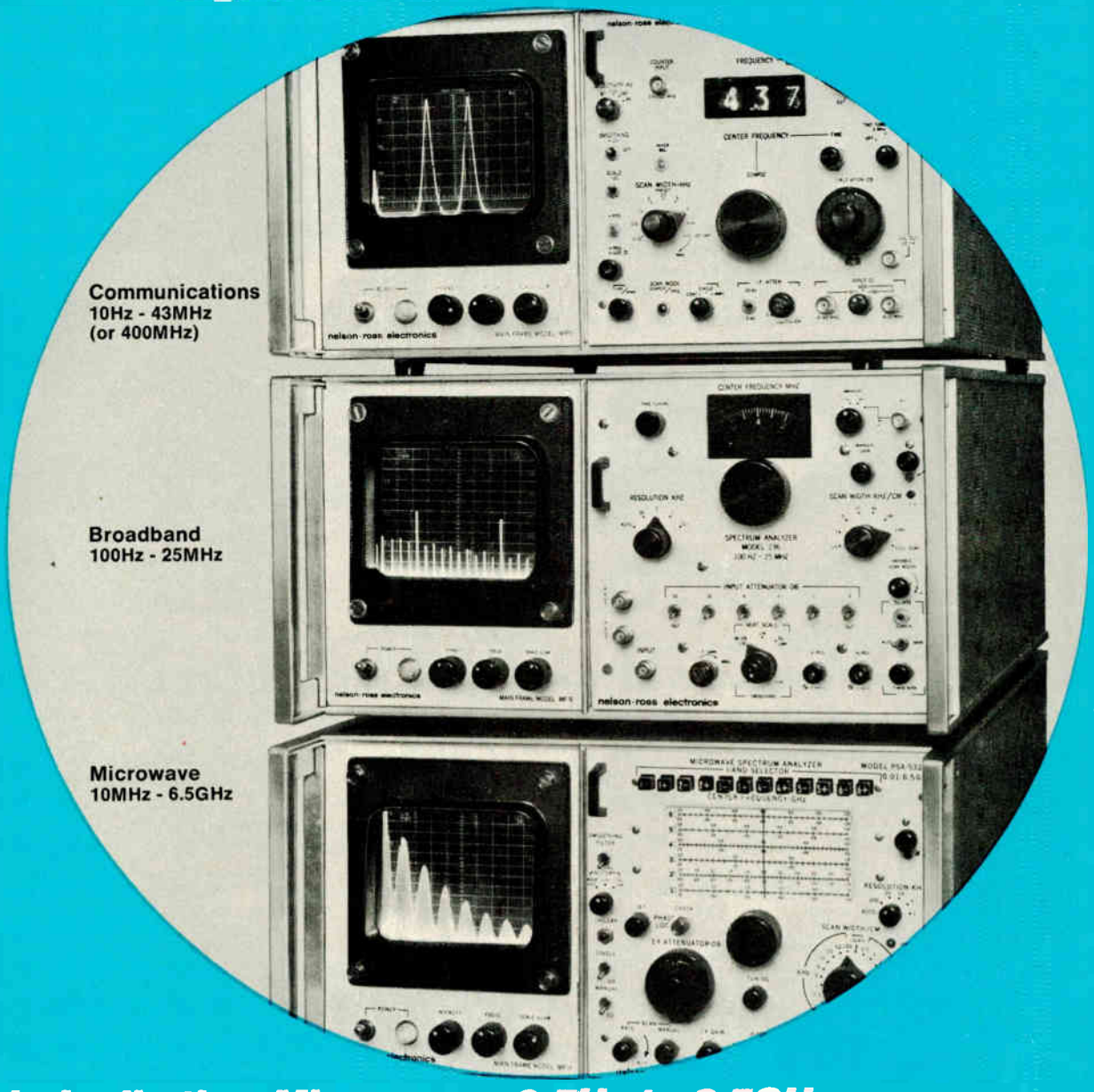

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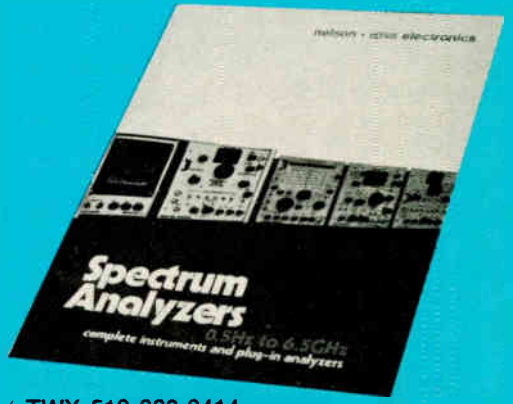

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Highlights

The cover: Sinking feeling in the marketplace, 81
Like a seesaw, the U.S. economy has swung toward recession, and the electronics markets have followed along—to some extent. As *Electronics'* annual survey shows, the overall electronic market growth rate has slipped to 7.8%, before taking into account the erosion of inflation. Next year? With growth at 5.3% and inflation at 8.5%, the outlook is unsettling. Cover is by Fred Sklenar.

A detailed summary of the various markets is presented in the fold-out chart on page 97.

What worries executives about 1975? 65
Just about everything. As the new year starts, a cross-section of industry leaders ponders aloud how the economic uncertainties—from fear of wrong Government action to vague feelings that even worse problems may be ahead—are impacting the progress of electronics.

The nonstandardization of C-MOS specs, 103
As complementary-MOS devices gain in popularity, the lack of standardization on some of the key specifications—such as noise immunity and worst-case propagation delay—can cause headaches for unwary designers.

And in the next issue . . .
Enhanced system reliability via component burn-in . . . the case for sinusoidal clock timing . . . standard logic for microprocessors . . . a thermal converter for ac measurement.

Electronics

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Publisher's letter

At the end of the year, as we put the finishing touches on our annual electronics market survey—and we have done it 17 times now—the phone calls start to come in. Market researchers, literally from all over the world, try to get a line on our results before we publish them. Our standard answer is "No, you will have to wait and read our first issue in January."

But this year it's all different. Sure, the calls started. But they started earlier than usual. And, the big difference was in the number of callers.

Never before have so many market observers appeared to have so little on which to hang conclusions. And, uniformly, the callers voiced their concern about the state of the general economy and, therefore, the performance of the electronics industries in the troubled year of 1975.

We knew that the economic picture was unclear and that the times are, to say the least, uncertain. But, with all those calls, we have discovered an independent barometer for forecasting the level of economic worry.

Seriously, there is much to be concerned about as crisis-ridden 1974 turns into not-exactly-hopeful 1975. On page 81, you'll find the start of our 16-page report on the electronics markets—and the news that the once-buoyant growth rate of electronics is faltering and swallowed up by inflation.

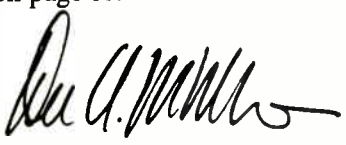
And then, on page 97, we follow up with a detailed product-by-product, component-by-component breakdown of the market. We include 1973, 1974, 1975, and 1978 so that you can spot the short-term and middle-term trends in the market segments.

Another year-end economic pulse-taking that has become a tradition at *Electronics*, is our look at what the leaders of the electronics industries are thinking as the New Year rolls in. On page 65, you'll find a Probing the News story on those thoughts. And "worry" is the word that sums them up.

Inflation, recession, the employment picture, even the fear that Washington may step in—and do the wrong thing—are deeply disturbing managers as they look for signs of what 1975 will bring. We believe that this year, our look into their thinking is more valuable than ever before. Don't miss it.

And, following that story is another one about the effects of national economic travails on the people who work in the electronics industries. It's about the spread of layoffs and unemployment to the ranks of engineers. What's more, the impact is being felt across practically all types of companies and hitting just about every level of experience.

Harder to pin down are the numbers involved where companies are clamping down on new hirings. The job freeze approach is particularly worrisome because of its meaning for this year's crop of engineering school graduates. We're sure you won't want to miss this story, which starts on page 68.



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Readers comment

Tips on power amplifiers

To the Editor: William Kraengel Jr. pointed out a very good application of an audio oscillator and public-address amplifier in the Engineer's notebook [*Electronics*, Oct. 31, p. 92]. But there are two problems an individual should be aware of when utilizing a P. A. amplifier to provide a constant-voltage sine-wave power supply. The first concerns the available frequency range.

Most P. A. amplifiers have a transformer-coupled output. In examining the specification sheet for an amp, you will find that the output transformer will be good at full power to approximately 50 hertz on the low end and between 12 kHz and 15 kHz on the high end. At lower power levels the amp will probably provide a clean sine wave from 20 Hz to 20 kHz, but one should not expect any more than that.

The second problem concerns the power-supply transformer. It must be kept in mind that virtually all P. A. power amps are designed to operate at a continuous sine-wave level of only one-third their rated power output. This is due to the 10 dB peak-to-average-crest factor of the normal spoken voice or musical source. So if a person is using a power amp for long periods, a good rule of thumb is to run it at one-third the rated sine-wave power; otherwise the power transformer may eventually destroy itself.

John Pritchett
James B. Lansing Sound Inc.
Los Angeles, Calif.

Pioneering overlooked

To the Editor: You may have been correct in reporting that a number of instrument makers are still sitting on their hands when it comes to using microprocessors in their products ["Microchips meet buyer resistance," *Electronics*, Nov. 14, p. 34]. We are disappointed, however, that you completely failed to mention Doric's pioneering in this field.

Albert B. Frowiss
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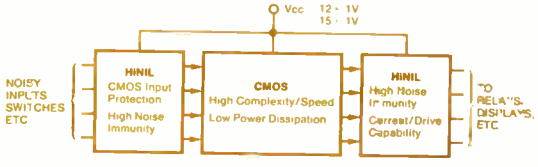

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40 years ago

From the pages of Electronics, January, 1935

Germans aid television

Information coming from Germany and England indicates that a "television race" is on in those countries, to see which nation will be first to develop a practical system of television for wide national use. The Hitler administration has been pushing for an early introduction of television in the Fatherland, under the direction of Dr. Goebbels and the propaganda ministry.

Great radio and public address hookups are the fashion in Germany since *Der Fuehrer* took charge. And the added advantage of being able to "see, as well as hear," the national idol, has been shrewdly recognized, so that all pressure is now being put on television as a further aid to Nazi solidarity.

Meanwhile the English are determined that Germany shall not be first to introduce into Europe practical television for the masses. The British imagination has been touched by the recent British Empire broadcasts, linking together all the far-flung colonies. So the radio authorities have been told to get ready for visual tie-ups also.

German television receivers

The Telefunken company has two types of television receiver, both using high-vacuum cathode ray tubes. The screens are 5.9 by 6.7 and 9.0 by 10.2 inches, the only ones with a material producing a black-white picture.

The cathode-ray-tube receiver of "Fernseh A.G." has a screen with dimensions 9.4 by 11.8 inches, the largest one available in Germany and with the best picture.

The television receiver of the "Radio A.G. D.S. Loewe" is also furnished with a cathode ray tube. This receiver, with screen dimensions of only 3.9 by 5.9 inches is the cheapest one on the German market, selling for $220 to $270.

A very interesting television receiver is made by the Laboratory von Ardenne. The dimensions of the screen are 5.9 by 6.7 inches; the color of the picture is light-green.

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Circle 9 on reader service card

Editorial

The inherent strengths of electronics

At a time when the highest officials in the country are calling inflation and recession the most desperate problems facing the nation—and unemployment and the high price of energy haunt industry—our annual survey of the electronic marketplace offers little comfort—on the surface.

There are short-term problems, to be sure. The unbalancing effects of double ordering, for example, are still depressing the marketplace. Inventories mounted while economic conditions caused a wind-down in production. Now, with companies sitting on their investment in excess parts—and with the price of each part eroding—the financial picture at many companies is not exactly a happy one.

Labor is suffering, too, because of the layoffs triggered by the falloff in demand for parts. Unemployment is up—and across the board, too, not just in marginal or selected areas.

Once, the U.S. had foreign markets as a bulwark against the rough patches in the domestic market. Now, though, the whole world is in the same economic boat, and the U.S. really only has an edge in advanced technology—the bread-and-butter items are too widely competitive.

But, below the surface, there are underlying strengths that support a long-term prognosis of fundamental good health for the industries based on electronics. This time, companies and their management are better prepared to weather whatever storm lies ahead. Look at these positive elements:

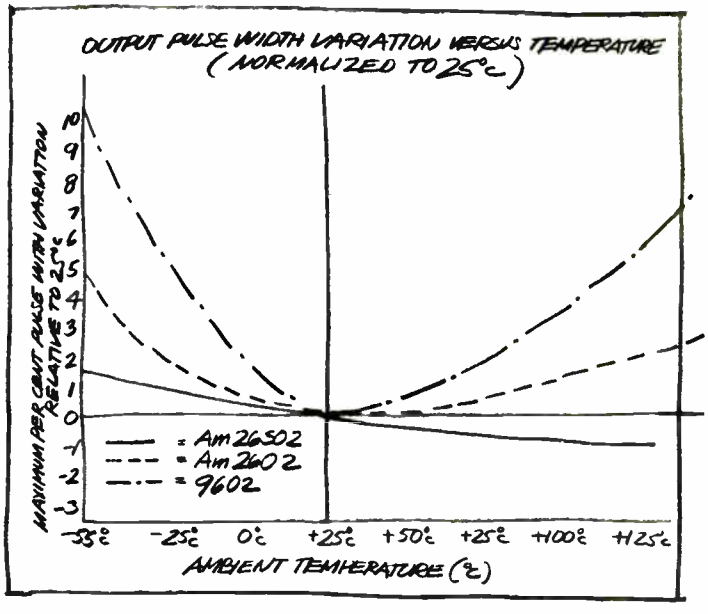
- *The already broad market base enjoyed by electronics is growing even broader, with electronic products moving into applications that, just a few years ago, were done by other means—or just not possible at all.*
- *Management has had a recent recession to learn from—and the decision makers are facing up to and tackling the tough decisions faster.*
- *All the signs indicate that companies, especially semiconductor houses, are being far more prudent than in recent years about capital investments, expansions plans, and the like. Growth at any cost has given way to growth at reasoned cost.*
- *The thesis that electronics is heavily involved in the solutions to many of the problems that beset us has never been truer. In the case of energy savings, electronic answers range from improved controls on how fuel is consumed in cars, homes, and factories all the way to substituting communications links for business travel. Look, too, at the potential in, for example, pollution control, increased productivity, and automation.*

There is, then, a firm basis for confidence that the electronics industries have an enviable potential for long-term growth—and the fundamental power to achieve it. A crucial key to survival for electronics companies is that management must retain its technological edge and maintain its momentum in new product development. The companies that do will be ready to seize the advantage from the upswing ahead.

Our new one-shot has it all.

All.

Very simply, our new Am26S02 ("S" for Schottky) is the world's best re-triggerable monostable multivibrator.



It offers blazing speed, unprecedented temperature stability and the kind of manufacturing tolerance you can write home about.

Naturally, the Am26S02 is built to MIL-STD-883 and MIL-M-38510 quality levels.

And naturally, the Am26S02 (as well as our Am2602 and Am9602 one-shots) is available for immediate delivery.

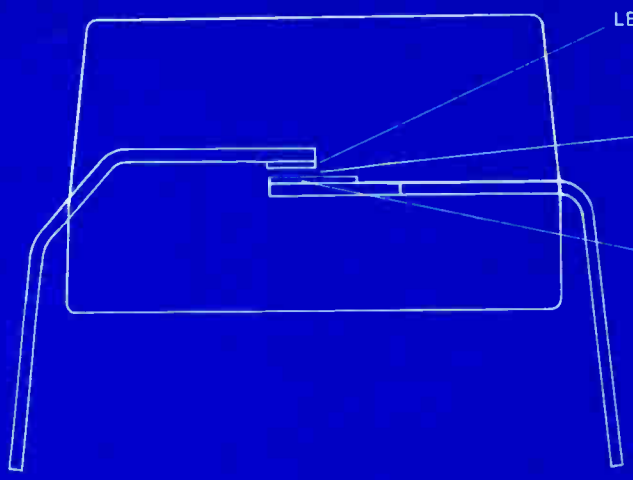
Some Choice Technical Tidbits Relative To The New Am26S02 One-Shot:

Output pulse width stability over temperature. (R_X=100k ohm)	
(−55°C to +125°C)	1.0%
(0°C to +70°C)	0.4%
Output pulse width manufacturing tolerance	3.0%
Minimum output pulse width	28ns
Delay; trigger to output	15ns
Delay; clear to output	6ns
Value of timing resistor (max.)	
(−55°C to +125°C)	50k ohm
(0°C to +75°C)	100k ohm

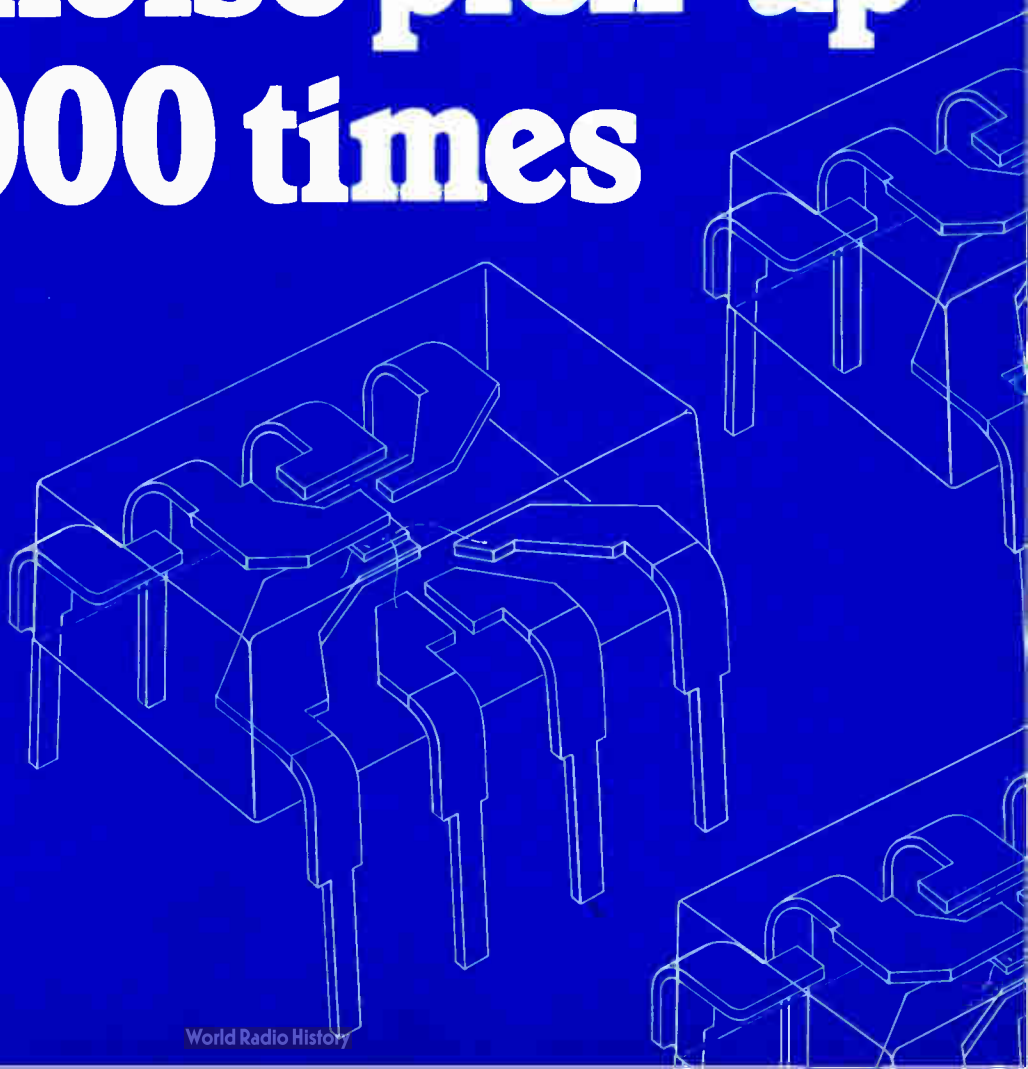
Advanced Micro Devices

Corporate offices are at 901 Thompson Place, Sunnyvale, California 94086. Telephone (408) 732-2400 or toll free from outside California (800) 538-7904/Southern California office: Beverly Hills (213) 278-9700/Mid-America: Oak Brook, Illinois (312) 323-9600/Edina, Minnesota (612) 835-4445/Eastern United States: Roslyn Heights, New York (516) 484-4990/E. Syracuse, New York (315) 437-7546/Baltimore, Maryland (301) 744-8233/Lexington, Massachusetts (617) 861-0606/Britain: Advanced Micro Devices, Telephone Maidstone 52004/West Germany: Advanced Micro Devices, Munich, Telephone (089) 53 95 88. Southern Europe: Advanced Micro Devices, S.A., Neuilly, France, Telephone: 747-4194. Distributed nationally by Hamilton/Avnet, Cramer and Schweber Electronics.

Circle 11 on reader service card



Ultra fast opto-isolator cuts noise pick-up 100,000 times



The specs are startling. Our IL-100 Isolite can transmit data at rates up to 5 megabits per second. And with common mode rejection of 50 db. That's better than any opto-isolator ever made, regardless of speed.

This performance is good enough to eliminate noise pick-up problems in nearly all hard-wired data transmission applications.

Such a state-of-the-art breakthrough means you can tie together computer and peripherals without resorting to brute force techniques for eliminating noise pick-up—such as laying in conduit and shielding systems, all of which are highly expensive.

And it means you save countless hours when a system is installed, modified or moved.

The IL-100 is a true solid-state device. It is DTL/TTL compatible, so it can be designed into your next solid-state system without the extra components required by pulse transformers.

It has an unusually versatile Schottky-clamped 3-state output that gives you built-in multiplexing capability without extra parts.

And its built-in Schmitt trigger virtually eliminates chance of oscillation, making your designs less critical and more reliable.

With propagation delay of only 75 nanoseconds, there is no opto-isolator made that offers comparable performance.

Don't use yesterday's technology to protect today's solid-state circuits. For details on the IL-100 ultra high-speed opto-isolator, contact Litronix, Inc., 19000 Homestead Road, Cupertino, Calif. 95014. Phone (408) 257-7910.

No wonder we're No.1 in LEDs

litronix

Circle 13 on reader service card

People

Martin of IIT looks to telecommunications

As newly-elected president of the Illinois Institute of Technology in Chicago, Thomas Lyle Martin Jr. is looking for interaction with industry. "I think it makes sense to build programs to match the local industries," he says. "Consequently, it makes sense in Chicago to go into advanced telecommunications."

Local man. Martin of IIT sees need for more telecommunications training.

Getting such a curriculum off the ground at the engineering school is not going to be an easy task, admits the 53-year-old educator. The school offers both graduate and undergraduate degrees.

"Our problem is going to be finding the people to do it. We're not going to find them generally in the universities," he points out. "In all likelihood, we'll be going to industry to look for faculty."

Experts. Since the Chicago area hosts telecommunications facilities of companies such as Western Electric, Bell Laboratories and GT&E Automatic Electric, Martin should have an adequate pool of experts from which to draw.

"The annual market for switched telecommunications systems right now is $30 billion world wide, growing 15% per year in the U.S. and up to 30% in parts of the world," he notes. "That's an enormous opportunity for the electronics industry and the U.S., yet there's not a single university in the U.S. that offers a program in switched telecommunications systems."

The soft-spoken Martin is experienced at tailoring his school to match local needs. As dean of the colleges of engineering at the Universities of Arizona and Florida, and most recently as dean of the Institute of Technology at Southern Methodist University, he established programs in solid-state electronics. He was also instrumental at SMU in organizing an instructional talk-back TV network linking classrooms and companies. He hopes to start a similar system in Chicago.

A Ph.D. in electrical engineering, trained at Rensselaer Polytechnic Institute and Stanford University, Martin has authored six books. His latest, and his first attempt at humor, is "Malice in Blunderland", a sprightly satire on administrative red tape. Written in a form that mimics scientific presentations, "Malice" is a compendium of laws, such as Murphy's—anything that can go wrong, will go wrong—which are purported to govern human actions in society.

"It's a commentary on administration and management, written when I thought I was moving out of administration and back into full-time teaching," he explains. "My mistake was publishing it just before I took this job. Now I'm being victimized by all the laws."

Del Frate drives for standard products

Daniel P. Del Frate came on the scene as marketing vice president at the Microelectronic Device division of Rockwell International Corp. to set up a whole new type of marketing effort. And it should radically change the large producer of metal oxide semiconductors from custom to standard in its product emphasis.

The division cut its teeth as a custom calculator chip maker, supply-

The new EPC 2200 XYZ recorder for spectrum analysis.

Low Cost. Lightweight. Precise.

The new EPC Model 2200 is the first truly fine quality, lightweight, low cost XYZ recorder ever made.

When matched with a spectrum analyzer, the Model 2200 prints spectral data on continuous, dry-paper hard copy over a 19.2″ display. A hard copy history-plot of spectral data not only permits data comparison, but reveals spectrum lines buried as much as 6 db below the noise level. And the 19.2″ display presents in excess of 3,000 data points with each sweep. Information that is subtle and transient on a scope becomes clear and permanent on an XYZ recorder.

The Model 2200 interfaces with either digital or analog equipment. It sweeps at speeds between 1/10 second and 8 seconds.

The EPC Model 2200 is currently built in four modified formats. Further customization is possible to meet specific customer requirements.

EPC

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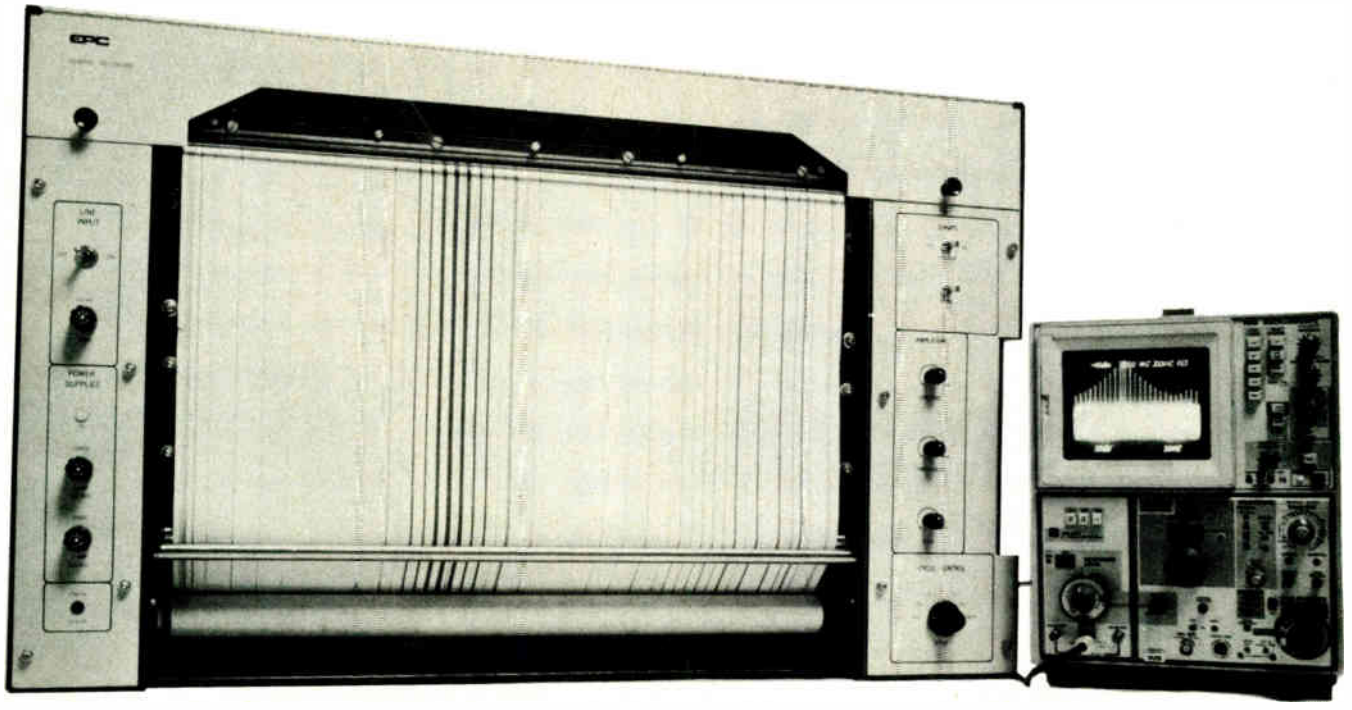
(617) 927-2523



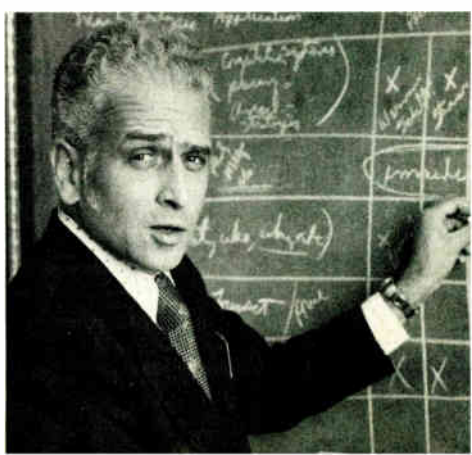
ing large quantities of circuits for a relatively small customer base. But the calculator circuit business has become seasonal and Del Frate's task is to beef up marketing of standard products, an area where Rockwell had always been weak. And he'll be using all of his commercial orientation gained in similar posts at RCA Corp.'s Solid State division and Westinghouse Corp.'s semiconductor operation.

One of his major efforts involves reaching more customers by supplementing the company's small central sales staff. Del Frate will add a dozen manufacturers' rep organizations by midyear, and distributors in the third quarter. He's also increasing his internal applications engineering department, a vital element for the smaller users he hopes to pick up.

"We hope to triple this," he says, holding up a Rockwell notebook of microprocessor applications data that has already become three inches thick.

Along with increased distribution, Del Frate is lining up marketable products. The first entry into standard products will be a high speed 1103A memory oriented toward big computer houses. A second-source 4,096-bit RAM is also coming. And the division's already substantial microprocessor business will swing from custom to standard as its PPS models go into production. Del Frate expects much from microprocessors in 1975. "Semiconductor sales may be flat or negative this year," he says, "but we see LSI up 10% to 12%, and microprocessors up a whopping 50% to 60%."

Switching. Rockwell's Del Frate is moving from custom to standard MOS.



The Long Legged Single Sided Hardboard Hybrid.

(Rare. Only 2000 known to exist.)

To an entomologist, a single sided solder plated hardboard hybrid may be pretty unexciting. But if you're an engineer struggling with a hairy design problem involving limited space, circuitry needs on several planes and low volume needs, then it just may be the answer.

Flexcircuits, like the small volume one you see here (we built only 2000), get the same Sheldahl engineering attention, 100 per cent quality control and on-time delivery as high volume orders. Our customers don't come in different sizes. They come with different *needs*.

For short runs of flexcircuits we offer the same capabilities as for high volume production: single or double sided circuits, plated through holes, reflow coated circuits, solder plated conductors, solder fused pads, film or epoxy coated circuits, back bared pads and flexcircuit/hardboard hybrids.

So whether it's a new product, design change or a prototype to help start an idea toward reality, consider flexcircuit technology and quality. It's been the answer for many companies—large and small—and could be just the answer you've been looking for. Call Sheldahl and find out.

Flexcircuit watcher? To get an 11 x 14 reprint of the above insect, suitable for framing, just write on your letterhead.

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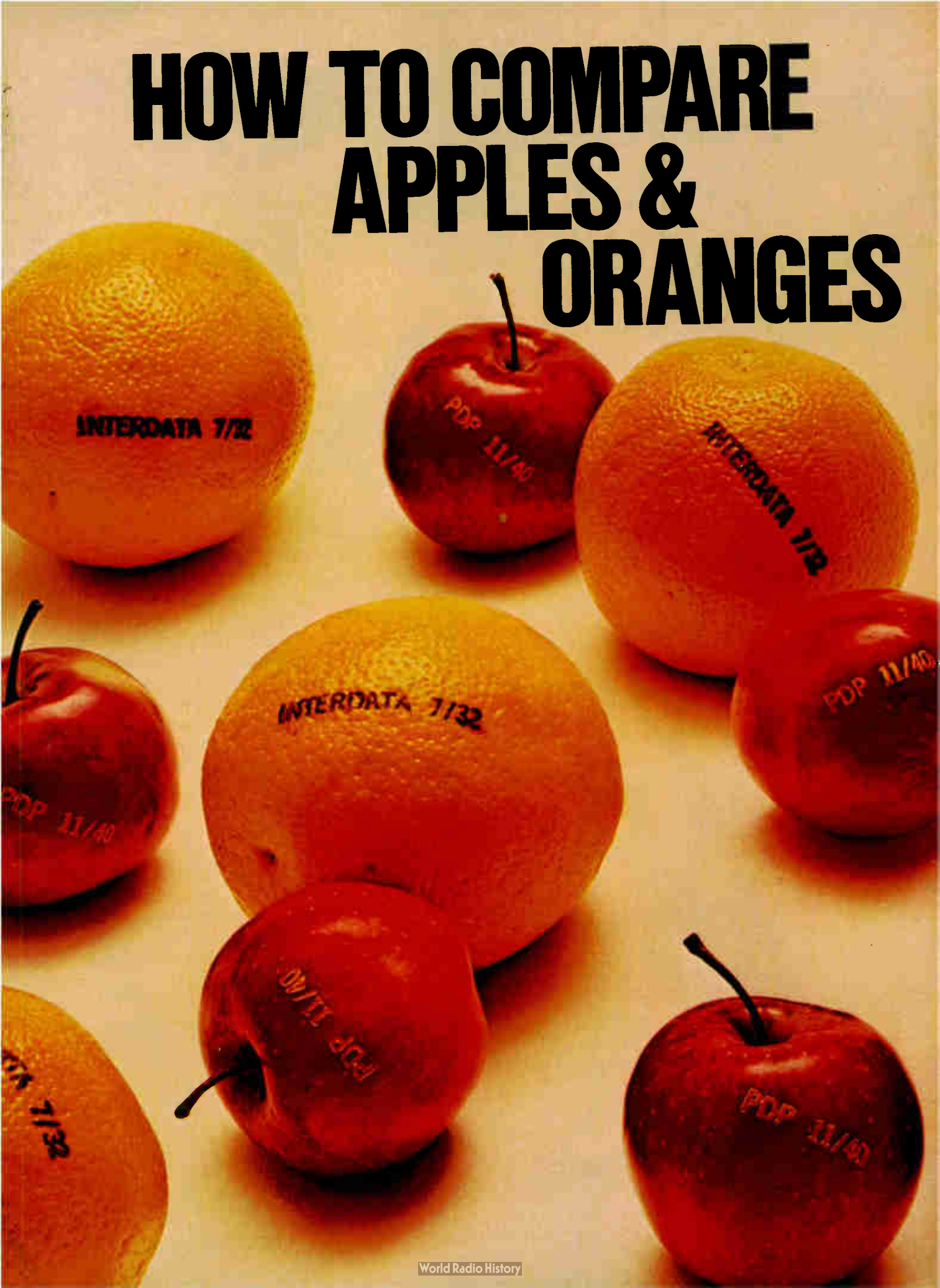
HOW TO COMPARE APPLES & ORANGES



OR THE INTERDATA 7/32 VS. THE PDP 11/40

It's a simple comparison when you think about minicomputer hardware in terms of software.

Interdata believes that hardware exists to make programming easier. That's the reason we invented a 32-bit minicomputer. And that's the reason there really can be no comparison with any 16-bit machine.

Just think about it.

Most 16-bit mini's were designed when memory cost you a dollar a word. Multiple registers meant four. Software was a set of diagnostics. And hardware was king.

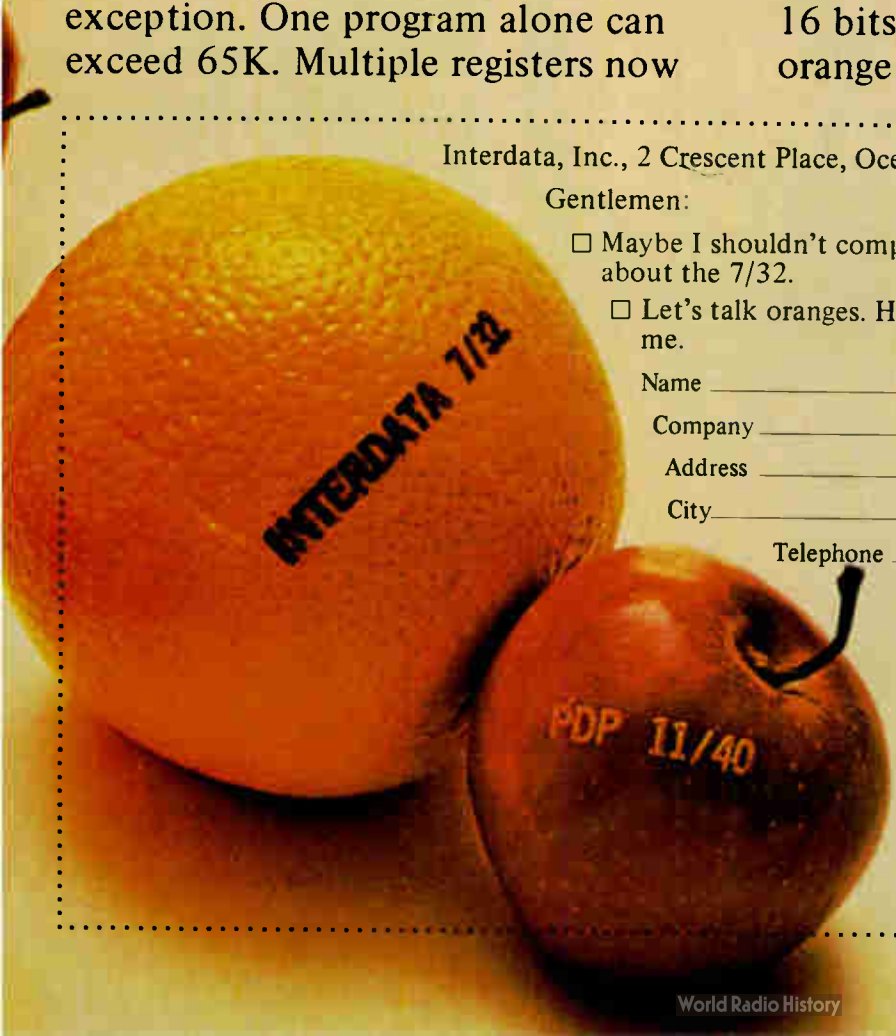
Not so now.

Large memories are the rule – not the exception. One program alone can exceed 65K. Multiple registers now mean 32. And most of your dollars are spent on software.

That's why Interdata made the 7/32 happen – to make your software simpler and cheaper.

For example, the 7/32 has a Real Time Operating System you can understand. A system optimized for FORTRAN programs. And a set of editors, debuggers, and file packages to brighten any programmer's day. All with a CAL assembler that gives you efficient code and is compatible not only with Interdata 7/32's but with our 7/16's as well.

So don't try to compare apples and oranges. It's unfair to the apple. Especially when their apple only has 16 bits to help their software and our orange has 32.



Interdata, Inc., 2 Crescent Place, Oceanport, N.J. 07757 (201) 229-4040.

Gentlemen:

☐ Maybe I shouldn't compare, but I've got to try. Send me more about the 7/32.

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Meetings

Computer Architecture, IEEE, University of Houston, Houston, Texas, Jan. 20–22.

Reliability and Maintainability Symposium, IEEE et al., Sheraton Park Hotel, Washington, D.C., Jan. 28–30.

Physics of Compound Semiconductor Interfaces, University of California, Los Angeles, Feb. 4–6.

Wincon—Aerospace & Electronic Systems Winter Convention, IEEE, Aerospace & Electronics Systems Society, Americana Hotel, Los Angeles, Calif., Feb. 5–7.

Nepcon '75 West and International Microelectronics Exhibition, Industrial Scientific Conference Management Inc. (Chicago, Ill.), Anaheim Convention Center, Anaheim, Calif., Feb. 11–13.

CAD/CAM III. Computer-Aided Design and Computer-Aided Manufacturing, Society of Manufacturing Engineers, Hyatt Regency O'Hare Hotel, Chicago, Ill., Feb. 11–13.

International Solid State Circuits Conference, IEEE, Marriott Hotel, Philadelphia, Pa., Feb. 12–14.

Compcon Spring—Computer Conference, IEEE, Jack Tar Hotel, San Francisco, Calif., Feb. 25–27.

Industrial Applications of Microprocessors, IEEE, Sheraton Hotel, Philadelphia, Pa., March 11–12.

Reliability Physics Symposium, IEEE, MGM Grand Hotel, Las Vegas, Nev., April 1–3.

Southeastcon '75, IEEE, Sheraton Center, Charlotte, N.C., April 6–9.

Intercon—IEEE International Convention, Coliseum and Americana Hotel, New York, N.Y., April 8–10.

Electronics Production and Test Equipment Exposition, U.S. Department of Commerce, Stockholm, April 7–11; London, April 15–18.

Now we've captured the Butterfly® switch with the Frost-Glo™ light

With the economy of one lamp, Licon adds eye appeal to lighted switching with our Series 01-669 LPB. We call it Frost-Glo. We've captured soft, even lighting... with no hot spots. Lighting to complement front of panel appearance on computer, computer peripheral, communications, office, test and medical electronic equipment. Eye appeal aside, Series 01-669 offers advantages you can't get with the conventional two light switch currently in application. Both have popular panel cutout size but there the similarity ends. Series 01-669 features snap-in front of panel mounting. Unitized one-piece design and construction. Equal length for both alternate and momentary versions. Single or double pole, versatile insertable legends and smart looking hidden legend capabilities. Rectangular one light display that is comparable to that of the two lamp competitors. Plus Licon's proven double break, double reliable patented Butterfly switch mechanism. And beautifully priced. For information and specs, write: LICON, Division Illinois Tool Works Inc., 6615 W. Irving Park Rd., Chicago, Ill. 60634. Phone (312) 282-4040, TWX 910-221-0275.

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Commercial gold—lowest price

20 microinches of gold. Amphenol has a full line of 225 Series edgeboard connectors. Some manufacturers offer a similar connector with a 10 or 15 microinch *gold flash* at comparable prices. But if you need gold, make sure you get at least 20 microinches of *gold plate*. Amphenol's got it.

Industrial gold—medium price

30 microinches of gold. More critical industrial applications may need a heavier gold plating on the contacts and a stronger dielectric material, like our industrial grade 225 Series connectors. Gold plated beryllium copper contacts and a glass fiber reinforced diallyl phthalate body make this the connector for all but your toughest jobs.

Strike gold

Amphenol has a printed board connector priced for your application. That's because we offer the same connector line with 20, 30 or 50 microinches of gold plating. Our 225 Series bellows contact edgeboard connectors let you design to the price level that best suits your needs.

Whether your application calls for a cost-saving commercial connector, or the very best connector money can buy, we've got you covered. From six to 100 contacts. In five different contact configurations. Four mounting types. And seven tail styles for solder or wrapped terminations. Taper pin and Crimp Poke Home® terminations give you additional versatility where you need it.

Amphenol 225 Series connectors are available in more places than any other brand, too. Because Amphenol has the largest network of stocking distributors in the industry. There's one nearby waiting for your call. Delivery is now.

Military gold—premium

50 microinches of gold. Your toughest jobs may require a connector qualified to MIL-C-21097 C/21—like our military grade 225 Series connector line. A full 50 microinch gold plating over beryllium copper contacts and our best dielectric means this connector will stand up to the most severe operating conditions. It's our best connector for your toughest jobs.

at your price.

Or strike bright tin/lead.

If economy is most important, find out about our bright tin/lead contact plating. Performance compares favorably with light gold, but the price is lower. Eliminating gold plating on your printed boards will cut costs even further.

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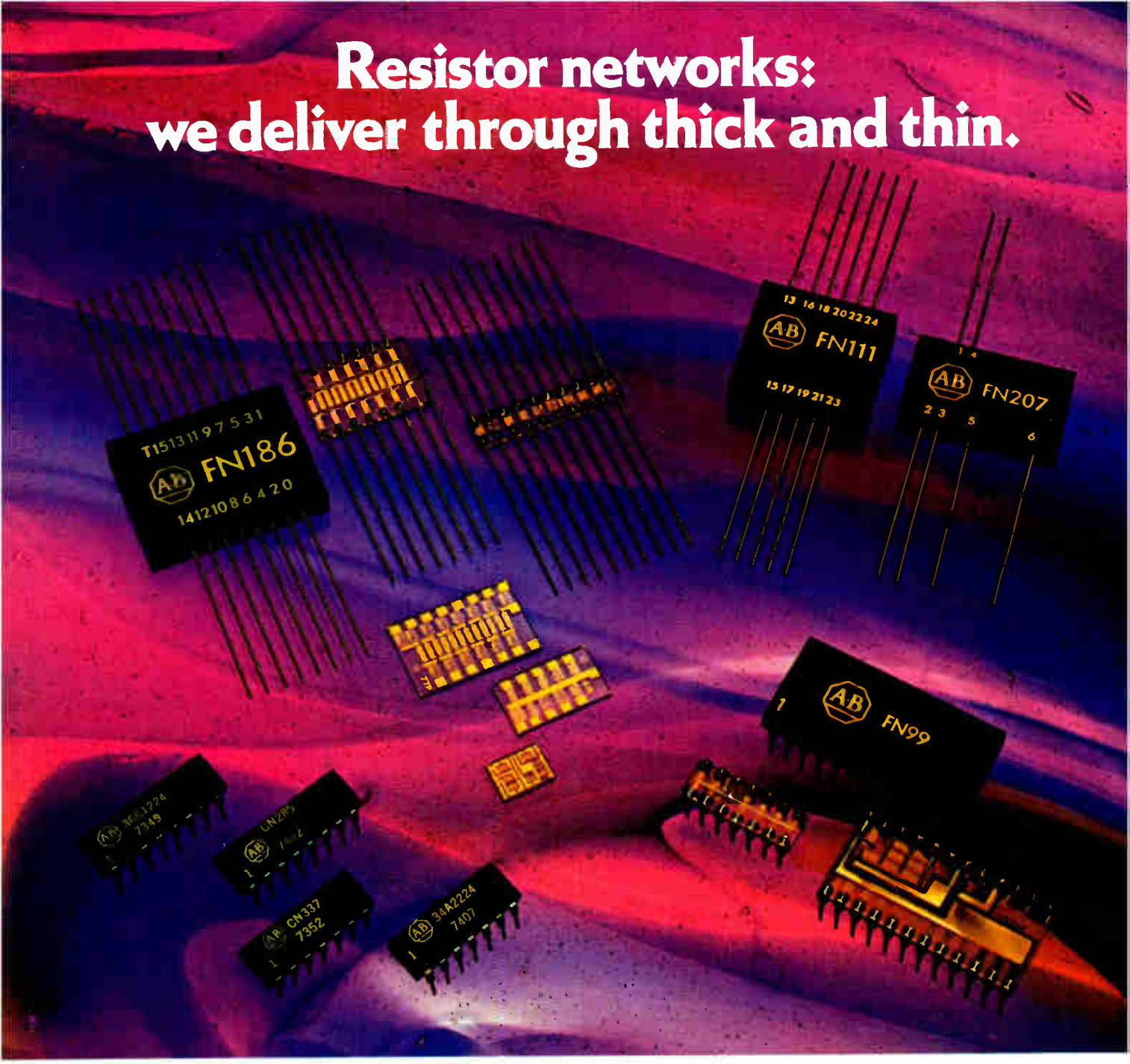
Resistor networks: we deliver through thick and thin.



Seventeen years of film resistor experience combined with quality production capabilities give you prompt solutions to your network needs. Whether you require precision thin film or semi-precision thick film in prototype or mass production quantities. Thin film in chip, conformal coat, flat pack and DIP. Thick film in standard 14 and 16 pin DIPs with resistor or resistor/capacitor configurations. Popular pull-ups and terminators off-the-shelf. Contact your local A-B sales office or write for our 5800 series publications. Standard items are available through your appointed Allen-Bradley Electronics Distributor. Allen-Bradley Electronics Division, 1201 South Second Street, Milwaukee, WI 53204. International Division, Milwaukee, WI 53204. Canada: Allen-Bradley Canada Limited, Cambridge, Ontario. United Kingdom: Allen-Bradley Electronics, Limited, Jarrow, County Durham NE32 3EN.

SELECTED SPECIFICATIONS

	Thin Film	Thick Film
TCR	±10 to ±25 ppm/°C	±100 and ±250 ppm/°C
TCR tracking	±5 ppm/°C	±50 and ±100 ppm/°C
Absolute tolerance	as low as ±.01%	as low as ±1.0%
Matching or ratio tolerance	as low as ±.005%	as low as ±2.0%
Resistance range	1K to 10 Megs (special 10 ohms to 50 Megs)	10 ohms to 1 Meg

If you're really serious about cost, be serious about quality.

A-B QUALITY

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Milwaukee, Wisconsin 53204

EC85B

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Electronics newsletter

Sense amplifier is fast enough for n-channel parts

A new current sense amplifier for n-channel memories utilizes emitter-coupled-logic processing to permit use with fast MECL 10K logic. The part, developed by Motorola Semiconductor Products, is **the first ECL-type product from Motorola's linear products group,** and is designed especially for such fast n-channel memories as the 7001 and 2501.

The new MC3461 permits a **typical access time of 50 nanoseconds;** the amplifier itself has a typical propagation delay of only 5 ns. It contains both internal latches and level translators for the two types of logic.

Signetics samples its 4-k RAM

Signetics Corp. of Sunnyvale, Calif., will begin sampling its 4,096-bit random-access memory this month. A 22-pin device, **compatible with either the Texas Instruments or Intel configurations,** it has, like the Intel product, a 5-volt substrate voltage specification and a speed of 300 nanoseconds. Company officials say they are working on a faster 200-ns version. The company expects to be in full production with the slower version by June.

SCR features speed, power

International Rectifier Corp., a major producer of high-power semiconductors, has developed a new type of distributed-gate silicon-controlled rectifier that provides **high power, fast switching, and low forward voltage drop.** The devices, to be introduced late this month, have voltage ratings to 1,600 V and average current ratings to 650 amperes, yet turn off in only 10 to 60 microseconds. The new diffusion process and gate structure have 20% less switching loss in higher voltages than similar SCRs now on the market.

New LCD promises visibility in dim and bright light

A new type of field-effect liquid-crystal display combines the properties of transmissive and reflective displays, **permitting it to be read in both bright and dim light.** The so-called transflective display is made for Tekelec, the Oxnard, Calif., maker of panel and multimeters, by two suppliers.

Tekelec president Phillip Wasserman says the display can even be read outdoors. It looks like a conventional reflective type under normal lighting, but is backlighted by a small bulb for darker conditions.

TI royalty action aims at calculators from Japan . . .

Texas Instruments will try to stem Japanese calculator exports by demanding retroactive royalties on the MOS ICs in them, says a Japanese publication, Nihon Keizai Shimbun. **Most Japanese IC makers have not made such payments because TI doesn't have patents in Japan,** although it has them in the U.S. In Dallas, a TI spokesman said there would be no comment.

TI's move also could slow transfer of MOS production by Hitachi, Nippon Electric, and Toshiba to Malaysia plants and by Nippon Electric to Ireland, because TI has patents in those countries. And, says the article, TI also will soon move against Japanese calculator makers that it feels are infringing on TI's one-chip-calculator patent.

Electronics newsletter

. . . Fujitsu claims DEC's PDP-11 infringes patents

Digital Equipment Corp's PDP-11 infringes on two of its Japanese patents, charges Japan's Fujitsu Ltd. **Not so, says DEC, but neither side appears anxious to go to court about it.** However, Fujitsu says it may sue DEC unless a "reasonable settlement" is reached. The Japanese firm says DEC precipitated the discussion in 1973, when it alleged that Fujitsu's U-200 minicomputer infringes on DEC's Unibus patents.

A subsequent study of the PDP-11, says Fujitsu, showed that the Unibus infringes on a Japanese patent for an index register, granted in 1960 and due to expire this year, and on multiple priority interrupts, granted in 1967 and running for 15 years. Furthermore, Fujitsu claims that the Unibus is an old concept that was common knowledge and not patentable. Fujitsu wants a cross-licensing or royalty agreement.

DEC has applied for a patent on the Unibus in Japan, but it has not been granted, and unless and until it is granted, a DEC spokesman says, "It is an Alice in Wonderland discussion. We have examined their contentions, our patents, and patents pending, **and don't feel we have infringed on anything."** He adds, "There are reasons for us to say to Fujitsu that there are patents pending in Japan that could be points of discussion."

Single-button dialing scheme comes to Telex

ITT World Communications Inc. will begin putting into operation this month its new Auto-Call Telex, or ACT, **a terminal that makes it possible to originate telex calls to selected overseas offices simply by pressing a single button.** The unit features a 2- by 2¾-inch key selector, with nine positions representing the customer's most frequently called numbers. The numbers are stored in a TTL read-only memory. Also included in the terminal is a separate key to transmit regular cablegrams to ITT Worldcom's international message-processing center.

The new unit will be available initially to ITT Worldcom Telex subscribers in New York City. It will be extended later to subscribers in Washington, D.C., and San Francisco. The ACT key selector and associated equipment are installed on ITT teleprinters without charge.

U.S. has lead of two years in IC technology

A just-released study by the Department of Commerce says, "American manufacturers in advanced product lines (ICs) have opened a technological gap of as much as two years over their foreign competitors **and are in an excellent position to make further inroads."** The lead is attributed to the "paucity of R&D funding" for basic research overseas, overcaution by foreign investors, and the size of the U.S. domestic market.

Addenda

A new retail point-of-sale system aimed at general merchandisers is being field-tested by Litton Industries' Sweda International division. Called the Sweda Series 800/80, it includes an in-store **minicomputer-controlled processor featuring a disk memory that can handle 2.5 million to 10 million bytes.** Sweda says a typical 800/80 system in the U.S. will cost $23,000 to $32,000 for the mini and other backroom equipment, plus $3,500 for each terminal. . . . A Columbus, Ohio, bank, City National Bank & Trust Co., has invested $150,000 in three minicomputers and 12 teller stations from Docutel Corp. of Dallas **to put 12 automatic tellers in one of its branches.** The installation is called the first of its kind and, for the banking industry, a look at the future.

These new Unitrode 300V power darlingtons

perform like this

Peak I_C A	V_{CEO}† V	h_{FE}	$V_{CE(sat)}$ V	Type No.	Package (Modified)	Polarity
1	300	1000 @ $I_C = 1A$	1.1* @ 0.5A	U2T713	TO-33	NPN
2	300	1000 @ $I_C = 1A$	1.5* @ 2A	U2T723	TO-66	NPN
5	300	1000 @ $I_C = 1A$	1.5* @ 5A	U2T833	TO-3	NPN

†V_{CEO} measured at 10 mA *Forced gain = 100

and...

Like all Unitrode Power Darlingtons these new 300-volt units exhibit the lowest saturation voltages available.

Like all Unitrode Power Darlingtons their short turn-on and turn-off times mean unusually high efficiency in fast-switching applications.

Like all Unitrode Power Darlingtons they give you greater savings in design and assembly time and lower component cost than is possible with discrete components.

Like all Unitrode Power Darlingtons they are planar for the highest reliability and stability.

Unitrode's full line of Power Darlingtons includes PNP and NPN transistors and a wide choice of characteristics in single and dual, mixed or matched, units.

Send for complete details on the entire line of Unitrode Darlingtons. For faster action, call Peter Jenner at (617) 926-0404. Describe your application on your company letterhead and we'll send a suitable sample.

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UNITRODE

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KIND HEARTS, BUT NO CORNETS.

No tubas, no trombones, no clarinets, no oboes, or flutes, no drums, no bass fiddles, or bassoons, nor guitars, nor pianos, nor anything on John Philip Sousa's list.

We haven't a thing that makes music. Unless you count ticking, buzzing and whirring...the sounds of science! We are U.S. Instrument Rentals... ...that's oscilloscopes, counters, analyzers, amplifiers, recorders, meters, and state of the art test instrumentation, you name it.

What is special about us is not so much kind hearts, but a commitment to tune out some of the sour notes of renting.

Sour Note Ever forget to return a piece of equipment and then get stuck for the payments?

Sweet Note Only we send you an automatic reminder when the rental period is up.

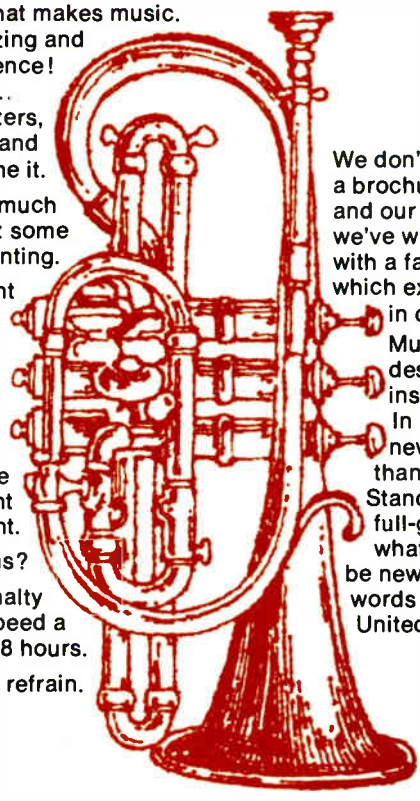
Sour Note Ever get the telephone runaround when you're trying to locate equipment?

Sweet Note Only we have IDIOM, a real time computer capability for instant inventory commitment.

Sour Note Ever have service turnaround problems?

Sweet Note Only we will pay you a 25% penalty in dollars if we can't speed a replacement to you within 48 hours.

With US, service is an essential refrain.



We don't have room to write a brochure about ourselves and our services here. Besides, we've written one already... with a fat catalog included which explains the foregoing in detail and much more.

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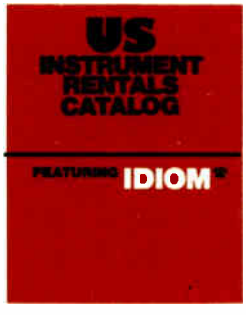

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Army developing fiber-optic cable for front-line use

Electronics Command funds work on replacing twisted pairs; lighter weight, less interference the major goals

The U.S. Army is trying to replace twisted-pair cable in front-line communications with cable made of optical fibers. Over the next few years, in fact, it expects to make major procurements of the new lighter-weight and wider-bandwidth links to replace its widely used 26-pair cable and the cable used for pulse-code modulation systems.

Fiber optic cable "is an area we think will have a tremendous impact on military communications in the future," says Rudolph C. Riehs, deputy director of the Army Electronics Command's (ECOM) Communications Automatic Data Processing Laboratory at Fort Monmouth, N.J.

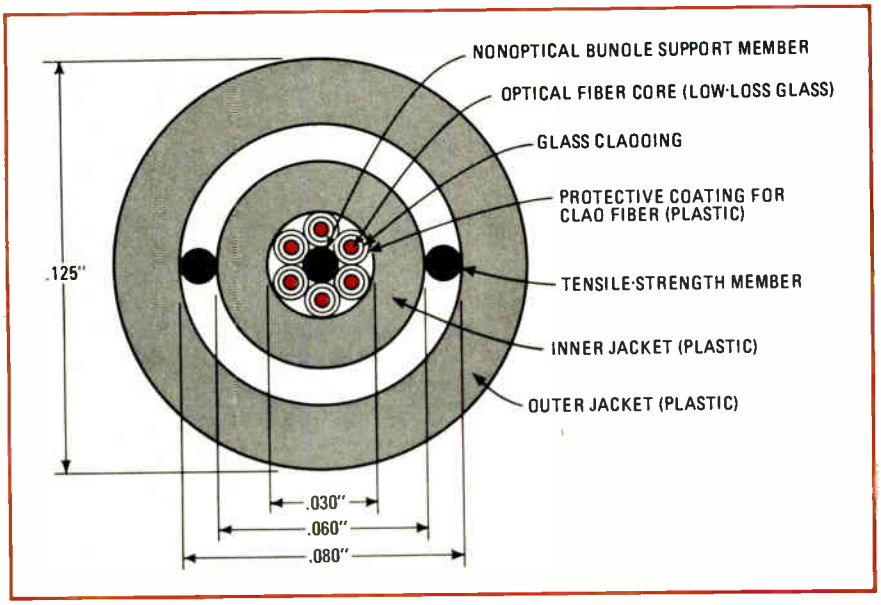
Indeed, the Air Force, Navy and Army plan to form a tri-service committee, he says, to investigate potential fiber-optic applications and to identify R&D approaches and problems. The Air Force and Navy are already at work on fiber-optic replacements for coaxial cable in aircraft and ships [*Electronics*, Aug. 22, p. 69]. They can make do with high-loss fibers for their usual short-haul needs. The Army requires low-loss fibers for the greater distances it must usually accommodate.

Serious. ECOM became seriously interested in fiber-optic communications last year, after Corning Glass Works, Corning, N.Y., had demonstrated glass fibers with attenuation at discrete near-infrared wavelengths of 20 decibels per kilometer. Subsequently, ECOM awarded Corning an $80,000 contract to ruggedize its optical-fiber cable. Corning expects to set up a production line next year, although ECOM officials stress that any major buys will undergo competitive bidding. ECOM, in fact, is also sampling plastic-jacketed optical fibers developed by International Telephone & Telegraph Corp.'s Electro-Optical Products division, Roanoke, Va.

The optical fiber cable has at least three major advantages over the Army's 26-pair cable. The fiber, for example, offers 100 megahertz of bandwidth compared with 1 kilohertz for the older cable. Also, the fiber cable is much smaller—0.125 inch in diameter, as against 26-pair's 0.625-inch diameter. And the fiber cable weighs about 30 pounds per 1,000 feet, while 26-pair weighs 200 lb for the same length.

A major disadvantage in getting the material into the Army's arsenal of field communications systems has been cost, although ECOM officials believe that the new cable—presently running at about $2 per foot—will begin to match the 26-pair cable in cost sometime in 1976. They also estimate that once in production, the cost will drop to about 50 cents a foot.

An additional advantage to the Army is that the new cable offers much improved security, since the data source can be digitized and multiplexed without making any physical changes in the material. In contrast, the Army



Conductor. Forward-area Army communications may soon be relying on fiber-optic cables only 0.125 mils in diameter to carry voice messages and digital signals.

found that transmitting in a digital mode with 26-pair cables produced crosstalk problems, which could only be solved by jacketing cable pairs within a single cable. This obviously increased the cable's size, weight, and cost.

The Army, says Riehs, is looking at optical fiber cable for several applications, such as intra-shelter wiring (probably within a command post), local loops within battle zones, and for communications up to at least 8 kilometers. The goal is to be able to transmit over this longer distance without repeaters and with a total attenuation loss of no more than 50 dB.

Several problems remain to be solved. New interface equipment will be required to achieve the wire-to-fiber changeover. Also, ECOM is battling with the problem of how to splice the new cable in the field. Jacketing the cable without giving away its inherent weight and size advantages is another concern.

Corning's ruggedized version of the cable currently embodies six glass-fiber strands surrounding a non-optical bundle-support member and surrounded by a plastic jacket. To increase tensile strength, two more members have been added and it is all covered by an outer plastic jacket. □

Reuters sells news to order over coaxial CATV networks

Convinced that the average individual prefers to select his own news, when he wants it, the British international news service, Reuters, is introducing a new, high-speed information retrieval system that operates over ordinary coaxial-cable networks. The system, developed by Information Dissemination and Retrieval Inc., a Reuters subsidiary in New York, is already operating on Manhattan Cable Television Inc.'s channel 26.

Services available from Reuters news files include general news briefs, stock and commodity-exchange data, money-market rates, and foreign-exchange quotations. Manhattan Cable also is marketing racing information supplied by Triangle Publications, publishers of the Daily Racing Form.

Indexing is based on the headline for each item. Each category of information is assigned a group number and a page number within the group. This coding appears on the left of the screen.

To call up news stories and other information for display on the CRT, the subscriber keys the appropriate code on the keyboard. The time the item was first transmitted appears in the right-hand column. Average waiting time is 2.5 seconds. The information is stored in a computer at Reuters, and is constantly updated and retransmitted. Cable companies will market the system in most U. S. areas and in Canada, first to commercial and financial organizations, then to home-TV viewers.

Memory

Fairchild schedules first CCD memories

Sample quantities of the first commercial charged-coupled-device memory will be available in a week or so from Fairchild Semiconductor. The Mountain View, Calif., company will introduce two types: a 9,216-bit serial storage memory, and, a few months later, a 16,384-bit Line-Addressable Random-Access Memory (Laram).

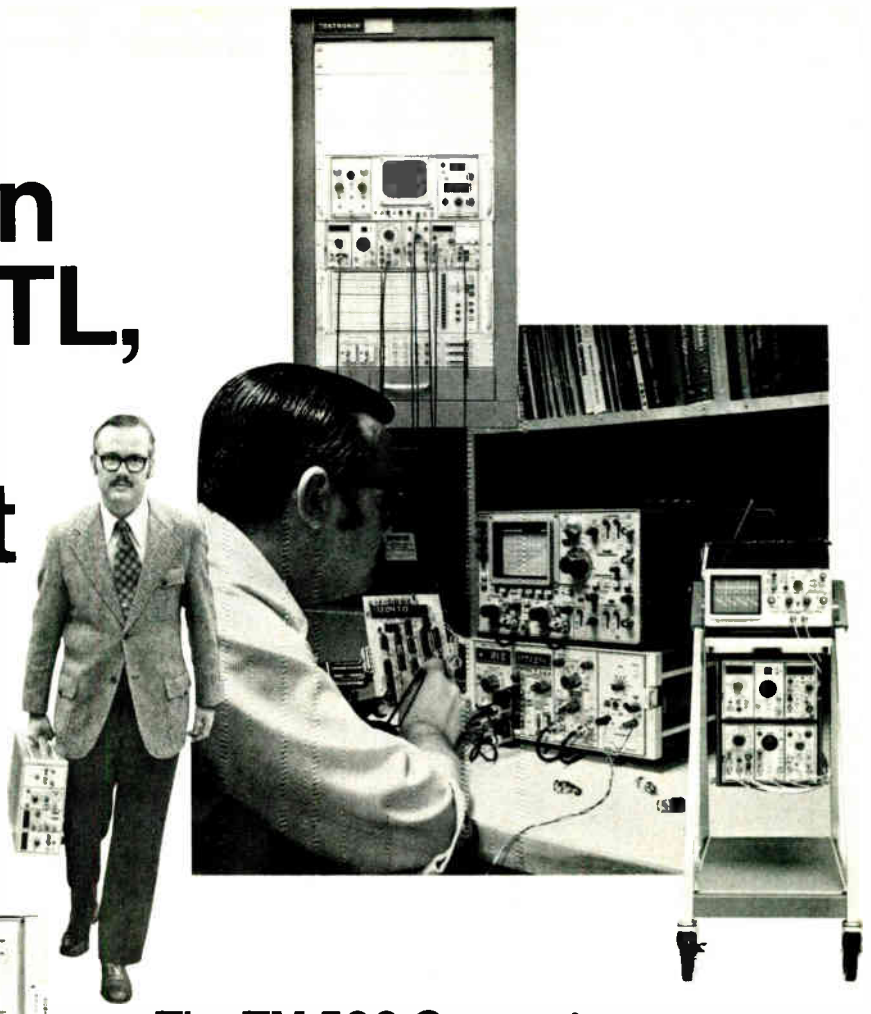
The 9,216-bit model CCD 450, has a 1,024-word by 9-bit configuration aimed at byte-organized applications such as terminal buffering, display-refresh, and data storage for microprocessor control. These applications are the kind usually performed by recirculating semiconductor shift registers.

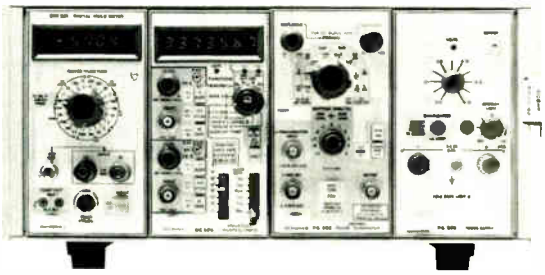
To do the same job with a CCD memory, Fairchild has organized the CCD 450 for fast data access into a serpentine loop structure of nine shift registers, each of which has 1,024 bits. Memory bits stored in the inversion regions—the potential wells under the depletion-biased electrodes—are passed along a series of memory loops during which each bit is refreshed by signal regeneration at the end of each loop. In the CCD 450, the memory cells are organized so that there are refresh turnaround cells every 128 bits. And since the registers are shifted in parallel, the 9-bit bytes are handled in a byte-serial mode.

James Early, director of research

If you design with ECL or TTL,

You need to know about Tektronix TM 500





If You're into High Speed Logic,

the Tektronix TM 500 High Speed Logic Instrumentation plus the Tektronix 485 Oscilloscope (350 MHz) or 475 Oscilloscope (200 MHz) provide all the instrumentation you need for TTL or ECL up to 250 MHz. The four plug-ins of the TM 500 High Speed Logic system are a PG 502 Pulse Generator ($1195) with 1 ns rise time and independently variable logic 1 and 0 levels . . . a DC 505 Digital Counter ($1395) with 10 ns single shot resolution and averaging to 100 ps . . . A DM 501 Digital Multimeter ($550) with temperature measurement capability added to all its conventional functions (so you can verify operating temperatures of logic IC's and detect hot spots in tightly packed circuitry) . . . and the PS 505 Power Supply ($175) with the 3.0 to 5.5 V dc high-current (4 A) output essential for breadboarding or testing TTL and ECL devices. Also, you can expand the capabilities of the system to provide jitter-free oscilloscope triggering for viewing any segment of long pulse sequences by including the DD 501 Digital Delay ($495). The 485 Oscilloscope features dual trace, 1 ns rise time, and delayed sweep.

Whatever Pursuit in Electronics You're Into, you should learn more about TM 500 instrumention. A particular group of plug-in modules in a four-hole mainframe provides the instruments most often needed in telecommunications, another fulfills the needs of industrial instrumentation calibration and troubleshooting, another for medical instrumentation, others for education, and so on.

The TM 500 Concept,

TM 500 is a growing, compatible family of 29 plug-in modular instruments, accessories, and one, three, and four-hole mainframes providing the common power supply. *It's multifunctional:* The plug-ins include 11 signal sources, 5 counters, 2 digital multimeters, 5 power supplies, 3 signal processors, 1 oscilloscope, 1 X-Y monitor and even a blank plug-in kit, so you can assemble the specialized circuits you require. *It's versatile:* You can select from general-purpose instruments, such as the DM 501 Multimeter, or highly specialized instruments such as the TG 501 Time Mark Generator. You can select a system of instruments exactly tailored to your needs. *It's synergistic:* The instruments can "work together" through a common interface circuit board, so your lab bench needn't be cluttered with interconnecting cables. *And it's neatly configurable:* The TM 501 (one), TM 503 (three), and TM 504 (four-compartment) mainframes are attractive and compact. Since the typical four-instrument system only weighs about 20 pounds, it can be hand-carried as easily as it goes onto a bench. The TM 504 ($225) is only 11" W x 6" H x 20" D. In rack mounting, each bay contains six instruments. And Tektronix SCOPE-MOBILE® carts let you put your entire instrumentation requirements on wheels.

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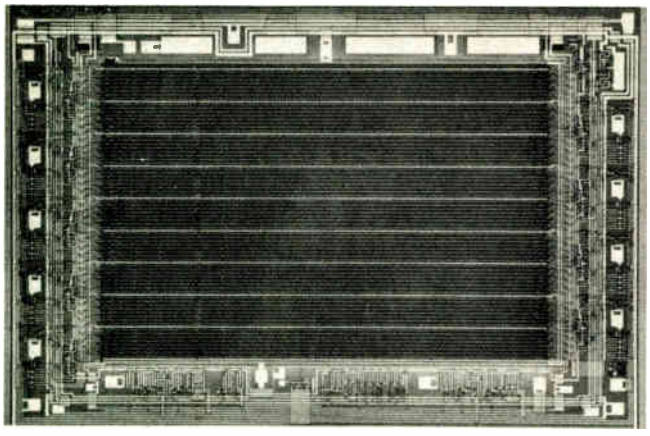

New model. Fairchild's nine-register 9,128-bit CCD memory has on-chip timing circuits (bottom, center) and fits an 18-pin package.

and development for the IC group at Fairchild, says, "We felt that the first such product had to be economical and easy to use. It had to be in a package and a pinout that was familiar, and have dissipation, access times and data rates similar to those in standard MOS packages." With this in mind, Fairchild put the 9,216-bit CCD into the familiar 18-pin dual in-line package of the model 1103 random-access memory. In addition to the nine CCD shift registers made with the company's self-aligned, gapless, buried-channel process, there are also isoplanar n-channel MOS circuits for charge-detection, timing and two-level conversion included on the chip.

What this gives the user, says Gilbert Amelio, director of the CCD group, is a read-access time to the first byte in the 70 to 100 nanosecond range. Worst-case access time to a bit is 330 microseconds; average time is 165 μs.

Impressive as this is, the 16,284-bit Laram is much more ambitious. Aimed at block-oriented, fast-access memory applications such as cache buffering, swapping stores and mainframes, it is structured in a line-accessed format that gives the user pseudorandom access. Its development was partially funded by the Avionics Laboratory at Wright-Patterson Air Force Base.

Composed of an MOS address-selection matrix and a number of CCD sequential shift registers, the device is organized somewhat like a RAM, except it addresses one register or line at a time, instead of a bit.

"This configuration allows an access time that is essentially dependent on the number of elements per line," Amelio says. In addition, since only one line is operative at any time, driving requirements and power dissipation are minimal.

Fabricated with the same processes used on the CCD 450, the 16-kilobit 220 by 200-mil Laram chip is configured into four sections of 32 lines of shift registers, and each line is 128 bits long. Each section has its own decoding matrix as well as recirculating loop and data-input/output circuits. It is packaged in a standard 22-pin DIP. At a 5-MHz data rate, it has a cycle time of 200 ns and a worst-case access time per bit of 25.6 μs and average access time of 12.8 μs. Power dissipation is 200 mW, which drops to 50 mW in the standby mode. □

Government

FAA selects scanning-beam MLS

After four years and some $50 million, a microwave scanning-beam technique for the next generation of instrument landing systems [*Electronics*, Oct. 31, 1974, p. 51] has been chosen by a special advisory group of the Federal Aviation Administration. The announcement was made a few days before Christmas after a vote by the advisory group on microwave landing systems composed of military, NASA, and FAA representatives.

The vote was nine-to-six with two abstentions, and it meant that industry teams headed by Texas Instruments, Dallas, and Bendix Communications division, Baltimore, will each receive as much as $15-million to build competitive prototypes. These will consist of 11 ground systems and 34 airborne packages. The FAA should begin to evaluate them in March 1976.

Formal contract signing will take place sometime before June 1975, when the FAA will present its views to the International Civilian Aviation Organization, which will be considering the design of a worldwide landing system of the 1980s.

The cost of installing and replacing ground and airborne instrument-landing equipment worldwide for commercial, general aviation and military use is estimated at roughly $1.5 billion. Thus, TI and Bendix have the inside track on an exceptionally large market. The scanning-beam approach employs narrow radar beams sent from the ground and signal processors in each aircraft to provide pilots with accurate elevation and angle-of-approach data with respect to an airport runway.

The TI and Bendix systems were chosen over doppler scanning systems proposed by teams headed by ITT's Gilfillan division, Van Nuys, Calif., and Hazeltine Corp., Greenlawn, N.Y. The $50 million spent thus far went for building and evaluating the preliminary designs.

More landings. Perhaps the biggest selling point for the new, C-band (about 4 to 6 gigahertz) landing system is that it will allow more planes to land in a given time than the very-high-frequency instrument landing system now being used. This is possible because the microwave system provides better position resolution for the aircraft, so that runways and aircraft can be spaced closer together. Moreover, planes can approach a runway from any point in a 120° arc, and at different descent angles. This means there is greater flexibility for flight paths to avoid unwanted noise over populated areas in the vicinity of an airport. With conventional ILS, only a single straight-in approach path

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REVIEW

JUNE
monday **17** 1974

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for small stand-alone systems

SEPTEMBER
monday **30** 1974

STATIC ROMS

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512×10	512×8
Single+5V supply	Single+5V supply

500 ns maximum Access Time

NOVEMBER
monday **4** 1974

256×4
STATIC RAM
WITH
ADDRESS/CHIP
SELECT LATCH
22PIN DIP
(RA-3-4256B)

minimum board space

DECEMBER
monday **2** 1974

16K
STATIC ROM
4K×4
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Select Latch

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PREVIEW

coming early in **1975**

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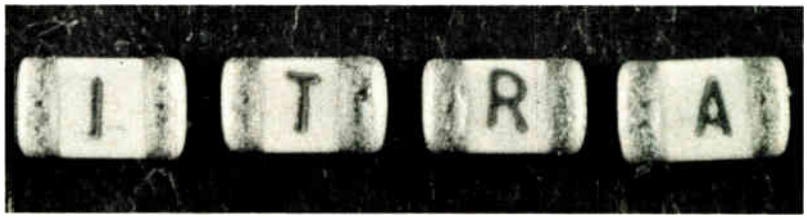
along the length of the runway is permitted, at a single, 3°-angle of descent.

Cost was a significant factor in deciding in favor of the scanning-beam system. The higher-frequency Ku-band (about 15 to 17 GHz) doppler scanning system would have required more expensive ground transmitters. And FAA's cost studies indicated that a scanning beam system for most airports would be about 12% to 15% cheaper.

For a while, it appeared that the doppler scanning approach, which is favored by the British, for example, was in the lead. But then a switch by scanning-beam advocates to a time-reference signal format perfected by Australian landing-system designers from a frequency-reference format [*Electronics*, Nov. 14, 1974, p. 49], promised improvements in cost, complexity and reliability. This seemed a factor in tipping the choice the other way.

Preliminary FAA estimates are that about 1,300 American airports could use the new landing system, which would cost more than $110,000 each. And 20 more of the largest airports, such as New York's Kennedy and Chicago's O'Hare, would need systems costing as much as $800,000 each. The price of the airborne processor packages, it is estimated, would begin at about $1,500. □

Color-coding comes to chip capacitors



For the most part, all tiny chip capacitors look alike. But chips of the same size can have different capacitance values, as well as different tolerances. And if accidentally mixed together, as can easily happen on the production floor or in the stock room, there is no simple way to sort them without measuring the capacitance of every chip.

Vitramon Inc., a manufacturer of chip capacitors in Bridgeport, Conn., has, however, developed a way to mark its devices, similar to the technique used on ordinary carbon-composition resistor bodies. Parts as small as 0.08 inch by 0.05 in. by 0.05 in. and ranging in value from 1 picofarad to 0.91 microfarad can be labeled. One of 24 letters is printed on each chip in one of six colors. The colored inks are chemically stable, as well as resistant to solvents, and can withstand soldering temperatures.

The letter designation represents the unit capacitance value, while the color acts as the multiplier. The colors are orange (× 0.1), black (× 1.0) green (× 10), blue (× 100), violet (× 1,000), and red (× 10,000). If the letter A, which represents 10 units of capacitance, is printed in black, the chip's value is 10 pF.

Air-traffic control

Air Force joins FAA in air surveillance

For the first time, the Air Force and the Federal Aviation Administration will share facilities for air-surveillance and en-route air-traffic-control. The peace-time surveillance function of the Air Force's SAGE (Semi-Automatic Ground Environment) system, which was developed in the 1950s, will be replaced by a Joint Surveillance System (JSS), to begin operation by 1980.

Requests for proposals to build the system will be issued this spring by the Electronics Systems division at Hanscom Air Force Base, Mass. SAGE's wartime surveillance functions will then be taken over by the Airborne Warning and Control System (Awacs). And when both JSS and Awacs become operational, SAGE will be phased out. The program is fully funded now for four ROCCs (Regional Operational Control Centers), to be increased to five in calendar 1975.

Like SAGE, JSS will consist of search and height-finding radars positioned around the perimeter of the continental U.S. to detect intrusions in the U.S. air-defense zones. Data will be forwarded in digital form from the radar sites to the ROCCs, where it will be displayed and correlated with information already on hand concerning flights. As today, when an unidentified aircraft turns up, Air Force interceptors will be sent to make an identification. All data except that from the height-finder radars will be sent from the radar sites to the FAA's en-route-traffic-control centers, where it will be used for aircraft identity and altitude control, as well as separation of aircraft flight paths.

Savings. The Air Force first broached the idea of JSS as a means of saving money. Current SAGE operating costs are about $130 million a year. But by sharing radar maintenance and personnel with the FAA, Air Force maintenance costs for JSS will, it is estimated, be reduced to about $35 million a year.

Col. Stephen J. Vogel, program director at the Electronics Systems division, says much of the reduction will result from fewer personnel. Each manually operated SAGE radar site requires 75 to 200 people, but a typical automated JSS radar site will need only about 20. Thus, the number of Air Force personnel needed will decline from about 8,000 for SAGE to about 1,400 for JSS.

The cost will be about $150 million to set up a system of 48 radar sites and 4 ROCCs. Col. Vogel says refurbished equipment will be used wherever possible. This will include radars, height-finders, and data-processing equipment for data reduction at the radar sites, communications equipment, and the data-

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processing equipment for the ROCCs. Included, for instance, will be SAGE radars such as the FPS-6 and FPS-90. And the Air Force may refurbish existing radar towers rather than build new ones.

For the communications lines that carry information from the radar sites to the ROCCs, the Air Force is evaluating options to buy or lease. And the ROCCs may use updated BUIC (Back-Up Interceptor Control) data-processing equipment, if it appears practical. BUIC is the SAGE regional command back-up system, which uses Burroughs Corp.'s GSA-51 computer system.

Only the radar sites will be jointly operated by the Air Force and the FAA. Of the 48 sites, 42 will be retained at existing FAA locations or at Air Defense Command bases to be turned over to the FAA. The six other radar sites will be at Air Defense Command bases in areas where the FAA has no need for information. Since these installations are for peace-time use, they won't be hardened against nuclear attack, which will also save money. The four ROCCs operated by the Air Force will replace the present six SAGE regional command centers. Sites for the ROCCs have not yet been determined.

In addition, the Alaskan Air Command may join JSS with 14 radar sites and one ROCC. Canada has also expressed an interest; if it joins it would have 40 radar sites feeding two ROCCs. Because Alaska and Canada have slightly different requirements, Col. Vogel hopes to have a modular ROCC system to allow as much standardization as possible. □

News briefs

IEEE offers advice on ethics of fired BART engineers

In an unprecedented move, the IEEE has volunteered as a friend of the court in the case of H.I. Hjortsvang and two of his colleagues against the San Francisco Bay Area Rapid Transit District, now in litigation in the Superior Court of the State of California. The judge is considering the move.

This opens the way for the institute to define the ethical practices of EEs, similar to the way lawyer and physician organizations speak for their professions.

In the BART case, the engineers are contending they should not have been fired for having complained to the transit district's board of directors about the safety of some systems designs. Their complaint was ethical practice, they say. BART officials fired them ostensibly because they took their complaint outside the organization's set chain of command.

IEEE's board voted to enter the case as a friend of the court in order to provide guidance on professional practices that the court could not evaluate in strictly legal terms. As such, the institute is now in a position to speak for the profession as an aid to the courts should other cases involving the ethics of EEs arise.

Watch module manufacturer acquires GaP technology

Integrated Display Systems Inc., Montgomeryville, Pa., jointly owned by General Electric Co. and Solid State Scientific Inc., has acquired AVX Corp.'s Opcoa division, a manufacturer of light emitting diodes and segmented displays. The acquisition gives IDS a leg up in gallium phosphide LED technology, an Opcoa specialty and considered more efficient at low currents than IDS's own gallium arsenide phosphide LED. Presumably, IDS, which had been organized to build digital watch modules, will now be able to turn out a larger LED digital watch display without taxing the battery.

Electronic Components Conference moving to San Francisco

The Electronic Components Conference, an annual fixture in Washington, D.C. each May, will be moved to San Francisco in 1976. Sponsored by IEEE and the Electronic Industries Association, the conference and its associated exhibits, will then move back East in 1977 and 1978 to a site in the Arlington, Va. area.

Ricoh takes over at Rapifax

Ricoh Co. of Japan has all but bought out its two partners—CBS Inc. and Savin Business Machines—in their Rapifax Corp. venture. Initially, Ricoh owned more than half of the Valhalla, N.Y.-based high-speed facsimile company's stock. Now it holds in excess of 90%. Ricoh has also installed a new president at Rapifax, Seifu Hirakawa, who also retains his position as president of Ricoh of America Inc., Fairfield, N.J. Hirakawa succeeds Edward Saxe, a former CBS executive.

Grumman to add countermeasures to F-111

The Air Force has selected Grumman Aerospace Corp., Bethpage, N.Y., to convert two F-111A fighter-bombers into electronic-warfare planes capable of jamming enemy radar systems. Grumman beat out the F-111's builder, General Dynamics Corp., for the award. The company will essentially modify equipment it has already built for the Navy's jamming aircraft, the EA-6B. However, instead of operating with a three-man crew, the equipment on the Air Force craft will be operated by one man. The equipment will consist of the ALQ-99A tactical jammer, for which Raytheon Co., Santa Barbara, Calif., will supply the active components, and AIL division, Cutler-Hammer Inc., Deer Park, N.Y., the passive. The prototype craft, to be known as the EF-111A, will accompany strike planes on combat missions to protect them from anti-aircraft-missile radar systems. Jamming equipment now is carried by the Air Force's EB-66, an aircraft deemed too slow for the intended mission. Robert C. Miller, a Grumman vice president and program director on the EA-6B will oversee the effort on the Air Force plane.

C-MOS/Darlingtons serve phone relays

By paying close attention to circuit layout and using some clever design tricks, National Semiconductor Corp. engineers have built high-

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■ All basic M6800 family devices operate from a single +5 V supply. Easy on costs, easy on the system. ■ Single bus architecture encourages ease of system expansion. ■ Word-oriented family RAMs and ROMs are specifically designed for microprocessors, yet other popular memories fit in easily and Motorola also offers a line of compatible memory interface devices. ■ The family features a set of programmable logic peripherals for I/O task management, a true set of building blocks designed for optimum parts count regardless of system application. Typical of this approach is the MC6820, a unique Peripheral Interface Adapter which greatly simplifies I/O interface. ■ The M6800 family provides a great new look in data communications systems with its programmable logic Communications Interface Adapters, MODEMs, and an MC6800 MPU instruction set designed for efficient execution of data communications.

All this and more. The M6800 total product approach goes beyond the devices to provide complete support as well. M6800 support software presently is available on G. E. Time-sharing and several alternative offerings are currently nearing availability. ■ Support hardware requirements are fulfilled with the M6800 Evaluation Module and the M6800 EXORciser systems development tool. ■ Documentation is comprehensive, with manuals and handbooks to cover every angle. ■ Educational programs, produced both in Phoenix and selected locations around the U. S. throughout the year, provide all the individual assistance anyone needs to start designing with the M6800 family for microcomputer systems.

Designers the world over are discovering that microprocessor programmable logic, applied in microcomputer systems, is the solution to a myriad of vexing problems. Discover, with them, the exciting advantages of Motorola's M6800 total systems approach. Write to Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, AZ 85036, or circle the reader service number for a special packet of M6800 family information. When you're ready to start design-in, call your Motorola Sales Office for prompt, professional guidance.

MOTOROLA M6800

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voltage dual-relay drivers combining the low-input-current characteristics of complementary-metal-oxide semiconductors with the high-output currents of bipolar Darlington pairs. Designated the 74C908/918, the C-MOS/Darlington driver will be the first of a series of integrated-circuit parts aimed at cracking the lucrative telecommunications market [*Electronics,* Dec. 12, p. 29].

In the past, because of the need for high-voltage breakdown (30 to 60 volts) and relatively high output currents, most high-power driving jobs have been handled by bipolar transistor-transistor logic or discrete devices. But by combining two C-MOS NAND gates and an emitter-follower Darlington pair on the same 72-by-83-mil monolithic chip, the Santa Clara, Calif., company has devices combining low power input with high output.

Layout. National's method of boosting the C-MOS breakdown voltages sounds simple: particularly careful attention is paid to laying out the C-MOS transistors in relation to the Darlingtons.

"When you put bipolar outputs on the same chip as a C-MOS circuit, the key thing you have to watch for is substrate currents," says Clark Davis, C-MOS design manager. "If you don't lay it out properly, you are just making a device that will latch up.

"To avoid this, you must be careful where these substrate currents flow. You have to make sure that the currents flow into areas where they don't hurt anything."

Parts are fabricated with the standard p^+ diffusion technique, says Davis. Output source currents for the 30- to 60-volt breakdown parts range between 250 and 350 milliamperes. But most importantly, they are said to have essentially zero standby power. Standard parts will be specified at 30 volts.

Prime parts designated for use as high-voltage telephone-relay drivers will be specified at about a 56-v breakdown and packaged in a 14-lead 2.5-watt configuration. "One of the more obvious advantages of such a device will be its usefulness in interfacing normal C-MOS voltage levels to higher-power driving relays," says Davis. "But one of its big claims to fame will be in such applications as sitting out on a telephone line, drawing no more than a little leakage current, until something happens. By contrast, bipolar telephone-relay drivers, even on standby, draw 10 to 20 milliamperes."

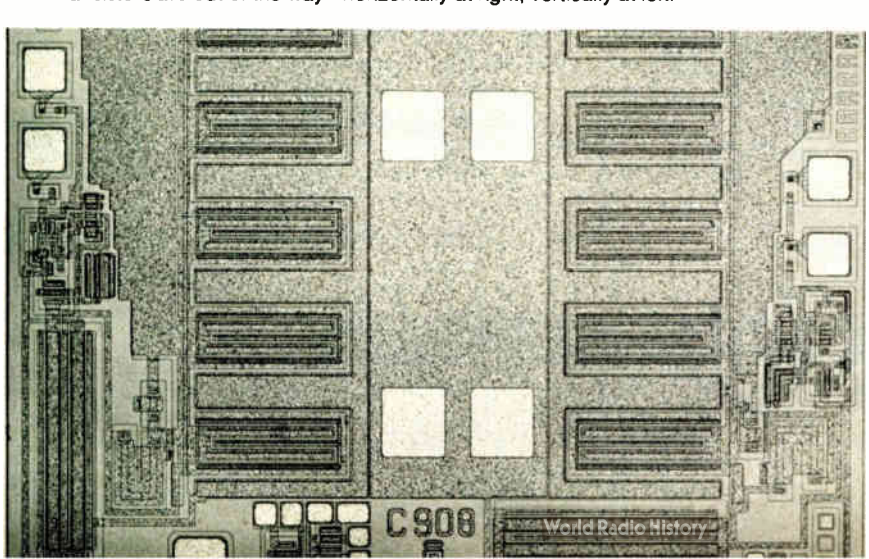
National is also able to build units with higher-voltage breakdowns by using a p^- well. "The problem you run into in the normal configurations," Davis says, "is that even though your p^- source and drain diffusions have a breakdown range of 70 to 80 v, you get a field-plated breakdown of a much lower value when you put a metal gate over the thin oxide atop the junction."

The field-plated breakdown is even more exaggerated when there is a relatively shallow, sharp curvature on the junction. On the other hand, when the device has a very graded and very deep junction, the breakdown phenomenon is nowhere near as severe.

"Using the p^- well, a very light p^- is driven 8 to 10 microns in depth before the n^+ diffusion is laid down to build up the n-channel transistor [of the Darlington pair]," says Davis. This results in a very deep, graded junction with breakdowns on the order of 60 to 80 volts.

The one big disadvantage is that this technique yields a relatively large transistor with low gain, says Bob Bennett, C-MOS/MOS product marketing manager. "But if I'm driving relays, I'm not looking for speed," Bennett says. "What is needed more than anything else is voltage and current." □

Layout. To avoid latch-up due to high substrate currents from Darlington pairs (center), C-MOS transistors are out of the way—horizontally at right, vertically at left.



Solid state

Thyristor boosts modulator power

A prototype high-power modulator thyristor looks as if it will economically boost the power levels of semiconductor modulator devices. The p-i-n type thyristor, basically a trigger for an output tube, was developed by General Electric Co.'s Hirst Research Center and the Royal Radar Establishment.

The prototype was developed by David E. Crees, Hirst's manager of the power-device design center and his RRE colleagues, N.S. Nicholls and Frederick Wood. Besides such military applications as medium- and high-power radar, the device also has a potential for the growing market for semiconductors in mass-transit traction motors.

Although the p-i-n thyristor has considerably higher efficiency and switching speeds than conventional thyristors, the researchers say it does not require protection from inverse voltage, which might be obtained by integrating an extra diode. The p-i-n device compares quite favorably

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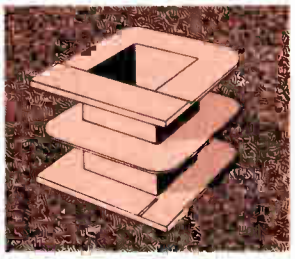
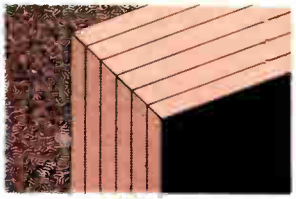


Special "split" bobbin (secondary wound alongside primary rather than over it) effectively isolates primary and secondary and reduces inter-winding capacitance. An electro-static shield is not required in all but the most sensitive applications. Hipot rating of 2500V RMS is standard. Bobbin winding technique affords a 40-50% savings in winding space over conventional layer winding. "Split" bobbin eliminates the need for inter-winding insulation and cross-over of primary and secondary leads.

Grain-oriented steel core is used at higher saturation flux densities and results in about a 40% reduction in turns required. Although the cost per lb. of grain-oriented steel is higher than that for ordinary silicon steels, the net cost is less, since less core weight is required and a significant reduction is made in copper weight.



Terminals, which are wedged into the bobbin wall, are designed so that they can be used as solder lugs or as 0.187" quick-connect types. Lead slots are incorporated in the bobbin wall leading to the terminals. It is not necessary to tape the start lead since it comes to the top of the coil through the slot and is thus separated from the winding. Separate lead wires or terminal boards and the extra assembly time to use them are eliminated.

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Electronics review

with such standbys as deuterium thyratrons, reverse-blocking thyristors, and reverse-switching rectifiers. The developers acknowledge, however, that the device, which is epitaxially complex, is not likely to replace the well-established thyratron until it has been proved reliable in operation.

Gaining power. Semiconductor modulator devices, such as thyristors, haven't had much success in medium- and high-power radar applications because it's been too expensive to serially connect the numerous devices required. But the researchers discovered that by adding an n^+ and a p^+ layer and changing the bevel of the solid-state structure, they had developed an efficient, economical device.

The researchers began by applying interdigitated gate-cathode geometry to a conventional npnp thick high-voltage vertical structure. Development led them to the npn n+–p, p-i-n structure, but the 50° positive bevel of the forward pn junction limited the blocking voltage from 1.3 kilovolts to 1.5 kV. Later, they negatively beveled the junctions at 2.5° to 3°, and the blocking voltage shot up to 2 kV after passification of the beveled surface with silicone rubber.

The resulting structure is an npn n+–p device fabricated with a 120 ohm-centimeter n^- base region 220 to 250 micrometers thick and a 10-μm epitaxial n^+ layer. Further, a p^+ epitaxial layer 40 μm thick forms the anode's p-emitter junction. The structure, which has a center amplifying gate, achieves a 2-kV blocking voltage with a capability of a trapezoidal 30-microsecond pulse of 1,000 amperes at a pulse repetition frequency of 330 pulses per second.

Efficiency. Deuterium thyratrons, reverse-blocking thyristors and reverse-switching rectifiers have total power losses of 160 W each, while the p-i-n device loses only 45 W. Power-operating voltages, respectively, are 20 kilovolts, 2 kV, 2.2 kV, and, for the p-i-n device, 2 kV. Operating currents, respectively, are 0.1 kiloamperes, 1 kA, 0.9 kA and, for the p-i-n device, 1 kA. □

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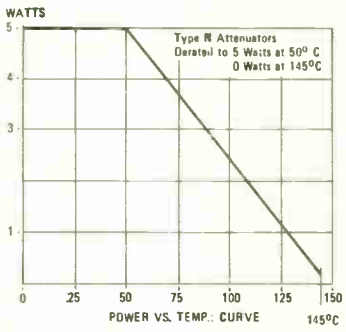

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Circle 41 on reader service card

News update

12 companies reply to call for scanner At the end of 1973, the National Science Foundation launched a $3 million experiment designed to come up with a prototype ultrasonic medical scanner. But the project had a bigger goal: to find out how companies can be induced to develop and market new technology with minimal Government intervention and funding [Dec. 20, 1973, p. 31]. The results are in, and officials of NSF say, "We are pleasantly surprised by the turnout." A total of 12 companies responded to the request, with about 20 attending a briefing that preceded a sign-up session. The 12 are Actron Industries Inc., Baird-Atomic Inc., Beckman Instruments Inc., Diagnostic Electronics Corp., Grumman Aerospace Corp.'s Health Systems division, Picker Corp., Litton Medical Products' Profexray division, RCA Laboratories, Rohé Scientific Corp., and Smith-Kline Instruments Inc. They are to submit prototype scanners by April 1977, with clinical testing to begin by April 1978.

Dogfight practice-ranges popping up all over Navy fighter pilots are allowed to fire only one live missile a year in air-combat training because they're so expensive. This has caused some concern about training methods for dogfights, methods that haven't changed much since the days of World War II. And when officials looked at the low kill ratios coming out of the Vietnam war, they decided that something had to be done. The something, it turned out, was the Air Combat Maneuvering Range (ACMR) developed by Cubic Corp. of San Diego, Calif., and delivered to the Navy about 16 months ago [Aug. 16, 1973, p. 33]. The system provides real-time monitoring and control of fighters maneuvering in dogfights while recording the action for playback to the pilots, and it seems to have passed its test with flying colors. Now that the Navy and Marine Corps are using their range—operated jointly for them at Miramar, Calif., and Yuma, Ariz.—the Air Force has ordered its own range. Due to become operational in December, it will be located near Nellis Air Force Base, Las Vegas, Nev. A second range for the Navy, to be operational by February 1976, has been ordered for the Naval Air Station at Oceana, Va.

Tight money holds up monolithic chip inductor "We have a tremendous interest" in the so-called Magna Chip monolithic chip inductor, says Joseph Lucia, marketing director of San Fernando Electric Manufacturing Co. in San Fernando, Calif. "The problem is that we're not in a position to allocate resources necessary to buy the equipment and begin to mass-produce it to bring the price down. We're kind of chasing our tail on it." Which is to say that the company finds itself in a position that is becoming more and more common these cash-short days: it has a potentially hot new product that it can't launch. In the case of San Fernando, the device, formed from a stack of U-shaped conductor patterns screened on a ferrite tape, is said to solve the materials problems inherent in tiny wound coils [March 15, 1973, p. 30]. Not only that, but Magna Chip can achieve inductances three orders of magnitude greater than present screened inductors, says the company. "We've made some small sales," says Lucia, "but nothing of any significance. A lot of people are playing around with samples—trying them on circuits." These users, Lucia reports, "all liked them, and we had no feedback that people had problems in using them." **—Howard Wolff**

Intended to bring *Electronics* readers up to date on news stories of the past months.

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BHmax (MGO)	1.05	2.5	2.5	3.5	2.8	3.5
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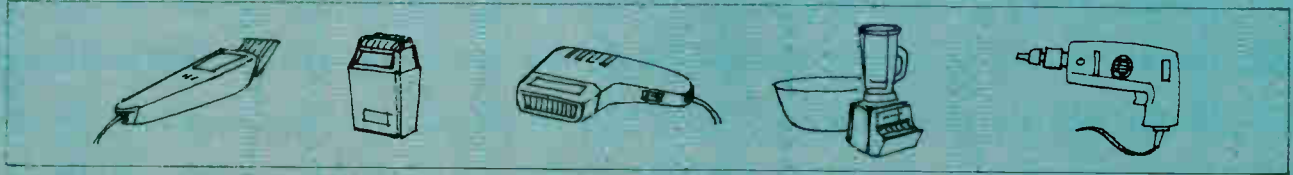

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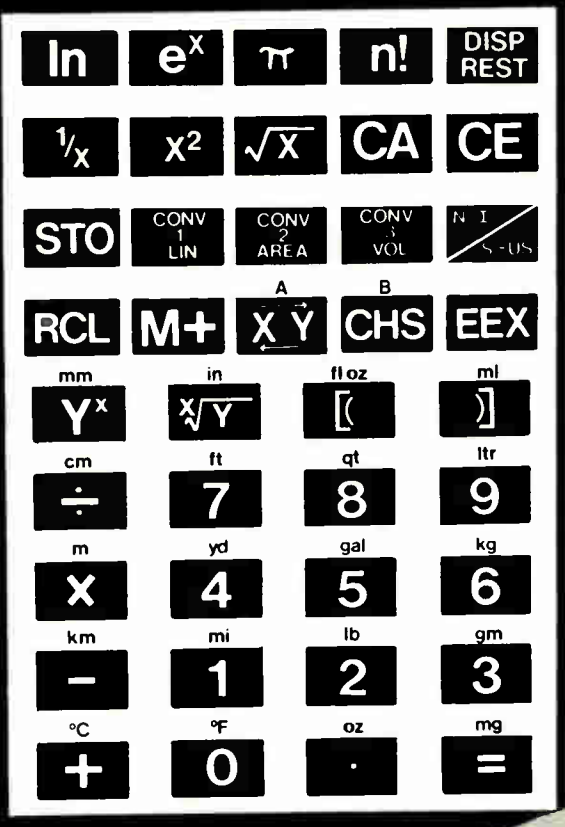

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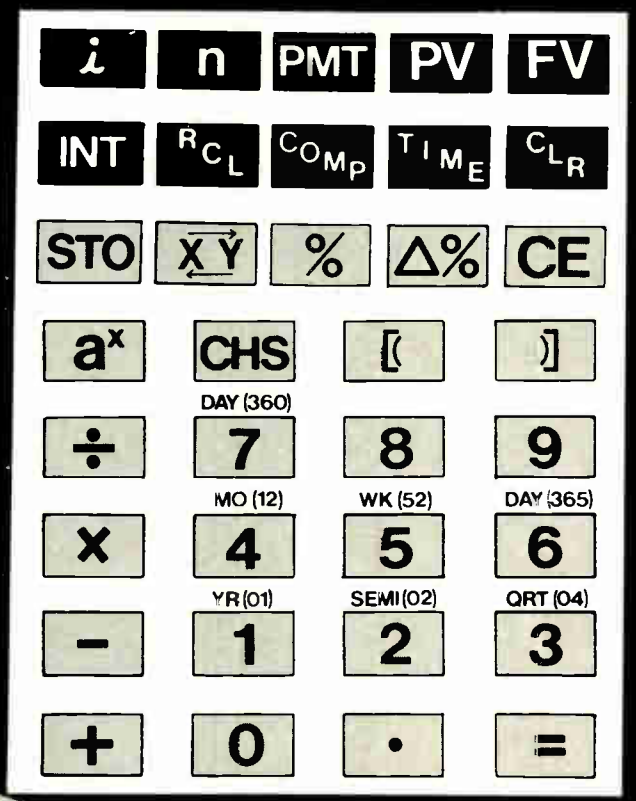

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YIELD

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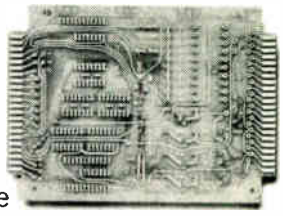

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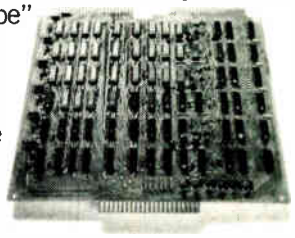

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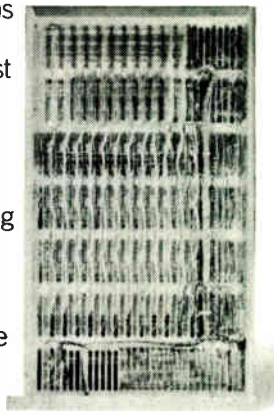

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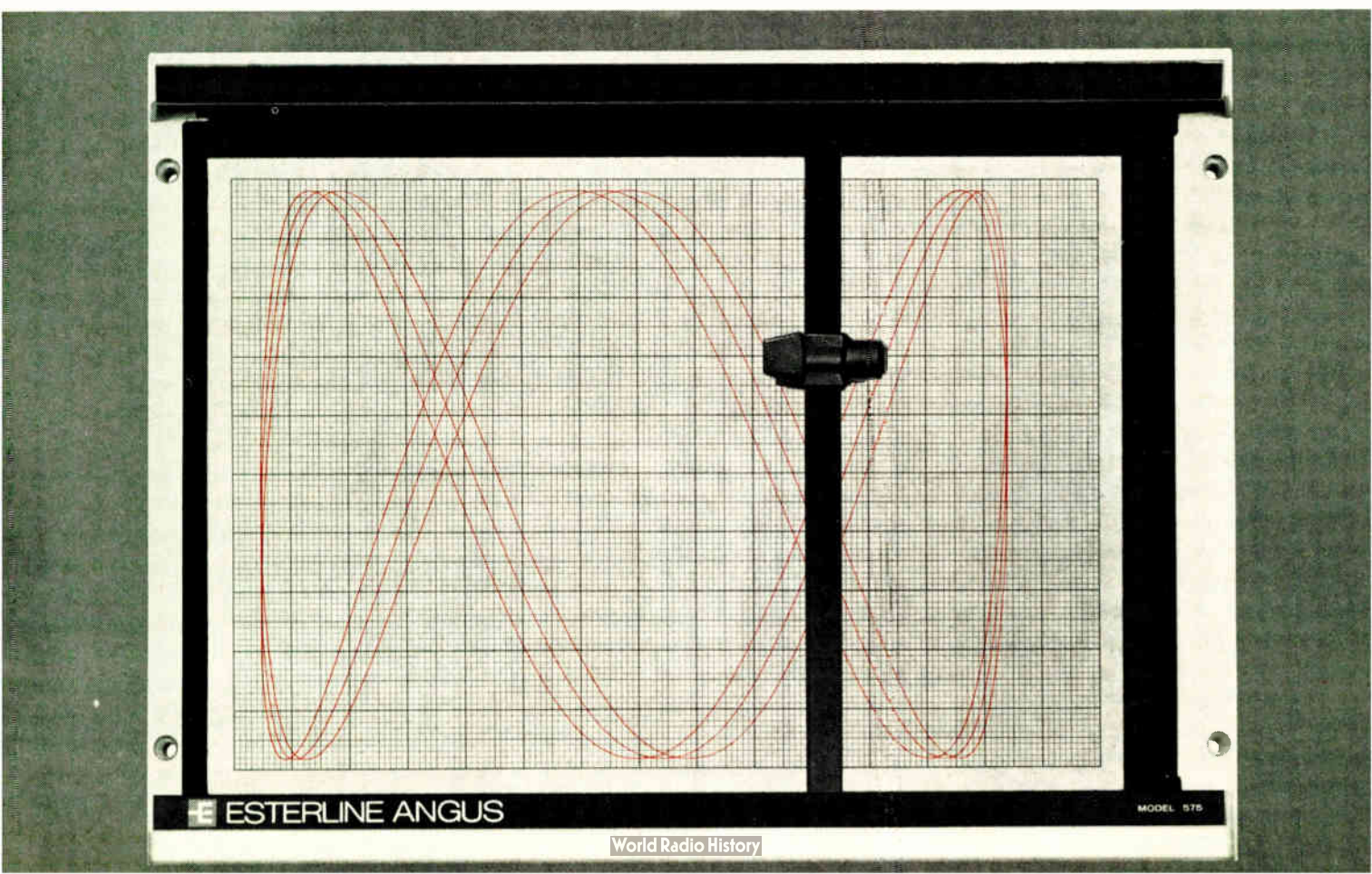

Washington newsletter

FAA predicts big year for planes, then a downturn

The Federal Aviation Administration says that **1975 will be the biggest year since 1966 for civilian aircraft makers, but after that it's all downhill.** The FAA's forecast of production from 1975 to 1981 indicates that electronics companies will have fewer new aircraft as vehicles for their hardware in the future. **General aviation aircraft production will peak at 15,000 planes next year** and then stabilize at an annual production rate of about 13,000 in 1978. Approximately 15,750 planes were produced in 1966, general aviation's best year. Commercial transports also will experience a downturn, going from 307 units in 1974 to 280 in 1981. The Aerospace Industries Association, furthermore, is even more optimistic in its 1975 projection, predicting a growth of general aviation production to 18,000 units.

In Washington, the minicomputer makes inroads

The growth of the minicomputer is beginning to show up strongly in one of IBM's traditionally big markets: the Federal Government. Although IBM is still the dollar leader, the Digital Equipment Corp. is now running neck and neck with Sperry Rand's Univac division for the lead in unit sales, according to recent Government reports. What's more, **about half of the 1,099 machines purchased or leased by Washington agencies in the last two years have been from DEC.** Its market share in 1970 was only 9.5%.

By the end of the 1974 fiscal year, DEC's share of the Government's computer inventory was 1,393 machines, 17.8% of the total, compared to Univac's 17.9% share, based on 1,400 units. **IBM's share of the total units has dropped to 1,363 from a 1972 high of 1,429,** according to the General Services Administration. IBM had 26.4% of the market in 1972, but has dropped to 17.4%. The Government currently owns and leases more than 7,830 machines, up from 6,731 in fiscal 1972. IBM, however, retained the largest share of the dollars—approximately 26% of the $3.8 billion inventory. Control Data Corp. ranks second, with approximately 20% of the total. DEC only netted about 5% of the dollars.

Airlines ready buying plans for terrain-alert systems

The major commercial airlines are expected to begin ordering ground-proximity warning systems after a Jan. 15 meeting convenes in Washington to discuss congressional and public pressure, according to aviation sources. The FAA has ordered the nation's commercial carriers to install the system, which warns a pilot that his plane is getting too close to terrain. The crash of a TWA Boeing 727 near Washington in November triggered the FAA's decision to require that the audio warning units be installed by December of this year instead of mid-1976, the original deadline [*Electronics*, Dec. 26, 1974, p. 30].

Two firms offer the systems: Sundstrand Data Control Inc., Redmond, Wash., and Bendix Avionics division, Ft. Lauderdale, Fla. So far, Bendix has received just one "verbal commitment" from a "small" carrier for fleet retrofit. "We expect a lot of major commitments to be made after that meeting, though," says a Bendix official. Domestic airlines—except Pan Am and Braniff—have refused to buy the system from Sundstrand, saying that they want to improve on its design.

Bendix has priced its system at between $4,000 and $6,000, depend-

ing on features—undercutting Sundstrand's $6,500 price. Both companies expect to sell similar units for other aircraft after outfitting the 2,300-jet commercial fleet before the FAA's Dec. 1, 1975 deadline.

Air Force eyes improved radars, training packages

A late-December shopping list issued by three Air Force laboratories **is heavy on radar and instrument-design needs.** A mini-radar for remotely piloted vehicles is being sought by the Air Force Research and Development division at Wright-Patterson Air Force Base. And the Special Weapons Center at Kirtland Air Force Base is looking for an airborne instrumentation system, adapting existing instrument-panel designs to modular growth in flight-simulation applications.

But the big plum **is a tracking and display system sought by the Flight Test Center at Edwards Air Force Base.** The high-accuracy system, based on using a number of radars to locate coordinates, **must be capable of tracking up to 40 targets simultaneously, at speeds up to Mach 4 and altitudes up to 60,000 feet.** While tracking planes at speeds of between 2,400 and 3,000 miles per hour, the system must be accurate to 4.5 meters for X and Y coordinates and 6 meters for Z, with processing by dedicated computers. Three CRTs and a 6-foot-square display screen will be Air Force options.

Device is sought to detect artery hardening

Medical electronic companies have until March 4 to send proposals to the National Heart and Lung Institute for a recently announced **multimillion-dollar project to develop a new instrument to detect and measure hardened arteries.** The new device will be able to detect thickened arteries without puncturing the skin. Technological improvement in existing systems, such as experimental ultrasonic scanners, are the first priority of the R&D project.

Medium-size banks look at funds transfer after Federal ruling

Banks are already reacting to the Dec. 12 rulemaking announcement by the U.S. Comptroller of the Currency that would **permit national banks to install electronic funds-transfer terminals in point-of-sale locations, such as supermarkets.** IBM says that it has received a 20% increase in bank inquiries concerning the terminal systems. Significantly, the increase comes from medium-size banks.

The big cloud on the horizon, though, comes from the Independent Bankers Association of America and some state banking commissioners, who have threatened to sue over the decision. They say the decision would doom the small banks, which cannot afford systems costing $300,000 and up. Some congressmen have indicated that they will seek legislation to postpone adoption of the ruling until a national commission report is submitted in 1976 [*Electronics*, Nov. 28, 1974, p.75].

FCC sales ban is aimed at improving citizens' band radio

Recently announced Federal Communications Commission prohibitions on linear amplifier sales for citizens band radios should give a boost to the $150 million industry and increase electronics company revenues, according to the Electronics Industries Association. **This step and stronger enforcement of FCC rules will clean up the airwaves** and thereby encourage serious users, says an EIA official.

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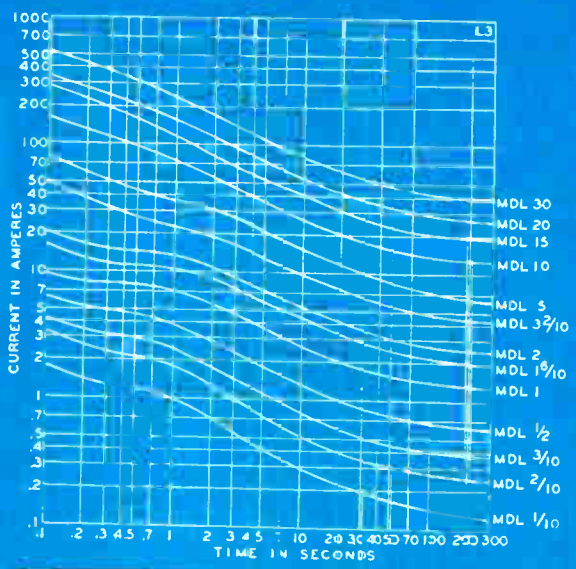
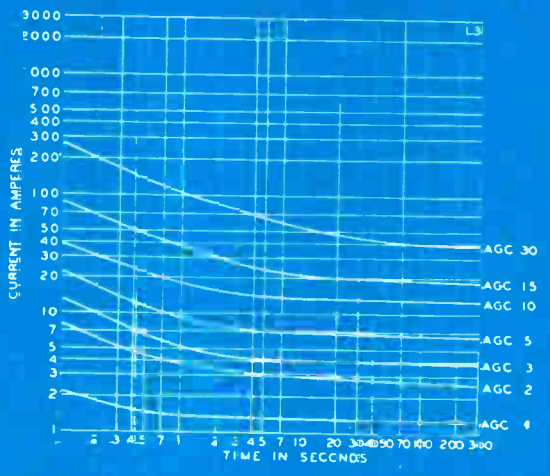


Time-current characteristics of BUSS® fast-acting fuses



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Voltage	Symbol	Amperes
250 or less	MDL	1/100, 1/32, 1/16, 1/10, 1/8, 15/100, 175/1000, 3/16, 2/10, 1/4, 3/10, 3/8, 4/10, 1/2, 6/10, 7/10, 3/4, 8/10 or 1
250 or less	MDX	1-1/4, 1-1/2, 1-6/10, 1-8/10 or 2
125 or less	MDL	1-2/10, 1-1/4, 1-1/2, 1-6/10, 2, 2-1/2, or 2-8/10
125 or less	MDX	3, 3-2/10, 4, 5, 6-1/4 or 7
32 or less	MDL	3, 3-2/10, 4, 5, 6-1/4, 8, 10, 15, 20, 25 or 30

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250 or less	MGB	1/16 or 1/8
		MBW & MBB fuses now called AGC.
250 or less	AGC	2-1/2, 3
250 or less	MTH	4, 5 or 6
		For 250 volt fuses above 6 amperes—See ABC fuses.
125 or less	GLH	7, 8 or 10
32 or less	AGC	4, 5, 6, 7, 7-1/2, 8, 10, 15, 20, 25 or 30

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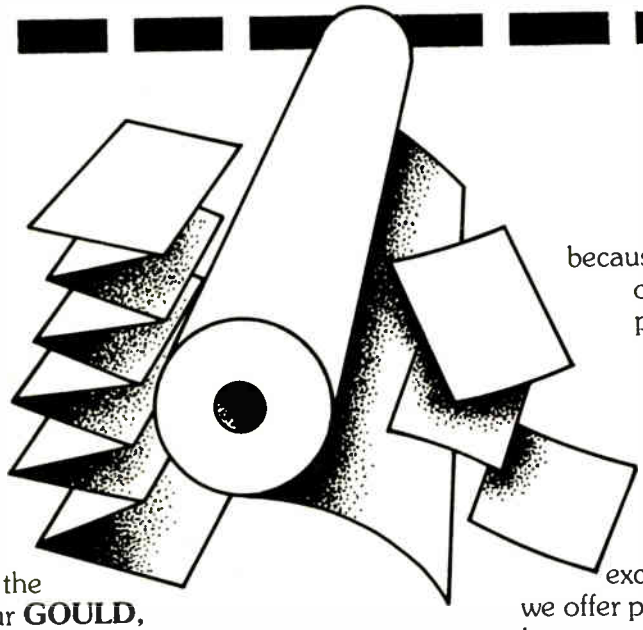

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Microprocessor halves processing cost in EEC's Camac measurement system

A new microprocessor module that can replace a minicomputer and interfacing can halve the cost of data processing in the European Economic Community's Camac (computer-aided measurement and control) system. The research team at the French Commissariat à l'Energie Atomique (CEA) that developed the JCAM-10 microprocessor module is negotiating manufacturing licenses with several firms in France for commercial production, but the laboratory is accepting small orders now and developing the software.

The JCAM-10, built around the Intel 8080 chip, has instruction speed of 4 microseconds, triple the speed of a computer using the standard Camac interface, and read-write speed is 8 μs, six times as fast as a Camac-interfaced system. The module, tentatively priced at $6,500 with 7,000 8-bit words of memory and interface can be matched to an add-on memory with a capacity of 49,152 8-bit words.

Pierre Gallice, the engineer in charge of development, claims that the JCAM-10 can process data from 24 modules loaded into two standard Camac racks. "It gives us the power of a minicomputer on one chip," Gallice says. In fact, the largest Camac configurations go up to seven racks holding as many as 24 modules each. For that sort of work, something like a Digital Equipment Corp. PDP-11 is called for, he says.

Pricing. Price comparisons, too, put the microprocessor module out front. Gallice and his team have just finished their first complete unit, and costing procedures are still under way. The price tag is likely to be about $6,500. Even if the price creeps up another 20%, the module will still be cheaper than a comparable minicomputer, which, together with its $3,000 or more interface could cost as much as $13,000. Even the latest in French microcomputers, the Micral S, would cost up to $8,350 with interface included, Gallice calculates. He says the module will reduce data-processing costs by as much as 50%.

As with most data processing, the really hard work comes in the software. And Gallice is claiming no wonders for JCAM-10. His team is just starting to work out a development program for Camac software now. He estimates it will be another year before the module reaches the stage where the end user has only to plug his fully programed Camac rack into his plant, laboratory, or hospital test system with little or no extra work on software problems.

Gallice has another good reason for helping Camac on its way to new fields. He is the French representative on one of the Camac committees in Brussels that have now brought the number of standard instruments up to 1,000.

U.S. companies like Aluminum Company of America, Westinghouse, and General Motors are already trying out the industrial potential of Camac. □

Around the world

Japanese build phone keyboard on substrate

A monolithic tone-keying telephone keyboard that operates on the piezoelectric principle is being developed by the Ibaraki Electrical Communication Laboratory of the Nippon Telegraph & Telephone Public Corp.

To fabricate the circuitry, copper is evaporated and etched on a thermoplastic substrate having a high dielectric constant that contains a fluorine such as particles of a ferroelectric ceramic. Instead of signaling by switches that close contacts, depressing the keys produces ferroelectric voltages in the conductor lines beneath them. The developers say that keyboards of any size can be built this way.

Philips gains partners as TED video-disk debut nears

The long awaited TED video-disk playback system from Telefunken/Teldec/Decca, which has mechanical pickup, is expected on the market this year, and officials are predicting sales of 25,000 to 30,000 units. The Philips-Gloeilampenfabrieken VLP (very-long-play) system isn't expected until some time in 1976, but Philips officials don't appear to be worried about the time lag. MCA Inc., Los Angeles, has a joint venture agreement with Philips to develop the optical system. Philips is also negotiating with France's Thomson-CSF for possible licensing, and Zenith Corp. of Chicago is another likely partner. Unexpected development costs have delayed and boosted the price of the TED system from about $480 to $600, and prices for the 10-minute disks will start at $4.

Programable 1-k ROM is ECL-compatible

One of the first 1,024-bit programable read-only memories to be compatible with emitter-coupled logic will be introduced by RTC-La Radiotechnique Compelec. One of the first buyers, presumably, will be Compagnie International Pour l'Informatique, which helped RTC develop the device, the GXB 10149. Production versions of the PROM will be considerably faster than the typical access time of 23 nanoseconds in the development version, and somewhat smaller than the chip, now 1.2 by 1.3 millimeters. The 1,024-bit memory matrix is split into four blocks of 256 bits each and has 66 bits for test points. The memory is programed by burning out nickel-chromium fuses at selected memory crosspoints, essentially made up of two transistors each. The selected fuses are burned out by applying a 25-milliampere pulse at 8 volts to the inhibit input.

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High-performance German speaker hangs on wall

A high-fidelity loudspeaker that can be hung on a wall like a picture will go to market in about six months, says its developer, J.W. Manger, an independent West German researcher. The JWM system, bearing its inventor's initials, **performed better than conventional speakers in lengthy tests at Germany's Physical Training Standards Bureau, but it "will cost no more than conventional systems,"** Manger says.

The speaker, only 2 centimeters thick, operates by means of a flat flexible resistive-type diaphragm working in conjunction with an electrodynamic drive. **Operation is in the bending-motion mode, in contrast to the principles used in today's loudspeakers,** in which a mass or compliance-type diaphragm operates by piston-like movements.

The speaker, described this month at a technical symposium in London, accurately reproduces even rapidly varying sound signals and square-wave pulses. The drawback of the conventional speaker, Manger says, is that it acts like a sound generator itself.

Japanese open up domestic market to all IC imports

On Christmas day, the Japanese government completely liberalized imports of integrated circuits. Imports of devices with less than 200 elements were liberalized last April, and capital investments for semiconductor production followed last month. **The government's sole remaining restraint on foreign companies now appears to be the power to impose emergency duties on imports of integrated circuits if the devices are being dumped on the Japanese market.**

Last year, Japanese production of integrated circuits amounted to $317 million, and imports totaled $110.7 million. During the first 10 months of this year, production was $308 million and imports $147 million. Still, the Ministry of International Trade and Industry says Japanese technology can hold its own in competition with foreign manufacturers. **However, development subsidies will continue under existing laws. In fiscal 1973 and 1974, they amounted to $11.7 million.**

Nippon Electric Co. Ltd., which claims to be Japan's largest manufacturer of ICs, had more business during part of the year than it could handle and was turning some away. Formerly No. 1 and now No. 2 Hitachi Ltd. also turned away business.

Endoscope has tiny color-TV camera in tip

An endoscope that contains perhaps the smallest color-television camera ever built may be marketed this year by Philips Gloeilampenfabrieken. **Prototypes, developed by Philips' Laboratoires d'Electronique et de Physique Apliquée, have already passed tests in three Paris hospitals.** Company officials are investigating marketing possibilities and formulating specifications for commercial systems.

The color camera in the endoscope, which has a head diameter of only 4.5 millimeters, attaches to the end of a catheter 4 mm in diameter that can be threaded through veins or other passages to examine the heart, abdominal organs, or even the brain, a spokesman says. The area under observation is scanned by a rotating mirror and a combination prism and lens, each driven by a synchronous motor only 3.5 mm in diameter. **Light is fed in and out of the head through glass fibers, and outcoming light is picked up by three photomultipliers having outputs that control a color-TV monitor.**

Ultrasonic river gage may go to commercial market

An automatic ultrasonic monitoring unit developed by a UK government agency to measure the flow of rivers and tidal basins may be marketed commercially. The Atomic Research Establishment, which developed the instrument package for the Department of the Environment's Water Research Centre, is reported to be negotiating with the Plessey Co. for possible marketing of the system. Designed for water-resource management and flood control, the instrument packages can be connected to a computer for monitoring of flowing or tidal bodies of water. **In the system, two ultrasonic units, positioned diagonally on the shore, exchange pulses through the water and communicate with a depth gage.** A console reads out quantities of water flow.

Japan's budget date will delay satellite launches

Japan's communications and broadcast satellites won't be launched by the end of fiscal 1976, as had been planned. NASA in the U. S., which will orbit the satellites, requires payments to start 24 months before launch. **The drawback: initial funds for the launch won't be included in the Japanese government's fiscal 1975 budget, which must be approved by the Diet, until April 1, start of the fiscal year.**

An official of the National Space Development Agency is confident that the delay will be only a few months. NASA in the past has been willing to waive rules and accept payments later, he says. But funds are now short in the U. S., and NASA is following the rules closely. **It will take at least two years to build the rockets for the launches, which will now have to come after April 1977.**

Germans transmit digitized TV images over glass fibers

Using equipment from Siemens AG, communications engineers at West Berlin's Heinrich-Hertz Institute have successfully transmitted digitized television pictures over a glass-fiber line four kilometers long. **The transmission line is a multimode fiber with an attenuation of 6 to 8 dB per kilometer. The system uses binary-difference pulse-code modulation at 24 megabits per second,** which corresponds to 320,000 picture dots having 3 bits per dot. The transmitter is a special long-life luminescence diode connected by an analog-to-digital converter to the television camera. **The receiver is an avalanche photodiode that feeds a monitor via a decoder.** The TV picture has a norm of 625 lines and 5-megahertz bandwidth.

Japanese may purchase foreign defense aircraft

U. S. airframe and electronics manufacturers could benefit from two actions by Japan's National Defense Council that would, if adopted, hurt that nation's manufacturers. The council has recommended that **the next generation of the airborne early-warning plane for the Self Defense Force be imported and that aircraft be imported to fill the gap while the next-generation PXL submarine reconnaissance plane is being developed.** Logical candidates for Japanese purchase are the General Dynamics YF-16 and the Northrop YF-17 advanced combat fighters, one of which will be selected by the U. S. Air Force. Both are also candidates to replace NATO's F-104s.

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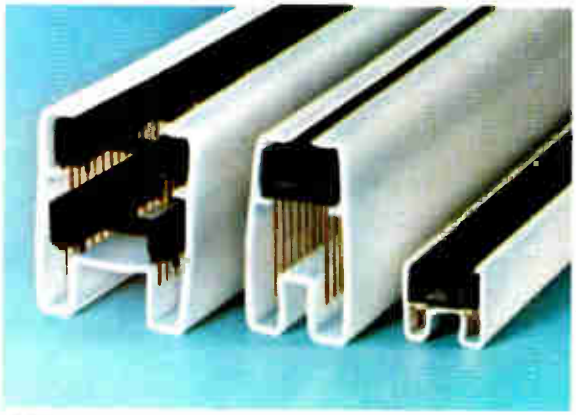

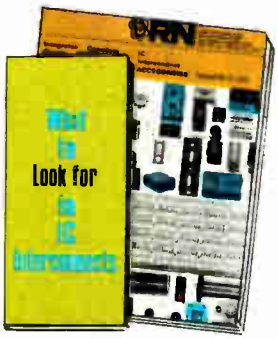

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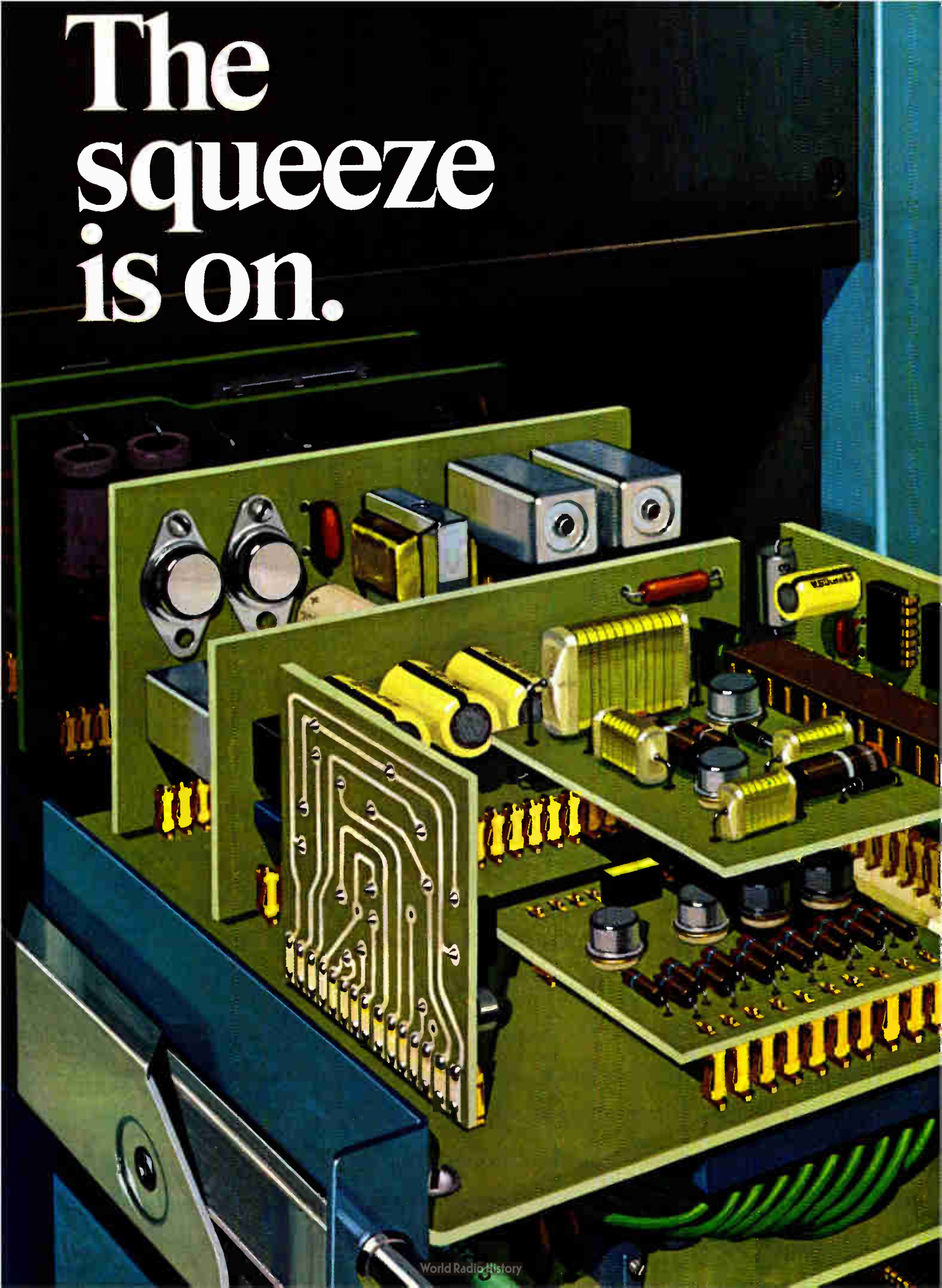

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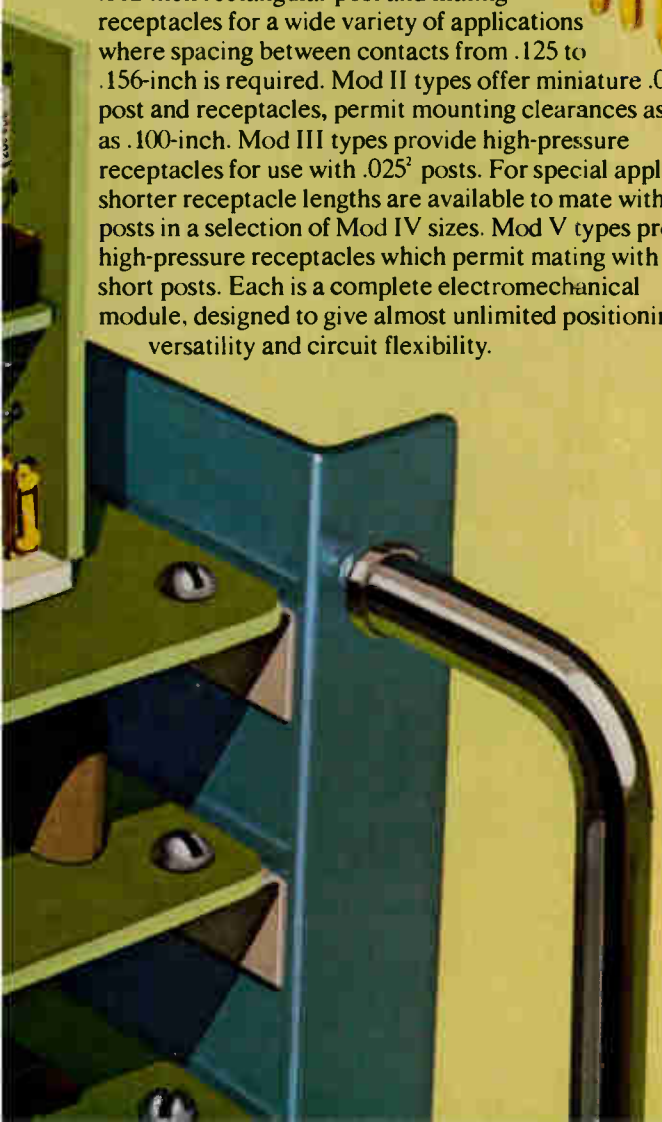

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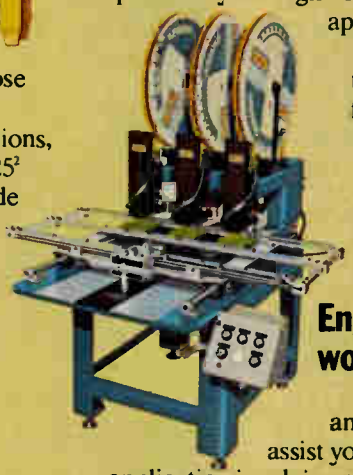

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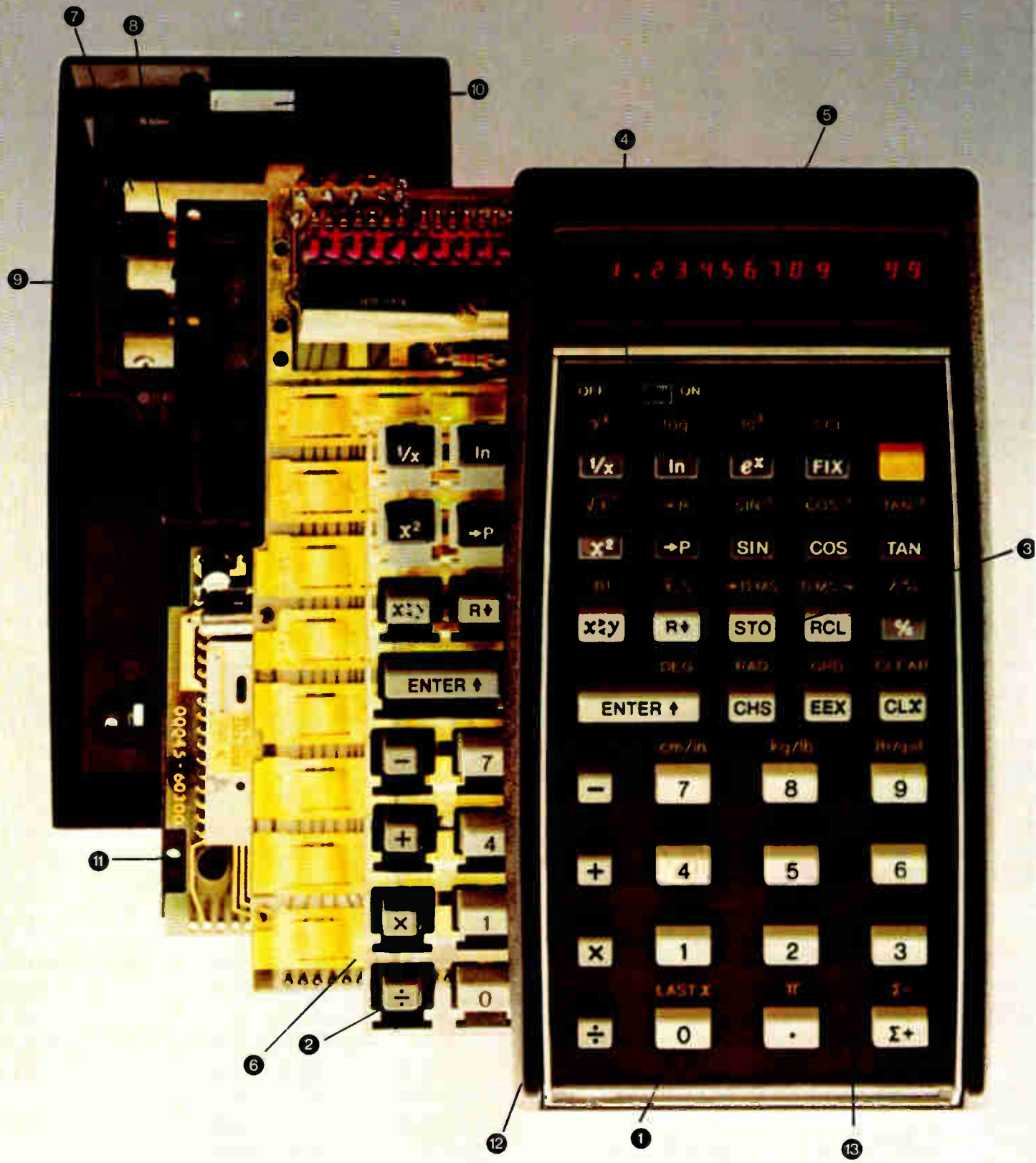

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Circle 64 on reader service card

Executives worry over economy

Inflation and recession top lists of electronics officials' bugaboos, but at Allen-Bradley they're preparing for the boom

by Howard Wolff, Associate Editor

Electronics executives are worried about inflation and recession. They fear that the Government will do the wrong thing or, worse yet, that it will do nothing. They're worried about inventory and capacity. In fact, as they peer into 1975, many are worried, like RCA's Irving K. Kessler, "in a word, about everything." However, Stanley J. Kukawka, vice president and general manager of Allen-Bradley Co.'s Electronics division, is getting ready for a boom.

But most officials expect that things are going to get worse before they get better. David H. Methvin, president of Computer Automation Inc., says the economy in general won't see an upturn before the end of the year. Donn L. Williams, president of electronics operations at Rockwell International Corp., puts it this way: "I believe that 1975 as a whole will be a soft year—a real soft year." The consensus appears to be that the business curve will remain flat.

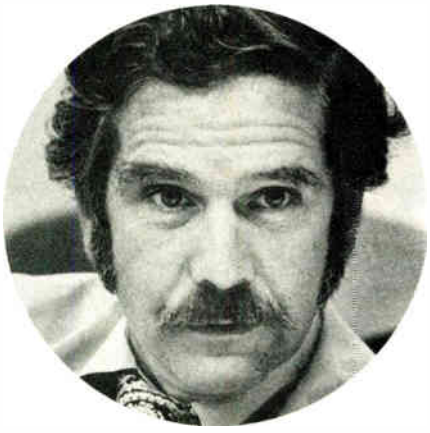
There was a time when electronics people looked to the Government, particularly the military, as the bedrock of their business. But things have changed, and RCA's Kessler, who's executive vice president for government and commercial systems, says, "The military will have to sharpen its priorities."

The Defense Department, he says, is hurt by inflation as badly as industry. "This will affect new starts," says Kessler, meaning that, within the next year or two, a number of the marginal companies in the Government electronics field will drop out, particularly those that are undercapitalized. Kessler worries that they may damage the rest of his industry on the way out with what he calls desperation pricing.

Order rates are a major concern in every one of the electronics industries. At Hewlett-Packard Co., John Young, executive vice president, says H-P officials are worried about their "ability to provide employment for our people." Young notes that he isn't preparing for doomsday—he expects only "some sliding off in the first six months of the year" and a flat growth rate for 1975 as a whole—but has made contingency plans for the worst-case situation, a possible business drop of 10% to 20%. Then, says Young, H-P might either build inventory or reduce capacity by "absolute attrition" and hiring freezes or by cutting the work week. Young says that at H-P, which has never laid off anyone, "our highest priority is to have a job for everybody."

Inventories. What's worrying Charles E. Sporck, president of National Semiconductor Corp., is that his customers will accumulate excess inventories. And he wonders "what kind of impact that will have on the real usage of electronic products." While customers are apparently shipping now as vigorously as they did before the downturn, Sporck says, "Clearly, our buiness is impacted now by excess inventories."

"If the economy doesn't fall



Seers. Looking down the road at 1975, Donn L. Williams of Rockwell International, Charles Sporck of National Semiconductor, and Irving Kessler of RCA agree that the year will be flat. Electronics executives are worried most about inflation, recession.

apart"—and Sporck doubts that it will—he expects inventories to be down by late spring, when there will be a rush to reorder. Then, says Sporck, the semiconductor industry would find itself worrying about shortages resulting from mushrooming demand and cutbacks in capacity. Sporck's scenario includes panic buying and a shortage that will be worse than the one preceding the current slump.

Sporck predicts that inflation overall is "on its way out," adding that "it never did exist in the semiconductor industry" because the industry has a flexible and realistic attitude about the economy. About the economy in general, Sporck says, "There is no danger of a depression. We are seeing a readjustment" from the "disjointed economy, where we had rampant inflation along with the distortions built in."

Now is the ideal time, Sporck continues, "for this adjustment to be allowed to correct the pressures on the economy—Government controls—that were destroying it." For example, he says, "in areas where there are tremendous shortages, let supply catch up." Or, where "fictitiously low prices were imposed on certain products," such as natural gas, allow price hikes. In other words, explains Sporck, "let this marvelous free-enterprise system work. Don't let it battle with its arms tied."

Another semiconductor industry leader, executive vice president J. Fred Bucy of Texas Instruments Inc., says, "Our worries in the semiconductor industry are very much the same as those of the rest of the economy, but may be accelerated." Bucy expresses some disappointment in the Federal Government.

"Unfortunately," he says, "you can't control inflation without having a little recession, so the problem is to control it without getting into too deep a recession. Our biggest worry is whether the Government can perform this balancing act. So far they have demonstrated no leadership whatsoever."

Contingencies. "I'm worried that the Government will give up its fight to stop inflation too soon, and then at some point, we'll start reinflating," Bucy continues. "We'll have a bigger disaster in the future because we refused to take a small dose of medicine at this time." In forecasting his industry's performance, Bucy is conservative. "I don't expect to see any semiconductor industry growth at all in the first half; I expect to see it continue to slide.

Holding the line. H-P's John Young says objective is jobs for everyone.

Analysts gloomy, but some see upturn

Executives at companies in the electronics industries are worried about everything from inflation to inventories, and so are the men on Wall Street who monitor those companies.

Securities analysts are taking a generally bearish view of the electronics industries in 1975, particularly the early part of the year. Electronics, most analysts agree, are growth industries, but they're not immune to changes in the economy, as the following comments indicate.

Benjamin Rosen, for years the semiconductor-industry analyst for Coleman & Co., New York, says, "As we enter 1975, one of the main difficulties is that all the major economies—domestic, Japan, and Europe—are down. This is probably unprecedented. That's on the demand side. On the supply side, we'll probably see some fairly low production rates going into the year. The first quarter will be the bloodiest of the year. But as we see some fiscal and monetary stimulation by the Federal Government take effect—and I think this can be anticipated—we could see very gradual improvement, with the fourth quarter of this year or first quarter of '76 turning out to be pretty buoyant periods again."

James I. Magid, vice-president and a semiconductor and television analyst with Drexel Burnham & Co.'s research department in New York, expects "an extremely tough year with a lot of consolidations and mergers. I think that by the end of the first quarter, the semiconductor segment will be 30% to 40% below the trend of the golden age of '72–'73, had that trend continued. Prices will be under big pressure. And we may see Japanese and European companies taking over some small, or even medium-size, [U.S.] companies."

Kent Logan, a partner and electronics analyst with H. C. Wainwright & Co., New York, projects a 12% drop in semiconductor sales in 1975, "but they could be off as much as 30% in the first half. We're seeing all the classical moves by the industry right now in response to the depressed market, including layoffs, cuts in R&D and other programs—that sort of thing. We'll see the larger companies, like a Texas Instruments, in a good financial position, continuing to put money into the development of new products, while the smaller firms will have to cut programs." In other words, Logan believes the big will get bigger in 1975, while many of the smaller firms in the electronics industries will be competitively weaker by year's end.

Robert Gutenstein, long-time electronics analyst with Kalb Voorhis & Co., New York City, says that "for the short term, we're going to have some very difficult business conditions. We're now going from a period of inventory reduction to a period of demand reduction. I think the Federal Government will be a very critical factor for the industry in 1975 in terms of its tax policies, military spending, trade relations, and so many other areas in which it will be making decisions. I also think we'll see more business failures and consolidations during the year than we have seen at any time since 1970."

Assuming inflation is under control by then, we should see some stabilization in the second half."

Bucy emphasizes, however, that there will be some false indications of growth. "In the first half of the first quarter, for example, we'll see some increase in orders because customers just did not buy for inventory in the last quarter of 1974. They'll be buying for replacement in inventory in the first quarter," he says. "Some people will read this as an upturn, but I think that history will show that this is just a flash in the pan, and we'll continue to slide. The biggest danger, since world economies are more interrelated than they used to be, is that, as the U.S. goes, so goes the free world."

Rockwell's Williams points out that "there are no real bright spots, really. Last year, the economy was held up by continuing capital expenditures. This year, we see cutbacks there too."

John Buchholz says he has no worries—only "healthy concerns." Buchholz, executive vice president of Bunker Ramo Corp. and chief executive officer of the firm's Amphenol divisions, is concerned with inflation and the high cost of money. "If we try to hypo the recession with quick remedies without considering the effect on inflation, we won't get to the root. We'll cure the symptoms without curing the disease." As for the high prime interest rate, Buchholz says, "When American business can't grow because the cost of money is too high, that's a bad sign. And I don't think we're going to bring the economy under control until we see the cost of money drop." Still, Buchholz expects only a flat 1975—the first half drifting downward and a gradual upturn in the last half.

At Zenith Radio Corp., the biggest worry for president John J. Nevin is not so much what the economy will do, but what the consumer will do. "I have to conclude that the short-term outlook for this industry is dismal," he says. "We're going to have to live with lower levels of sales in the months to come, and I suspect that it's going to be hard for any company in this industry to earn an acceptable profit in the coming year." But Nevin says, in the long term, that when the recession ends, the television industry will benefit from pent-up demand.

But all isn't gloomy. The minicomputer business, says Computer Automation's Methvin, could grow 25%, even in a flat year. "They're not yet a necessity," he reasons, "but they're tools, and they help reduce costs as wages go out of sight." For the economy as a whole, Methvin predicts that unemployment will rise, but he says that the chances of slipping into a full-blown depression are slight. Actually, Methvin suggests that the recession will be good for the country because the U.S. "needs a good dose of salts. The idea of full employment sounds good, but it doesn't work."

His scenario for bad times includes some lessons learned in 1970–71. This includes smaller raises, pay cuts if necessary—and an emphasis on productivity. In 1970–71, says Methvin, "we learned that we could produce the same amount with fewer people."

Optimism. Another silver lining is foreseen in the process-control industry. The key, as with minicomputers, is the need for customers to improve productivity. However, David T. Kimball, president of Leeds & Northrup Inc., says that, although spending to improve productivity will continue in 1975, "customers will be more concerned with what they get for their dollar than with what is the cheapest answer to the problem. Price competition is not going to be as intense."

Inflation is the big worry, adds Kimball, as indicated by proliferating cost-of-living and escalator clauses in contracts. "In fact, we're building in clauses that say if inflation continues, our price automatically goes up." Kendall feels that if his forecast of a 10% to 20% increase in business comes true, then his company's 7% personnel cutback of last October will be enough.

Perhaps the most optimistic executive around is Allen-Bradley's Kukawka, who is preparing for a resurgence of prosperity. His rationale: "We're putting our house in order—reconditioning old products and getting new products, tooling, and mechanization on stream—because whether it's the middle of 1975 or the beginning of 1976, the boom is inevitable. The company that pulls its punches at a time like this will lose market share when the big push comes." Allen-Bradley's plans are based on a flat to slightly rising first half, a growing second half, and a booming 1976. □

Looking ahead. Richard Kendall of Leeds & Northrup sells productivity, Allen-Bradley's Stanley Kukawka is getting ready for the boom he says must follow the recession, and Zenith's John Nevin expects 1975 to be a dismal year in the consumer electronics industry.

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You and your career

Uncertainty hits EE jobs

Layoffs increase slightly as most electronics companies clamp freeze on hiring engineers until business recovers

The rising number of layoffs and "furloughs" hitting the electronics industries is starting to take a toll of engineers. While nowhere near the national percentage, EE unemployment appears to be spreading across practically all types of companies and hitting every level of experience. Engineers for aerospace and defense contractors, hard hit during the 1970-71 downturn, seem to be more stable today than others—such as engineers in the harder hit consumer electronics and semiconductor industries.

In some cases inventory imbalances of components and semiconductors have caused severe cash shortages among manufacturers, triggering general layoffs. To reduce losses caused by rising costs, companies have closed down entire plants. And now with order levels still flat, the cuts orginally aimed primarily at production workers are reaching deeper—into the engineering departments.

The situation has caused the Institute of Electrical and Electronics Engineers (IEEE) to organize a kind of employment alert. IEEE has started a monthly survey of its membership to get an early fix on the job situation in the hope of minimizing a severe crisis at least by having some statistics to support requests for government spending for job-creating programs.

The latest unemployment estimate taken from a poll of 2,500 members in November indicated that of 1,284 useable responses, 2.18% were involuntarily unemployed compared with 1.9% in 1972, the last time the survey was taken. Over 71% of the unemployed were 40 years old or over. Another 4.83% of the IEEE members polled indicated they were either underemployed or working full time in a position other than the field of their primary technical competence. According to IEEE spokesmen, the monthly surveys will continue for the foreseeable future, so that, unlike during the last unemployment crisis, there will be some source of fairly reliable job information that is specifically tailored for the EEs.

One question difficult to answer today is how engineering cutbacks will affect companies in their efforts to snap back from the sales slump. A number of firms won't talk about EE layoffs, indicating a fear of revealing potential technical weakness.

"There is a considerable amount of indecisiveness by top management concerning cuts in professional staffs. Management has lost control of the ability to forecast what's going to happen in this crazy economy," charges Harold Almand, head of the Council of Engineers and Scientists Organization, a large East Cost engineers union.

Agencies. Perhaps as good an indicator as any of trends in EE employment for 1975 are employment agencies. On the West Coast, two such establishments in the Silicon Valley area south of San Francisco report that their figures follow closely national reports of unemployment among electronics professionals. At one of them, Corporate Technology Inc. in Sunnyvale, Calif., John Reinhardt, a partner in the agency, says resumes from EEs looking for jobs are up 4% to 5% over a year ago. At the same time, he points out, requisitions from companies with vacancies are down some 30%.

Another San Francisco area agency, Thomas Kelly and Associates, is finding the same things true. William Irwin, a partner in the firm,

Street pounding for new grads?

Employment experts are generally puzzled in trying to forecast the engineering job market this year. For example, the College Placement Council Inc. reports that electronics and aerospace companies expect 31% fewer openings for graduates this June compared to last year. Yet employment increases for bachelor's degrees in engineering will come from companies involved in energy research and development.

It appears that women will have better chances at locating jobs. Offers increased 34% over the previous year for this group, according to the council. This compares with a 5% drop in jobs available for Ph.Ds and just a 7% increase in prospects for engineers earning their master's degrees.

Nationally, for all engineers, the council predicts an increase in demand for new grads of only 9% in 1975 over 1974. However, this statistic is complicated by the fact that there are smaller graduating classes—11% fewer freshmen enrolled in engineering schools in 1971, with smaller classes expected for the next three years. Because of the uncertainty in the economy, there are also indications that companies have not firmed up their hiring plans for this year, which could make all of these projections invalid.

says that companies now are looking for EEs who can redesign products to cut cost and improve efficiency. What they aren't looking for, he says, is the design engineer who can turn out new products.

Farther down the coast, in Beverly Hills, Calif., Harris Krainman of Lannen Associates finds applications from unemployed engineers are up, while fewer companies are looking for them. Krainman says that what jobs are being filled are being filled by specialists, particularly in computers and data processing. However, it is pointed out that the biggest employers in the Los Angeles area are the huge aerospace firms, and they maintain their own personnel departments.

Across the country on the East Coast, the New York consultant firm of Deutsch, Shea & Evans maintains an index of demand for engineers and scientists gleaned from employment advertising in newspapers and technical and professional journals. According to Deutsch, Shea's latest monthly report, for November 1974, the index stood at 92.9. By way of comparison, Deutsch, Shea's index was 113.3 in January 1974, while in July it stood at 152.9.

Fat vs lean. Five years ago many electronics companies said reductions in their engineering departments were necessary to "trim off the fat" of unproductive EEs. Presumably then, with the fat gone, pink slips handed out today would be slicing into good performers untouched by the previous trimming. Thus, the EE unemployment statistics do not tell the whole story, nor are companies admitting on the record the seriousness of the cuts.

Equally serious for the profession is that many companies that have not carried out extensive firing have nonetheless put a freeze on new hirings in order to trim by attrition. This portends difficulty for new graduates, although the national average shows a small increase in demand of 9% (see "Street pounding for new grads?" p. 68).

Not every electronics company is cutting down. Hewlett-Packard Co.,

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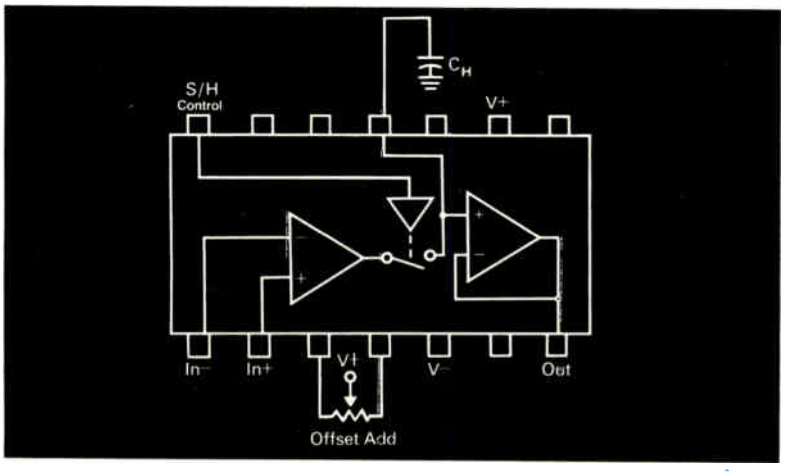

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Palo Alto, Calif., has always had a policy against dismissing personnel, and executive vice president John Young says H-P will continue to find other ways to solve the downturn problem. "We feel that when we have a general problem, we share it," he adds.

Data General Corp. has not laid off any engineers, in fact, it has continued to do replacement hiring and some expansion. And the company expects to continue hiring in 1975 as well as maintain its college recruiting program. The only factor that might alter these plans is a sharper decline in the gross national product, and that will hurt everyone, a spokesman states.

Also, some firms, such as government contractors, are actually hiring small numbers of engineers. The Aerospace Group at Hughes Aircraft Corp. is looking for 100 engineers for its Canoga Park, Calif., operation. Overall, Hughes has maintained a rather stationary level of employees with only a slight increase to show for the last five to six years.

Bendix Corp.'s Communication Division near Baltimore, Md., expects a few job openings for both new grads and experienced personnel, due to the recent Microwave Landing System contract award (see p. 32). Approximately 500 to 600 engineers are on the Bendix workforce in Baltimore, but general manager Frank Adams says only a 1% to 2% increase may occur. He sees "essentially a flat employment picture, with maybe a slight gain" for the rest of the year.

These 12 months will be "a year of growth" in employment, according to Conrac Corp. president Donald H. Putnam. Conrac's aerospace operations have remained stable in engineering employment and the company's Cramer division, part of the industrial group, is down just four engineers out of more than 60 over the past few months.

No hiring. Elsewhere, the employment picture is not too encouraging for EEs. IBM, Honeywell Information Systems, Digital Equipment Corp., and Computer Automation Inc. are not hiring at all in order to reduce by attrition.

National Semiconductor has laid off about 3% of its engineers, and has no plans for hiring at present. Teradyne Inc., Boston, has let a few engineers go in shelving projects with no short-term payback. Hiring plans at Teradyne are also essentially flat.

So it goes throughout various segments of the electronics industries. At Bell Laboratories, the Conference on Professional Technical Personnel, a nonbargaining union, reports that 100% of its members surveyed said they would prefer to have lower wage increases during the year than see anyone laid off. This coincides with the lab's policy, so that at present there's a freeze on hiring, but no firing. □

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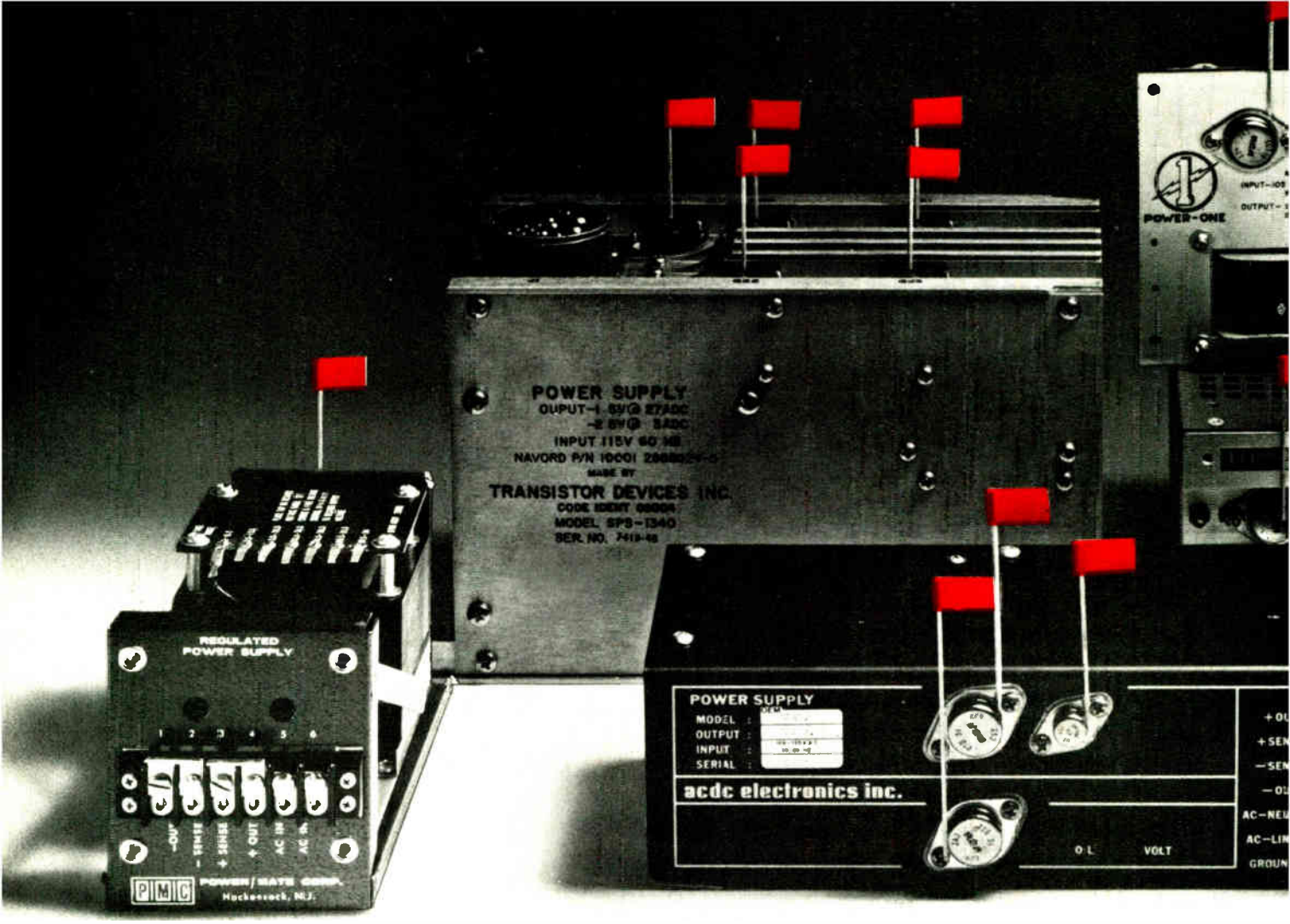

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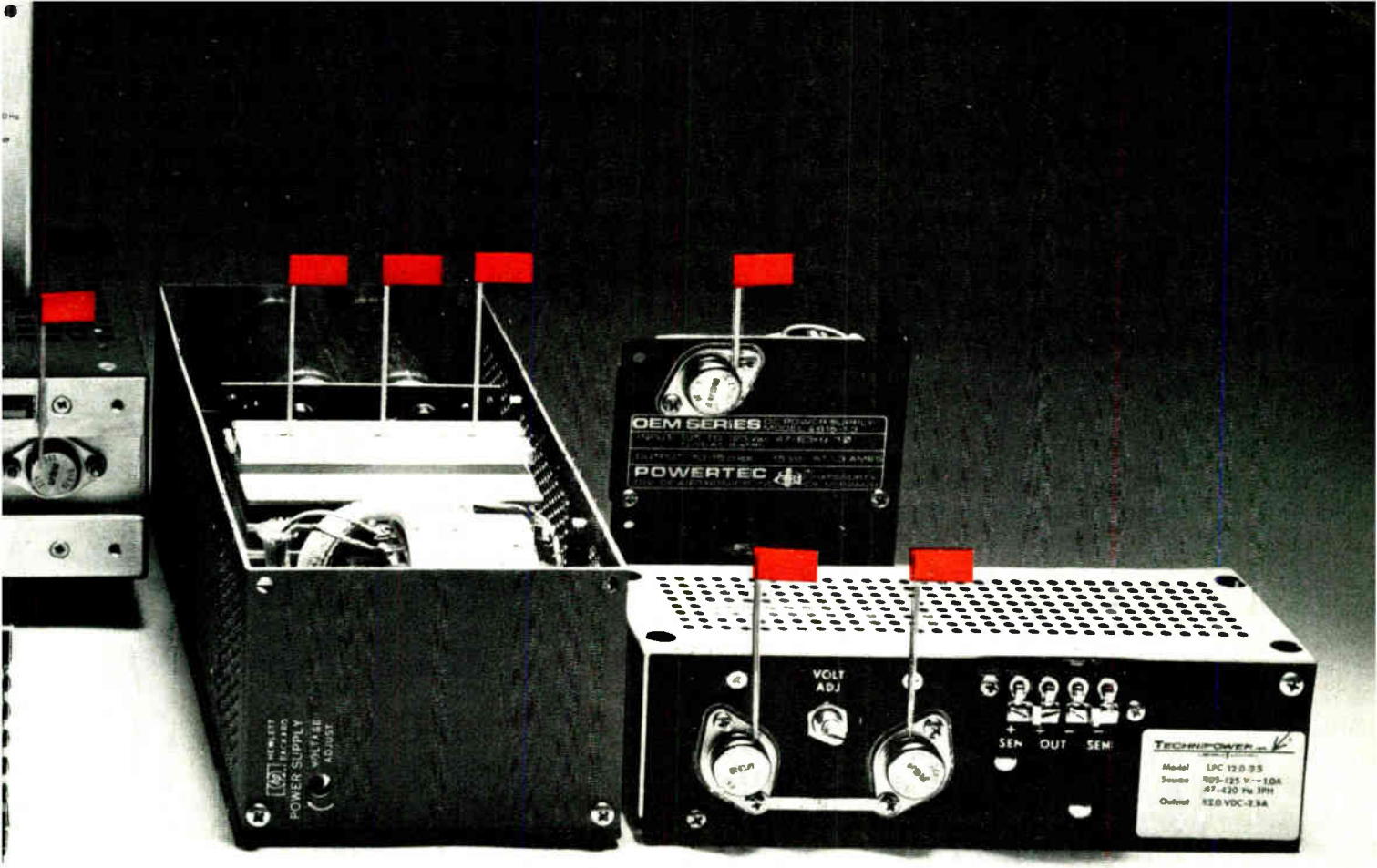

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Companies

Sinclair keeps it lean

By subcontracting the manufacture of calculators, and now watches and other new products, British company has sustained growth

by William F. Arnold, London bureau manager

Clive Sinclair's formula for producing his pocket calculators—control the design and quality but subcontract the manufacturing—is leading Sinclair Radionics Ltd. to greater diversification in 1975.

In fact, the confident British entrepreneur shortly will introduce a new series to augment the various models of inexpensive calculators on which he has based his reputation as something of a merchandising wizard. The new series will start with a simple four-function model, and range up to a super-scientific item, due out before the end of the year, and designed to nibble at models by Texas Instruments and Hewlett-Packard. And Sinclair recently announced a deal by which Gillette Co., the razor maker, would market a Sinclair-made calculator in the U.S.

The 34-year-old company president has still other plans afoot in his headquarters, a converted English mill. He plans to introduce this year two different products rumored to be in the mill for some time: a digital wristwatch and a monochrome television set with a two-inch screen [*Electronics*, International, Dec. 12, 1974].

Considering that the company has also introduced a 3½-digit multimeter based on an LSI chip and continues to make consumer audio equipment, one would expect a large bustling corporation headquarters overseeing several factories. Instead, Sinclair Radionics has only 250 employees and expects to make about $17 million for its fiscal year ending in March—the first year the company hasn't doubled sales. It does have offices in Munich and New York, and has recently hired a consultant to keep tabs on the latest circuit designs with chip makers on the San Francisco peninsula.

How does such a relatively small operation achieve such high-volume success? "Our policy is to produce only standard products in large production runs," Sinclair says. But it's obviously more complex than that.

His own way. Clive Sinclair, founder and president of Sinclair Radionics, subcontracts the manufacture of his products.

He began the company in 1962 by selling radio and amplifier kits through magazine ads because it requires little capital or manufacturing facilities. The same keep-it-lean philosophy operates today.

Essentially, Sinclair's team designs the product to make sure it can be built at the target price at one end, and checks for production quality and packages it at the other end. Production is usually farmed out to a subcontractor who has the headache of managing the necessary labor force.

Sinclair says he has his "own management on the premises" of his subcontractors, some of whom are just across the river from his mill offices. To ensure rigid control, the company has designed its own automatic test equipment, which it does not intend to market.

Design is crucial in Sinclair's high-volume, low-production-cost world. His 22 engineers, headed by Michael Pye, R&D director who was hired away from Texas Instruments, work on one spacious floor of the mill. There, circuit designs are simulated on Sinclair's own computers. Though many prototypes might be built before the right model is chosen, concept-to-production has been accomplished in as little as six months.

With the watch, Sinclair acknowledges "an established market pattern"—and formidable competition among regular watch and newer solid-state houses—"which won't be disturbed overnight." Even so, the watch is slated for production the first half of 1975.

The "Tiny Telly" due later in the year presents different terrain. Ac-

cording to Pye, there have been two tricky areas: perfecting the circuitry, and the tube. Sinclair was almost ready to go with one circuit design but delayed producing it to try it again. The result is a cleaner design with fewer discrete components.

The key to producing the set, he adds, is a low-power cathode ray tube which the company has patented. While most tubes need more than half a watt, Sinclair's will need only 30 milliwatts. Thus it will run on four AA-size batteries for about seven hours instead of the usual two hours from 10 batteries.

Instead of magnetic deflection techniques, the Sinclair tube uses electrostatic deflection, in which the potential between two plates bends the beams. This makes it easier to produce a low focus spot and gives a low power tube, Pye notes. He says a prototype set performed well in a taxicab in London, where frequency congestion is much less a problem than in the U.S., and that the sets should work well in trains, among other places.

Sinclair estimates that about $600,000 has been spent so far on developing the 10-ounce Tiny Telly, which he describes unpretentiously as "a transistor radio with a picture thrown in." It will be marketed for under $240. And, in a possible departure from the successful formula, the company might produce the set itself, at least initially.

Even with the new products, Sinclair says "calculators will always be a major part of our business," and they will "be good business for some time to come." They should be. Sinclair is producing more than 70,000 units a month, of which 60% is export with more than 10% going to the U.S. Britain remains the largest market. Overall, the calculator provides 85% of Sinclair's income.

With his policy "to innovate, not to follow industry," Sinclair has other ideas brewing. Although the new DM2 multimeter seems to be going well, he says he has no plans for more instruments. "With possible exception of oscilloscopes, I don't see a large volume market." He also admits to being "interested" in a minicomputer, the next logical step from scientific calculators, but has "no concrete plans." □

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U.S. MARKETS 1975

The growth rate in electronics continues to decline as inflation wipes out profits and inventory imbalances curtail production; total growth is predicted at 5.3%, but some sectors should do better

U.S. MARKETS

☐It's practically a foregone conclusion that the growth rate in U.S. electronics industries will continue to totter downward, notwithstanding an occasional exception among the various market segments. Inflation wiped out last year's gain of about 7.8% industry-wide; apparently it will be much the same this year, with inflation expected to run at about 8.5%, and electronics sales, according to the *Electronics* survey, to increase by only 5.3%.

While signs of the slowdown had loomed a year ago—even as the booming sales pace of 1973 continued into the first half of 1974—its dimensions have become ever more clear. Serious setbacks have moved in on certain areas of electronics, notably television receivers, discrete semiconductors, and certain passive components, and the situation is not expected to improve very soon. Business has, in fact, slacked off to some degree in virtually every part of the industry. Add inflation, and the result is a tremendous squeeze on profits and a heavy burden of inventory imbalance.

The question is, when will the decline bottom out? In large measure, of course, the answer is bound inextricably to the fate of the nation's economy in general. Projections for the gross national product this year vary, naturally, but many observers in electronics predict a drop of 2% to 3% in real dollar terms. The McGraw-Hill economics department, on the other hand, foresees a modest real decline of just 0.1%. A lot will depend on the Government's response to unemployment, which has increased so rapidly and suddenly in recent months that most concede it ranks with inflation as a critical economic problem.

Toward the end of 1974, many officials in the electronics industries were expecting an upturn in the economy in the second half of this year. As the recession drags on, however, more predictions seem to be mentioning the fourth quarter as upturn time, and some do not foresee a recovery until 1976.

There are those in electronics who have learned that a company broadening its market base has more of a chance of surviving when the total economy hits the skids. They also know that a broader base provides more avenues for recovery. Then, too, with the country's previous recession only a few years back, many electronics managers are appropriately wiser, and, historically, the electronics industries have outperformed the GNP as a whole.

Waiting for the comeback

Recovery will take longer to be noticed in those markets where overstocked inventories have been a problem, as with semiconductors, and passive components; and a shorter period of time for equipment producers, such as in data processing and industrial electronics. This is a typical pattern in previous recovery periods following inventory imbalances.

Data processing, in fact, has come through the last six months relatively unscathed. This market segment includes such healthy outfits as point-of-sale and banking-terminal companies. Once again, data processing accounts for more dollars than the Federal category, although there may be EDP gear purchases by Federal agencies hidden in the data-processing column. In any case, Federal spending has staged something of a comeback recently, causing some electronics firms to renew interest in this market.

As for the electronics markets *in toto*, making projections for recovery is a chancy affair. But, taking a consensus point of view, it's expected that an upswing will be under way or in sight as 1976 approaches.

FIGURING THE U.S. ELECTRONICS MARKETS

	(in millions of dollars)			
	1973	1974	1975	1978
Industrial and commercial	19,553.0	22,227.7	23,603.1	32,522.0
Consumer	7,014.2	6,768.5	7,186.8	9,586.0
Federal	11,929.0	12,497.0	12,910.0	15,019.0
Total markets	**38,496.2**	**41,493.2**	**43,699.9**	**57,127.0**
Components				
Semiconductors	2,097.7	2,466.5	2,558.4	3,539.0
Other components	4,906.1	5,088.4	5,234.2	6,263.0
Total components	**7,003.8**	**7,554.9**	**7,792.6**	**9,802.0**

A detailed listing of individual product categories appears in the foldout at the end of this report. The figures are *not* adjusted for inflation.

Solid state

Upturn hoped for by year-end

Semiconductor manufacturers are girding themselves for a tough year. Many industry leaders who have publicly predicted a turnaround by midyear are saying in private that if inflation is not slowed, and the economy does not recover, the slump in semiconductor sales could last into 1976.

Reacting to that slump, the industry has cut its total labor force by more than 12% and its production capacity by almost a third. Product lines are being consolidated, the development of new technologies is being postponed, and plant facilities intended for new products remain empty.

Figures don't tell it all

With that background, the expectation is that semiconductor sales for 1975 will reach $2.6 billion, an increase of only 3.7% over 1974. The integrated-circuit sector will be strongest, growing about 7%, while discretes will drop about 2%.

Just how bad today's semiconductor marketplace already is, though, is not apparent from 1974's market total, which posted a respectable 17.5% increase over 1973 to reach better than $2.4 billion (see Table 1). The reality is that a best-ever first half, in which sales grew at an

astounding 50% rate, was followed by a sudden drastic drop in market activity.

Few segments of the semiconductor industry escaped the decline. Hardest hit were such venerable near-commodities as small-scale and medium-scale transistor-transistor logic, small-signal transistors, operational amplifiers, and voltage regulators, calculator chips, and TV and audio circuits. But even the high fliers of a year ago, like semiconductor memories, power and field-effect transistors, complementary metal-oxide-semiconductor logic, and interface circuits for communications systems, did not escape.

Unit prices plummeted as manufacturers attempted to move out high inventories amid slackening demand. Then, when overstocked distributors began returning many components to their suppliers, the prolongation of the inventory imbalance, combined with the increasing cost of borrowing money, sent some suppliers into a panic. The price wars began and will undoubtedly continue into 1975, or at least until ordering picks up again.

The market follows its script

Despite the sudden change in its fortunes, the industry's individual market segments for total shipments (Table 2) continued the trends of the last few years, with one exception—the military market revived and partly compensated for weakness in the consumer segment. Indeed, military sales, which had been almost flat for the last couple of years, ended up with a 6.2% increase in 1974 and should gain up to 10.4% in 1975.

Maturing programs, such as the Poseidon strategic missile and Trident submarine development, the F-14 and F-15 aircraft, an assortment of tactical missile systems, and revamped avionics and navigational equipment have all combined to boost demand for radiation-hardened C-MOS and low-power Schottky TTL products, as well as a host of high-reliability custom logic circuits.

Equally vigorous in 1975 will be the industrial market, especially in terminals and transmission equipment for telecommunications and in LSI versions of process-control equipment. Here the thrust is toward low-power C-MOS for new gear and LSI microprocessors for redesigns of existing gear. RCA Corp., Somerville, N.J., National Semiconductor Corp., Santa Clara, Calif., Motorola Semiconductor, Phoenix, Ariz., Solid State Scientific Inc., Montgomeryville, Pa., and Harris Semiconductor, Melbourne, Fla., among others, are building C-MOS line-driver, receiver, and modem multiplexing ICs. Moreover, a whole family of C-MOS microprocessor parts, including modem multiplexing circuits and I/O chips for telecommunication peripherals, will be introduced this year by Intersil of Cupertino, Calif.

As for the computer segment, the modest 1975 growth shown in Table 2 will be primarily due to increased activity in peripherals and add-on memories. Mainframe customers are still a major unknown. Manufacturers of large computers are apparently undecided on how the LSI and microprocessor revolution will affect them and have put a hold on many new mainframe designs that use TTL and ECL controllers.

The minicomputer market, however, remains as healthy as ever, with good demand for Schottky TTL and larger LSI processor parts. Terminal equipment, too, continues strong as data-processing and time-sharing facilities proliferate and point-of-sales systems come on stream.

TABLE 1: SEMICONDUCTOR SALES

(in millions of dollars)

	1973	1974	(% change)	1975	(% change)
Discretes	776.4	860.7	+10.9	844.4	−1.9
Integrated circuits	1,133.4	1,381.7	+21.9	1,482.4	+7.3
Optoelectronics	61.2	71.2	+16.3	76.5	+7.4
Hybrids	126.7	152.9	+20.7	155.1	+1.4
Total	2,097.7	2,466.5	+17.5	2,558.4	+3.7

Although it grew fastest of all the markets for semiconductors in the last two years, the consumer segment seems to be undergoing a short-term downward correction accompanied by price erosion. True, unit volume continues to increase, but 1975's expected slackening in consumer demand may mean no dollar growth in semiconductors whatsoever. In short, it may be another case of volume up, prices down, growth zero.

Where the action is

Short-term slumps aside, there are very real opportunities for long-term market growth throughout the spectrum of semiconductor products. MOS products remain the prime prospects, with memories, microprocessors, and the C-MOS industrial circuits showing, by far, the most promise.

The MOS memory market, spurred on by the introduction of the 4,096-bit n-channel random-access memories, will again more than double in 1975 and could reach $230 million by the end of the year. Memory suppliers are positioning themselves for high-volume 4-k RAM production as prices break the $10 barrier and mainframe manufacturers become interested.

Many analysts put the number of 4-k RAMs to be sold in 1975 as high as 6 million units, up from less than 1 million in 1974. This makes the 4-k market worth almost $100 million dollars. The 1103 1,024-bit RAMs will also remain strong, peaking at about $75 million in sales this year before giving way to the higher-performing, more cost-effective 4-k product.

An equally bright hope is the easy-to-use 1-kilobit static RAM for peripheral and terminal applications. Built with n-channel MOS techniques or the newer mi-

TABLE 2: U.S. SEMICONDUCTOR GROWTH RATE

(percent)

Segment	1972	1973	1974	1975
Government/military	3.7%	0%	6.7%	10.4%
Industrial	15.0	26.9	29.1	2.6
Computer	18.0	40.5	8.8	2.4
Consumer	73.6	73.8	17.0	1.5
Distribution	39.2	25.7	26.0	1.7
Total	29.9%	33.4%	17.5%	3.7%

cropower C-MOS memory technology, products of this type may well reach $75 million in market value by the end of the year, even despite softening prices.

Also coming along strongly is the programable ROM, now being made in the 2,048-to-4,094-bit range with the 8-bit words necessary for microprocessor systems. Since the applications of these systems are multiplying rapidly, and since every microprocessor system requires a read-only memory program, the ROMs are being sold first as prototype development components and then in many cases as the high-volume production choice.

The microprocessor market, which amounted to a mere $10 million in 1973, reached $28 million last year, and may well exceed $53.5 million in 1975, giving it the fastest rate of growth of all semiconductor devices. Undeniably, the general semiconductor slowdown has to some extent inhibited microprocessor system development. But just about every logic system and computer control designer has been working with microprocessors, so that when the market turnaround occurs, orders will spurt ahead.

As suppliers began to line up their entries for this expected demand, bipolar LSI processors took shape. These systems, aimed directly at the makers of computers and high-speed controller and data-processing equipment, should gradually gain market momentum throughout 1975 and signal the beginning of the end of hard-wired TTL systems.

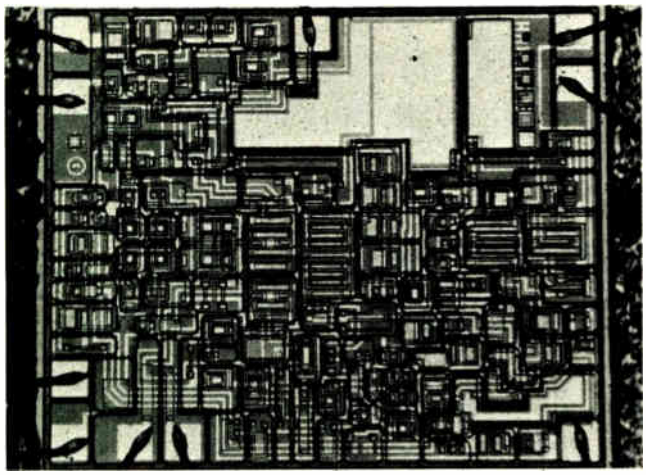
Where the action isn't: TTL and ECL

Texas Instruments, the Dallas, Texas, supplier of the largest standard TTL families, has finally conceded that conventional TTL has reached the no-growth point of its product life-cycle. This doesn't mean that the $380 million conventional TTL product market will evaporate overnight, of course—unit growth can be expected for several years as existing systems are replaced and peripheral control equipment is added to new systems. However, it does mean that Texas Instruments, as well as most other TTL suppliers, will put little capital into developing new conventional TTL products. Instead they will be putting their effort into new LSI bipolar families with Schottky TTL, new forms of unsaturated logic, and integrated injection logic.

The impact is already being felt. Intel Corp., Santa Clara, Calif., and Texas Instruments have introduced new lines of bipolar LSI circuits in wide-word formats for LSI processor jobs.

A logic family that isn't growing as expected is emitter-coupled logic. Instead of taking off in 1974 as many predicted, ECL, in fact, gained only a percentage point share of total digital logic market, in part because mainframe manufacturers are proving unwilling to convert the present TTL and Schottky TTL controllers to high-performing all-ECL systems.

ECL opportunities are much better in high-speed data-communications systems, where C-MOS and Schottky TTL are too slow to handle the megabit data rate requirements, and in high-performance military systems. Look for ECL to remain in the $60 million market range for the next few years.



Military picks up. Single-chip sample-and-hold circuit from Harris Semiconductor lands military jobs as that segment prospers.

Linears and discretes

The over-all prospects of the linear sector remain good, with 1975 growth rates of approximately 7% tracking those of ICs generally. For the time being, however, some linear products are in difficulties, what with consumer electronics cooling off and an oversupply of operational amplifiers in the industrial market causing price erosion and heavy distributor cancellations. Standard 741 op amps were selling as low as 26¢ by the end of the year, and similar price cuts were made in regulators and comparators.

One of the best linear markets in 1975 will be in communications. Phase-locked loops, line drivers and receivers, and modem interface circuits will all continue to enjoy increased use in microprocessor-driven peripheral data-communications systems as well as in intelligent terminals.

In 1973, sales of discrete semiconductors, particularly small-signal transistors, unexpectedly grew about 15%—only to fall back again in 1974 to the long-term steady decline forecast originally in 1972. The exceptions to this over-all decline should be field-effect transistors and varactor diodes, which will grow somewhat because of the increased interest in digital tuning in television, audio, and military applications.

Dollar sales of silicon power semiconductors, the bright spot this year as always, will grow by better than 40% to $216 million, despite continued price erosion. The mix of these semiconductors should not change appreciably, except that power Darlingtons are expected to grow at the expense of other devices, like power zeners, rectifiers, and diodes. Thyristors should improve about 7%, and modest gains should also be made by high-voltage pnp and npn transistors, which, up until a few months ago, had been in short supply for some three years.

Ailing from double-order-itis

Last January, components manufacturers were looking forward to the upcoming business year with cautious optimism. But their fat backlogs and hopeful mood had collapsed by the summer or, in some cases, even earlier. Orders dwindled and are still dwindling, yet the rising costs of raw materials are forcing companies to raise their prices. Inflation and tight money are hardly helping, either, and 1975 is expected to be a no-growth year.

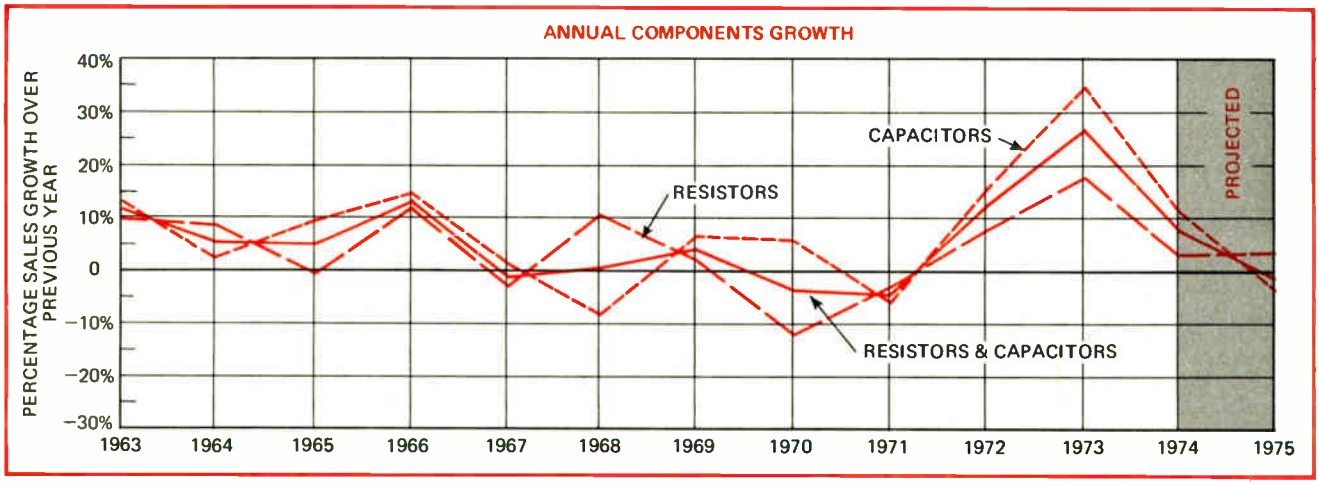
It's now clear that a good deal of last year's component shortages was not real, but a replay of the double-ordering inventory debacle of a decade ago, in 1964. OEM-equipment builders, as well as components distributors, overloaded their shelves and all too often placed duplicate orders with different components suppliers.

New orders actually began to fall off early in 1974, then plummeted during the third quarter—and still haven't stopped dropping. Now running about 60% of what it was this time last year, the new-order rate is expected by most components manufacturers to bottom out when it reaches the 50% level. The turnaround point should come about midyear, making sales growth essentially flat overall.

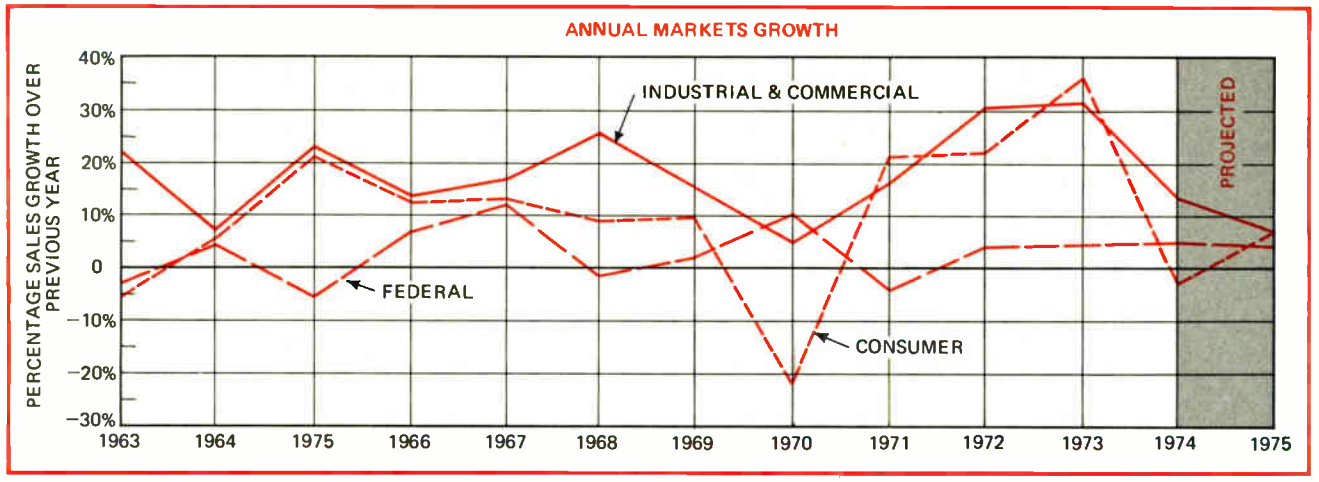
Components with the longest and therefore evidently the least realistic lead times during the shortages are hurting the most. Exceptions are electrolytic capacitors, sales of which are only just beginning to erode after a healthy 1974, and wristwatch displays, which are still enjoying a very real and substantial backlog of orders.

The sudden softening of the consumer market has hit components suppliers hardest. The slumping sales of automobiles and television sets account for the sharp dropoff in new orders for many resistors and capacitors. For instance, *Electronics'* chart shows sales of carbon-composition fixed resistors, wirewound variable resistors, and mica capacitors all down from 1974. In addition, the decline of the once booming hand-held calculator market is causing a downward slide in sales of miniature keyboards, key switches, and displays.

Compared to the drastic drop in most consumer-related sales, the industrial market, although it failed to live up to the high expectations of early 1974, has softened only slightly. Resistor networks, both thick and thin film, should do well this year because much of their



Markets growth history. The sharp drop in consumer sales in 1970 put a damper on growth and again in 1974. Industrial sales growth also softened in these two depressed years, but the military market remained firm.



Passives profile. The sales growth of resistors and capacitors generally track each other. However, in 1968, resistors enjoyed a good year, but capacitors were hurt by a decline in electrolytics.

sales are to the relatively strong instrumentation and computer industries.

As for the military and aerospace areas, components manufacturers not so long ago were scampering to shift such business away to the industrial and consumer markets—but this year, military and aerospace spending for components is expected to hold its own, or even increase a bit. Hybrid microcircuits for military and industrial applications will bolster the sales of chip capacitors in 1975. The performance of these devices has improved so much in the last year or two that they are replacing some disk capacitors, as well as the low-value tantalum and aluminum electrolytic capacitors.

Like resistors and capacitors, relays and switches are becoming increasingly more compatible with integrated circuits. Therefore, many relays and switches are now available in pc-board configurations, and some can be bought in dual in-line packages. The newer relays are highly sensitive devices that use little power and come in small low-profile packages, yet have a remarkable power-handling capability. The industrial market for this new breed of electromechanical devices is expected to stay reasonably firm through 1975.

Modular packaged circuits, which have had a history of steady growth, will also be somewhat affected by 1975's sagging economy. Still, data converters, both analog-to-digital and digital-to-analog units, should do well. Also new applications inside environmental control and energy conservation equipment continue to open up for special-purpose modules.

Although more light-emitting diodes may be sold this year, their sales growth in terms of real dollars will probably be flat. The second-generation LEDs will be capable of more than their predecessors—for example, individual devices often include an integrated circuit, enabling the LED to be more than just an indicator. Multidigit LED readouts, according to the *Electronics* chart, should reach $85 million in 1975, an 11.8% increase over 1974.

The immediate future of optical couplers still looks bright. They should enjoy a growth of close to 10% in 1975. Suppliers are even talking about increasing coupler complexity and speed before the end of the year.

Distributors foresee a hardworking 1975

Industrial distributors are looking forward to a busy year in 1975, but not necessarily a good one. Semiconductor sales are expected to be flat and distributors are still shaking off the last of the double and triple ordering that started some 18 months ago. Evidence persists that parts suppliers want to unload wherever possible, while distributors are trying very hard to balance their inventories and refine their own forecasts for the year. Meanwhile, suppliers and distributors are under some pressure from users' much tighter inventory management.

"We've gone from a boom to normal conditions," says Charles L. Grant, manager of marketing services at Cramer Electronics Inc., Newton, Mass. "We just buy what we know customers need." And customers, he adds, are buying only enough to keep their production lines going.

Grant notes that while sales are now solid, they don't quite fill Cramer's budget. "Distributors have to work harder to get orders now," he says. "Instead of placing gigantic orders, customers are placing several smaller orders. These are the distributors' bread and butter, where the higher profits are."

The Cramer executive doesn't see any "great upsurge in business" in 1975. But he does expect business from end users to begin picking up around mid-year.

Art Willis, vice president for product management at Arrow Electronics Inc.'s Electronics Distribution division, Farmingdale, N. Y., says he doesn't expect the flow of parts from supplier through distributor to end user to approach normalcy until at least the end of the first quarter. "We're working not from a high gross profit from individual lines, but from a balanced inventory management concept," he says. And with suppliers asking distributors to stock and sell harder than ever, Willis feels that Arrow and other distributors will have to do a much better job of forecasting and financial management during the year.

Like Grant, Nat Strunin, vice president of marketing for the Wyle Distribution Group in El Segundo, Calif., says that "inventories in 1975 will be much more in line with demand. There's a better mix because products that were difficult to get are now being freed up" and the inventory mix will therefore adhere more closely to the customer's needs. "I think that reduction of lead times on deliveries by manufacturers will help alleviate the situation also," he says. "We have been adjusting inventories within the company for at least, I would say, seven or eight months, trying to bring them more into line with what our current needs are." Aligning supply with demand is very important to distributors right now.

Already, says William Cacciatore, vice president of Hamilton/Avnet, Culver City, Calif., "there's a much better balance between usage and inventory. You don't have an exorbitant amount of heavy purchasing based on shortage of product. Inventories will be in much better condition than in the past 18 months."

Reflecting on the double and triple ordering that occurred during 1973 and into last year, Wyle's Strunin says he doesn't believe that will happen again. "If parts are available on a more normal, regular basis, I think companies will be prone not to do that," he says.

But Joel Girsky, secretary-treasurer of Jaco Electronics Inc., Hauppauge, N. Y., doesn't agree. He describes distributors as "very immature" as an industry, adding that he doesn't feel they have learned much from their recent experience. "Distributors were the most greedy bunch of guys in the world about 18 months ago, then when they ran into trouble they said their suppliers caused the problems. I know it will happen again. I see 1976 as another boom period, and we'll have the same damn thing again."

Bolstered by minicomputers

Minicomputers, some peripherals, and microcomputers will help pull up 1975 sales in the U.S. computer industry—but not by much. The total industry sales projection this year amounts to a rather limp 4.8% increase, to $16.4 billion, over the 1974 figure. But it would be lower if an 83% sales jump were not expected for microcomputers, a 35.8% gain for minicomputers, and a 14.5% rise for data terminals. Of course the minicomputer and microcomputer categories account for only about 5% of the total computer market. Larger computer systems—those selling for $50,000 and up—account for about one third of the market, and the *Electronics* consensus indicates a shrinking sales picture in this area—from $6.5 billion in 1974 to $5.6 billion in 1975—which explains the so-so total growth percentage.

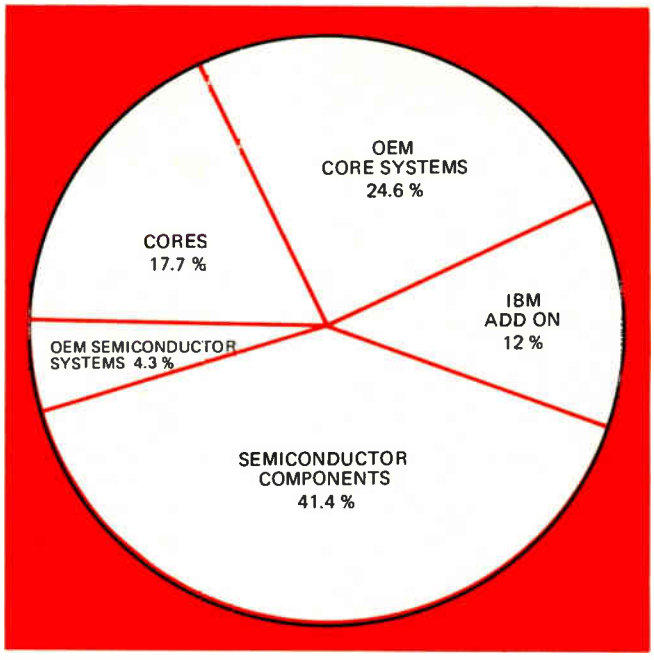
To some computer-company officials, the flattening sales outlook is suggestive of a maturing large-scale computer marketplace. The extremely rapid growth of the past several years could not have been expected to go on indefinitely, they say.

Sperry Univac reports that its shipments last year of large and small systems ran faster than the industry average for systems of all sizes. The company says this indicates that the long-predicted trend toward elimination of medium-scale systems is accelerating, which produces what is sometimes called "the saddle effect." Multiple installations of single medium-scale computers are gradually giving way to large consolidated systems sharing on-line files and having many remote terminals, and to scattered interconnected minicomputers.

1975 "will be a year when the rich get richer and the poor get poorer," predicts Frederick G. Withington, senior staff member at Arthur D. Little Inc., Cambridge, Mass. He foresees a downturn in total market shipments by as much as 30%, and says the main reason is near-saturation of the market for the IBM System/370 models 158 and 168. This tapering off is, of course, accentuated by the state of the economy, but revenues will continue rolling in from equipment rentals. Withington also predicts "a new surge in the marketplace during the late 1970s," after IBM introduces its next generation. In fact, he expects the installed base to increase more between now and 1980 than it has the past five years.

The coming of age of the minicomputer business shows up dramatically in the sales figures for its most firmly established firm, Digital Equipment Corp. DEC's sales for the fiscal year that ended June 30, 1974, were over $400 million, putting it in about the same league with Control Data Corp., which is best known for its large-scale machines. As a group, minicomputer manufacturers are expected to increase sales this year to $815 million, up from $600 million last year; they are expected to reach the $1 billion mark by 1978.

Problems encountered by minicomputers during the 1970 recession have largely been overcome in the present situation, most observers feel. Besides a maturing market and increasingly sophisticated equipment,



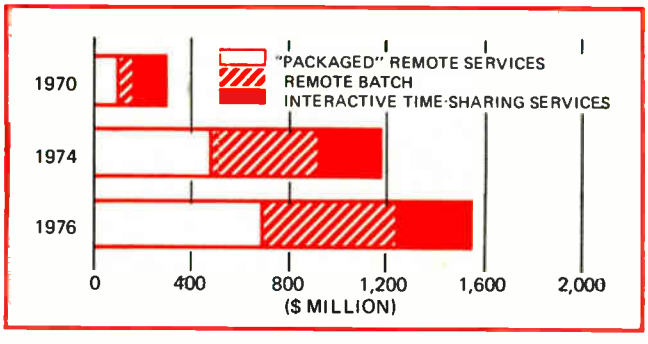
there's more diversification among producers and a more wide spread customer base than before.

Growth in computer peripherals for data communications continues at a healthy pace, though dampened somewhat by the recession. At the beginning of last year, terminals were connected to 25% of all installed computers. By 1978, it's estimated they will be included in up to 35% of installed computer systems—an increase from 300,000 terminals to nearly 1 million.

Good growth is also likely in other kinds of peripherals and mass memories. Arthur D. Little's Withington, while pessimistic in other respects, is decidedly less so in regard to peripherals. The reason, he says, is "a lot of users who have existing systems will continue to add peripherals, but not new computers."

The *Electronics* chart indicates an over-all growth rate of 11.4%, this year, to $5.6 billion, for data terminals, key-entry terminals, and input/output equipment.

Microcomputers possibly are benefiting from the recession because of the ease with which they can be adapted to particular applications by changing software. This offers many businesses much of the productivity enhancement and cost-cutting advantages of computer technology at a price they can afford. That could well explain the chart figures, which show microcomputer-system sales rising to $60 million in 1975, as opposed to $32 million last year.



U.S. MARKETS

Consumer/commercial

TV slumps, funds transfer jumps

A pall of gloom hangs over most of the consumer electronics market, but there are a few prosperous pockets, including audio, microwave ovens, and watches.

The glamor consumer categories of 1973—color television, calculators, and automotive electronics—took a beating in 1974. What about 1975? Don't ask.

The basic problem, the economy, has caused havoc with profits as well as sales. Inflation has eroded spendable personal income while falling demand has confused finished goods pricing policies. The portents are not encouraging for consumer electronics until the second half of this year.

By contrast, there's considerable optimism on the commercial electronics front concerning cost-cutting and productivity-improving equipment for banks, stores, supermarkets, hotels, and offices. It appears that because of the troubled economy, businesses are anxious to invest in electronic funds-transfer and point-of-sale equipment to improve efficiency.

Figures in this year's *Electronics* survey reflect the grim and the hopeful. Total consumer electronics, including automotive, fell 3% in 1974, logging in $6.95 billion in U.S. consumption. This year, according to returns from the *Electronics* questionnaire, there should be a mild recovery to a total value of $7.37 billion. Since it's easier to be optimistic about 1978, the $10.18 billion prediction is not surprising.

On the bright side, a good indicator of over-all commercial electronics performance is the point-of-sale category, which the *Electronics* table shows grew 65% last year to $317 million. Another 83% spurt is expected for this year for a sales figure of $580 million. Other funds transfer equipment should follow this trend closely.

TV sets turned off

Last year was most unsettling for color TV, after the industry racked up record sales in 1973. Suddenly amid all that prosperity, signs of alarm appeared.

Four TV manufacturers were either snuffed out or purchased (see "Color TV scorecard," opposite page) as two foreign companies gained control of American set makers. In October, production slowed suddenly, and by November layoffs and long holiday closings marked a virtual standstill for this $3 billion business. Early predictions of annual sales of 8.8 million to 8.9 million color-TV sets to dealers had to be revised. Now it looks like 1974 will be more like an 8 million set year. In 1973, by comparison, unit sales exceeded 9 million.

This year an annual sales rate of 7.3 million to 7.5 million sets won't be surprising during the first six months. In the second half, the rate should pick up to 8 million or 8.5 million units, which would put 1975 even with or just under last year.

Color-set manufacturers desperately want and need price increases, but getting any significant hikes to stick has always been difficult. Nevertheless, more list price boosts will be announced.

As one marketing vice president summarized the situation, "We need to do something to optimize that miserable bottom line. Cost reduction and increasing productivity have been used up. Offshore manufacture is now almost a monthly decision."

The audio market in the U.S. is a bit brighter. A-m/fm radios are holding their own, tape cassettes (including tape-radio combinations) are doing well, and sales of entertainment equipment among present car-owners, are growing despite the slump in Detroit.

Stereo equipment has usually outperformed the rest of the entertainment electronics field during economic recessions, and last year was no exception, as the *Electronics* sales table indicates. But this year there should be only a 1.4% increase in hi-fi audio components sales. Four-channel stereo has been a disappointment and isn't expected to do much this year. Sometime toward the end of 1975 the FCC's long awaited standards for four-channel discrete fm broadcasting should be known. If it has the hoped-for effect, quadraphonic components sales should pick up in 1976.

For calculators, subtraction

Calculators have had a couple years of multiplying growth, but last year was more a question of who would survive. Now, fewer companies are dividing up most of the market, and in 1975 the once exploding calculator industry will apparently see the subtraction of several from its ranks. Unit sales will continue to increase, but profits will separate the survivors from the dropouts. According to the *Electronics* consensus, dollar sales for four-function hand-helds in 1974 were $265 million. This year sales are predicted to level at $268 million.

Microwave ovens are still not big business in the U.S., relatively speaking. But the growth has been steady and last year electronic ranges took off, outperforming the conventional range business. Unit sales for the U.S. were about 750,000 compared to 440,000 in 1973, according to Litton Microwave Cooking Products, Minneapolis, Minn. Electric-range sales dropped about 10% and gas-range sales about 20% in the same period. Also, the U.S.-produced share of the domestic consumer microwave oven market last year reached 75%, compared to a low of 55% in 1972. Next year, microwave ovens should approach the first 1-million-unit, $400 million annual rate of sales.

Electronic watches did not take off in 1974 as predicted. Lowest-priced units ($150–$175) were sometimes unreliable, and high-end watches ($250–$2,000) were still too expensive to attract a big market. As a consequence, the expected entry of three or four semiconductor firms was also delayed. This year, sales will pick up substantially to $125 million, as the new electronic watch companies and the traditional firms square

Color TV scorecard

Shake-ups are not unusual in the TV industry, but 1974 produced enough to upset everyone. Here's the score card:

- Motorola's entertainment products division was acquired by Matsushita, the Japanese consumer products giant. It's name: Quasar.
- Magnavox was also acquired by a foreign company last year. This buyer was Philips, the European electronics giant, which had for some time been shopping around for an entry into the U.S. entertainment electronics market.
- Philco-Ford, on the selling block for several months, became the property of GTE-Sylvania's entertainment products division.
- Admiral, acquired by an American conglomerate, officially became part of Rockwell International's consumer products group.
- Teledyne discontinued its Packard Bell color-TV and audio operations entirely last spring. A West Coast-oriented firm, Packard Bell had twice unsuccessfully tried to go national.

Is this the end of the shake-up? At least four or five of the remaining U.S. producers are teetering financially, but there will probably be a breather as the industry attempts to sort out the changes in 1974.

off. The $50 digital display watch may not make the scene, but a $100 unit is certainly a possibility if there are enough watch cases available.

The automotive electronics market slowed down last year as the Detroit Big Three postponed new electronic parts and accessories in the wake of a disastrous sales collapse. If anything, the next few years could be a period of retrenchment in electronic applications. In the meantime, the best bet for electronics growth is diagnostics. GM for one has already begun pilot operations of minicomputer-controlled diagnostic systems at various key dealerships. Even with new-car sales stalled, maintenance of vehicles on the road will be important.

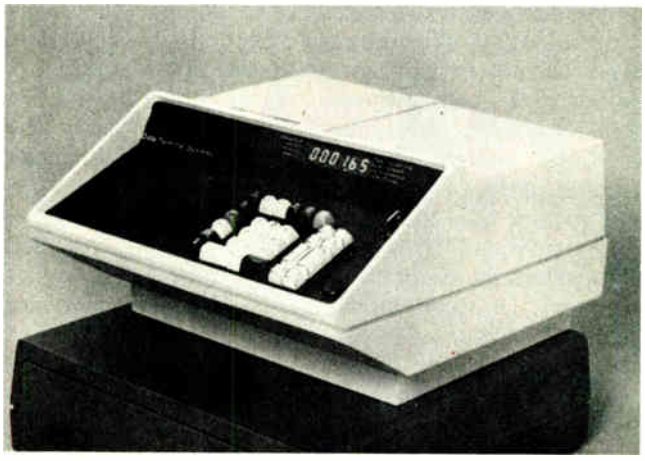
As for cable television, it's been another grim year for the hardware suppliers, and there are no turnaround signs for this year except for pay-TV terminals. A common measure of the state of this industry's health is the number of miles of cable laid during the year. According to one estimate, there were 16,000 miles of cable installed in 1974, compared to 24,000 in 1973. This year another 16,000 miles should go into use. This is just half of what the industry was geared to do, so it's reasonable to expect price-credit wars and a shakeout of suppliers.

In language not often heard these days, suppliers of electronic cash registers, point-of-sale systems, and automated-bank-teller terminals are saying "excellent," "strong," "darn good," and the like. Each of the various segments of this market has a different set of reasons for investing in electronics systems in the face of a recession. But it all adds up to a bright spot in 1975.

First, in the department stores, discount houses, and other retail operations, the accent is on credit authorization this year. The reason is obvious—to maximize cash flow, these stores want to minimize credit risks and bad debt losses. Smaller merchants may only want credit-authorization keyboard terminals. Larger stores and chains will go for total POS systems.

Supermarkets are mainly interested in improved productivity. Considerable attention this year will be focused on tests of check-out scanning systems. These have become controversial because of lukewarm consumer reaction to automatic price look-up at the check-out counter. Eliminating price tagging is supposed to be one of the important savings to supermarkets. If consumer resistance forces stores to duplicate effort on price marking, payback on system investment could be extended from 2 or 3 years to seven years.

The banking industry will go whole hog into electronic funds-transfer equipment this year to capture consumers and their money as efficiently as possible. On-line systems tied to autotellers—remote and on-premises—are the main thrust of this business now. Although there have been piecemeal efforts to install funds-transfer systems, the Federal Government seems ready to encourage more elaborate total programs. Now that the commercial banks and the savings institutions are locked in fierce competition, electronic equipment to provide a competitive edge is more important than ever. As a result the piecemeal operations will begin to coalesce into integrated, operational systems in 1975.



Money collectors. Banking terminals like the NCR 770 (top) and electronic cash registers like the Data Terminal Systems Model 319 (bottom), expect a good year despite the recession.

U.S. MARKETS

Federal

Inflation raids U.S. piggy bank

Federal procurement officials have $413 million more to spend for electronics this calendar year than last, and what will it buy? "Less," says one of them, attempting a thin smile.

After all, today's annual inflation rate more than swallows up a mere 3% jump from the nearly $12.5 billion that went on research, development, and hardware last year, according to the Federal budget planners surveyed by *Electronics*, to the $12.9 billion they estimate will be paid out this year. In other words, "there is something like a $1 billion shortfall between what is proposed for purchases this year and the $14 billion the Government would need to buy the same amount as in 1974," explains a defense planner.

Outlays for military electronics are projected at $11.3 billion in 1975, or close to 88% of the Government total. But suppliers in this area may be in trouble, even though the increase in Pentagon spending will be slightly more than for most other agencies. The defense portion of the fiscal 1976 Federal budget, to be submitted by President Ford to Congress late in January, may well rise more than 15% to nearly $105 billion, but the figure does not truly reflect the funding pattern to come in military electronics.

First of all, the spending period covered by the request does not begin until July 1. Also the new 94th Congress—oriented as it appears to be toward social, rather than military, programs—can be expected to try to cut Pentagon spending. For this calendar year, the outlook is "decidedly tough," says one budgeteer.

The few optimists on defense spending in the capital believe outlays over the next 12 months for electronics R&D will not remain essentially flat at the forecast $3 billion level. They also refuse to buy the 2.5% jump to $5.57 billion in electronics procurement because "it is too small in light of the economy overall," as one of them explained. "Defense spending is one way to funnel money into industry in a hurry and hold down unemployment." But challengers to that view persist, noting that much of the increase in DOD outlays this year will be spent internally, coping with increasing costs of logistics and other non-hardware operations.

In support of this position they cite DOD's operations and maintenance accounts, which are expected to rise by more than 9% to nearly $2.7 billion, one of the largest increases to be found in the entire military budget. "Stretchouts in procurement of new systems are going to continue," contends one Air Force spending planner. "That only means there has got to be more money for upgrading old ones and to keep existing forces operating." Such statements are translated as meaning more business for existing system subcontractors—suppliers of instruments and other parts to inventories.

Total allotments for aircraft and missiles are increasing. While individual programs like the USAF B-1 bomber—now always prefaced with the descriptive "controversial"—could be cut back, the outlook is hopeful for new and relatively low-cost fighters such as Northrop's YF-17 and McDonnell Douglas' YF-16 counterpart and F-15 Eagle.

Defense Secretary James R. Schlesinger is expected to use the U.S.-Soviet arms agreement-in-principle, which was negotiated at Vladivostok, as a lever to persuade Congress to complete funding the B-1 as well as major upgrading of remaining intercontinental missiles with multiple warheads and their associated control electronics. Heavy emphasis is expected to be placed on the Poseidon/Trident missile force, officials say, in order to bring the U.S. arsenal to the levels in the proposed agreement.

Civilian aerospace dim

Key words for electronics in civil aerospace programs at the National Aeronautics and Space Administration and the Federal Aviation Administration are "deferral" and "recession"—at least for the early part of the new year. Despite NASA's limited success in moving into the energy R&D market, its budget for electronics outlays will remain essentially flat at $800 million, according to an inside estimate. As for the FAA, "what used to be spent in one year will now he spent in three," sighs one industry source familiar with agency spending plans.

Congress and the White House budget office have not yet reviewed FAA spending plans for the second half of 1975. The result could be significant cuts in those spending plans. Meantime, the multimillion-dollar Airport Trust fund is swelling like an unmilked cow due to spending deferrals for runways and landing systems. Aviation industry sources estimate that to date about $190 million has been withheld and a further $260 million will go unspent for the next two or three years.

FAA sources explain that most of this money would not have been spent, regardless of President Ford's deferral request, because it is money put aside for future projects such as the Microwave Landing System. In addition, the facilities and equipment fund for FAA control towers, en route monitoring systems, and other electronic systems has approximately $227 million the next 12 months, but how much will be deferred has not been determined.

Electronics firms may extract some hope from the future beyond the next two fiscal years, however. The FAA plans to procure the multimillion-dollar Microwave Landing System and Discrete Address Beacon System for its landing and communications systems of the future. MLS is worth $1 billion in international sales, say industry sources, including "hundreds of millions of dollars" for up to 1,300 American airports.

DABS, a digital data link between aircraft and airports, is worth up to $190 million, according to FAA estimates. The Federal agency intends procuring prototype

Going aloft? Some aircraft, like this Northrop Corp. YF-17, have a good chance for funding increases this year because they cost much less overall than major bombers.

MLS and DABS systems this year, to the tune of $35–$40 million. For companies involved in the DABS and MLS competitions, the funding appears substantial for the end of the 1970s and the early 1980s.

Inflation robs law, medicine

Domestic agencies, such as the Law Enforcement Assistance Administration with its total budget of $880 million and the Department of Health, Education and Welfare with a capital grant budget of $4.5 billion, will have little good news for electronics companies this year. The agencies report that local authorities are planning to reduce their expenditures in the next 12 months for equipment and technical hardware that would only refine police or medical services. Up to $440 million of LEAA's funding is available to police departments and regional law-enforcement agencies on a discretionary basis. "It used to be that up to 60% of the Government funds went to sophisticated gear, but in the last 12 to 18 months we've seen an increase in funds going to labor and fuel costs," says a LEAA program officer.

HEW's primary program for funding new hospitals, the Hill-Burton Act, was not funded in 1974, and health-care grants are consequently expected to drop to an estimated $3.3 billion in 1975 from $3.6 billion in 1974. An additional $29 million will go on equipping the National Institutes of Health. HEW officials say that a substantial portion of the $3.3 billion will be spent on health-care electronics in the next 12 months, but a smaller percentage than in previous years. "A lot of hospitals are trying to make do with what they have, as are laboratories of the National Institutes of Health," comments a HEW official. NIH had $39 million for new equipment and facilities in 1974.

The Department of Transportation, advocating mass transit as the cure to urban transportation ills, doesn't expect its grant programs to be used for electronics. The Urban Mass Transportation Administration estimates a paltry $7 million will be spent on electronics in urban areas. A reluctance on the part of state highway departments to put cash into electronics at a time of decreased highway revenues and increased fuel and labor costs is the strongest influence on the depressed highway controls market. Again, the "do without" philosophy becomes apparent.

Communications

No longer recession-proof

The communications-hardware business, which tends to follow population and business growth, is traditionally among the most recession-resistant of all the electronics markets. But no segment can be totally recession-proof, and communications markets for 1975 will grow by only about 5% above 1974 level. When inflation factors are included in the growth figure, the net result will be, at best, a flat year.

For the year just past, *Electronics* estimates a 13.4% increase over 1973, with data communications being a major contributor to the increase. The data-communications business, at $614 million, showed a whopping 38% gain over 1973, but in 1975, though still outpacing the rest of communications, will probably grow only 9%, to $669 million.

This slowdown will be directly manifested in many other communications segments, too, through the effects of fewer housing starts and the high cost of money for capital investment. Also, the growing reluctance of state utility commissions to rubber-stamp requests for telephone-rate increases will force telephone companies—independents as well as Bell System—to wait longer for the increases that could be applied to new investments in capital equipment.

The interconnect situation

It is still rather early to evaluate fully the impact of the Justice Department's antitrust action against AT&T—the most significant development in communications since the Carterfone decision of 1968. But in 1975, AT&T will certainly be watched closely for any relaxation of its rigid opposition to certification of equipment for direct connection to the switched telephone network, regardless of chairman John deButts' pledge to "fight the suit to the bitter end." But the company did open the door a crack in 1974 when it allowed independent manufacturers of message recorders and other answer-only devices to build, to AT&T specifications, protective circuits directly into their equipment.

U.S. MARKETS

Competitive questions aside, AT&T remains the biggest private spender in the communications business. During the second half of 1974, there were continual revisions of its 1975 spending plans. By year's end, Donald Jones, AT&T vice president for construction plans, said that the company's spending for 1975 will total about $10 billion, roughly the same as in 1974. But he quickly added that on a real dollar basis, this level of spending represents a cut of between 9% and 10% because of inflation.

Mobile radio on land . . .

If the communications market has been resistant to recession, then land-mobile communications has been, in recent years, among the most resistant elements of that market. In a recession, business firms concentrate on cutting costs, and, for those that use vehicles, mobile radio has offered an obvious method to improve efficiency.

What's more, in recent years, Federal Government support of public-safety mobile-radio systems has grown, and such support will probably hold up well in 1975. Mobile radio will thus outpace the rest of the communications market, but not by much. *Electronics* pegs the increase at about 6% at $382 million, despite the nearly 11% increase in 1974.

Despite all the news made in 1974 about the Federal Communications Commission's new frequency assignments for land-mobile systems in the 900-megahertz region of the spectrum (on docket 18262), not much business will result for at least three years. The FCC is still digesting comments that were made in response to its action.

AT&T, in particular, was unhappy with the smaller-than-requested frequency allotment for cellular systems, while the independent radio common carriers may bring suit against the FCC in 1975 to allow them to share in the new frequencies. Even if these questions are settled next year, it will still take a couple of years before final designs on operating systems are completed and any impact is felt on sales.

. . . and at sea

Marine mobile gear has been going through a conversion period as boat owners switch over to very-high-frequency single-sideband receivers, which the FCC has said will be required equipment as of Jan. 1, 1977. The switchover has been quite rapid in the past two years, and not much of a retrofit market is left. Thus, with the boating market following the downturn of the economy (and the energy problem is not helping much), marine mobile radio will do well to avoid losses in 1975 at $15 million.

Data-communications equipment, although few would deny that it will be among the last segments to feel the effects of recession, still will not escape a continued lethargy in the electronics business. All the signs point to growth for data communications, but for 1975, it will show less than 10% increase to $669 million, primarily because businesses are delaying new-equipment purchases as they retrench to wait out the recession. In better times, a 25% annual increase could easily have been projected for this field over the next several years. The equipment is available, transmission facilities are available from the Bell System as well as the specialized common carriers, and the concept of remote data processing has been accepted in principle by the business community.

Satellite type. One of the many new applications for communications satellites was demonstrated by Dow Jones & Co. in a three-month experiment, when the firm used the Intelsat IV satellite to transmit facsimile information from its composing room in Chicopee, Mass., to its printing plant in South Brunswick, N.J. Comsat provided ground stations and digital interface equipment.

Satellites above it all

One of the stars in the whole communications picture is satellite communications. An idea whose time has come, both domestically and internationally, it has gained too much momentum in the past few years to slow down over the next year. Many foreign countries are expanding their communications systems through Intelsat or through their own planned domestic satellites. U.S. domestic satellite systems will expand in 1975, too. Marisat, the maritime satellite, will be launched next year, opening up brand-new markets for shipboard gear.

Electronics pegs the ground station market for 1975 at $272 million (the first time the category is carried in this report). But there should be many developments in such new applications as television distribution and communications to offshore oil-drilling rigs, and the field could mushroom beyond the somewhat conservative estimates on the charts.

Keeping ahead of the gloom

Chilling economic reports about the rest of the economy are causing industrial electronics firms to fill order backlogs as fast as they can, in the belief that each order delivered is one less that can be cancelled. In itself, though, the industrial electronics sector is still relatively healthy. Backlogs in many instances are still growing, even if at a slower rate. And the further up the electronic-systems ladder a company operates, the better its outlook for 1975.

According to the *Electronics* table, total industrial-electronics-equipment sales in 1974 were $1.09 billion. This year they're estimated to gain 12.8%, reaching $1.23 billion.

Even the controls segment of the plunging machine-tool business isn't doing badly. Nineteen-seventy-four was such a record-breaking year for machine tools that if the predicted slowdown of 20% this year occurs, it would still leave electronic-controls manufacturers in good shape.

Numerical control machines that offer increased productivity are holding up rather well, with lead times for the controls running 24 to 26 weeks. At the same time, NC machines are garnering a larger portion of the available market, so that while sales of traditional machine tools may be going down, sales of controls for NC machines are going up. Foreign orders have helped keep backlogs relatively stable.

James Conley, manager of domestic NC sales for General Electric's Industrial Control Products department, Waynesboro, Va., has found that a good indicator in the controls business is the ratio (in total dollars for the preceding 12 months) of new metal-cutting-machine orders to the orders shipped. "At one point builders were booking close to 1.9 orders for every order shipped," says Conley. "This has dropped, but at latest reports, only to 1.5. When it gets down to 1.2, then I'll start to worry.

"The cancellation ratio [ratio in dollars of net new orders to cancellations for metal-cutting machinery over the preceding 12 months] is holding at about 7%," he continues, "compared to a normal figure of 6% to 6.5%. And this 7% covers all metal-cutting machinery, including the items used by the automotive industry."

In addition, this percentage is somewhat inflated by what happened after price controls were removed early last year. In some cases machine tools soared 50% because of the tremendous increases in material costs. Castings, motors, gasketing are all way up. The controls portion hasn't gone up anywhere near this amount.

Expansion may be delayed

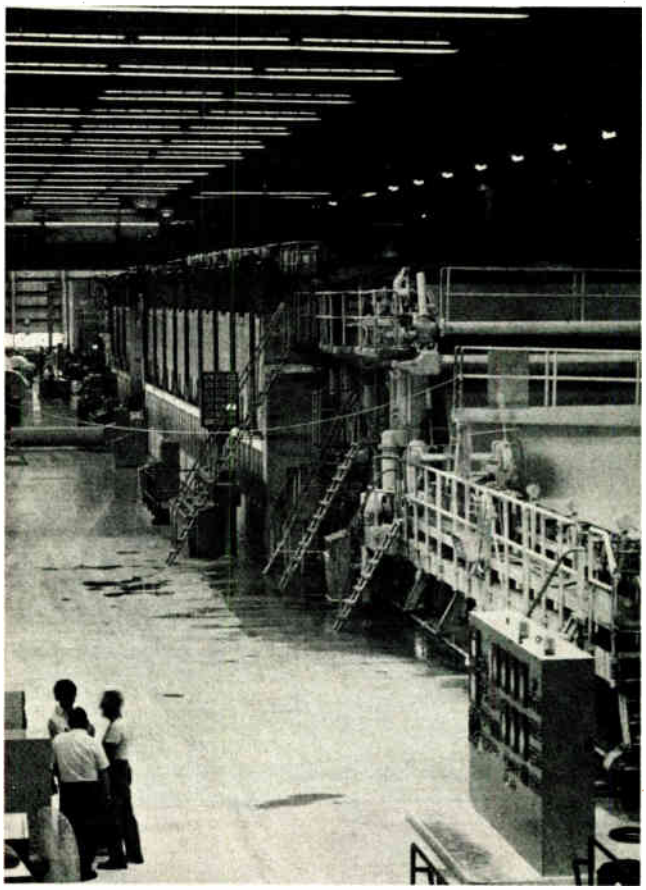
Machine-tool controls tend to follow plant and equipment expenditures, not the GNP. So the big question is whether industry will continue with its plans for expansion in 1975 (see "McGraw-Hill's economic outlook," next page). In favor of expansion is the fact that certain industries are still production-limited, but whether or not they will do something about it will depend largely on the availability of reasonable financing.

For the process-control makers, the market will drop about 15% in units in 1975. In terms of real dollar growth, however, the chemical industries are still planning to spend 22% more for plant and equipment, petroleum will be up 42%, iron and steel 18%, and pulp and paper 12%. The only disappointments will be rubber, down 18% in real dollars, and textiles, down 35%.

"While large capital expenditures have been predicted for these industries, high interest rates and disturbing decreases in demand are expected to nibble away at these figures," claims Jim Hettenhaus, manager of marketing research for Fisher Controls Co., Marshalltown, Iowa.

The net effect will be that if the companies follow through with their planned expenditures, it probably won't be until the latter part of the year. The one bright spot appears to be the petroleum industry, which is going full speed ahead, thanks to the demands of the energy crisis.

In the chemical industry, approximately 8% of the total plant and equipment expenditures goes for process control, while in the paper industry it generally runs 4% to 5%. The petroleum companies traditionally earmark 10% of the cost of a refinery for instrumentation. However, part of these percentages represent pneumatic controls, a strong contender when dealing with explo-



Computerized paper. In-line process measurement and control—which results in paper that runs closer to spec with less scrap and reduced consumption of expensive pulp—should do well this year.

U.S. MARKETS

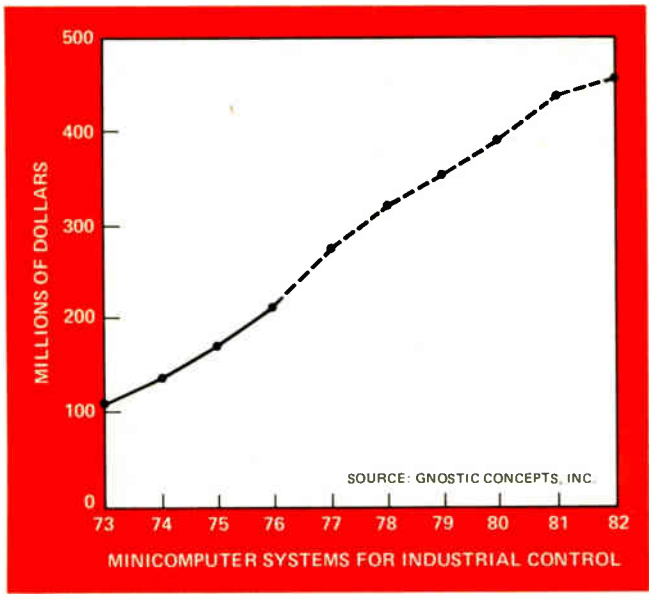
sive products in the field. But there's still a lot of electronics business to be found in the central control room, because the big push is toward computerization.

Another strong trend is toward intrinsically safe equipment—that is, equipment incapable of releasing sufficient electrical or thermal energy, even under abnormal conditions, to cause ignition of a hazardous atmosphere in its most flammable concentration. Many process companies are not only asking for but requiring that new instruments and controls be intrinsically safe.

Capital will also be short this year among the utilities. Dollars spent by the electric utilities in 1975 will equal 1974, but in terms of real growth, that actually means a decrease of 12%. For gas utilities, expenditures will rise 11%, but that spending level actually represents a 1% decrease in real terms.

The industrial market for microcomputers and minicomputers looks fairly healthy in 1975. According to Michael Gutman, microprocessor marketing manager at Digital Equipment Corp., Marlboro, Mass., the microprocessor—defined by DEC as a processor module plus read/write memories, read-only memories, and other auxiliary components—will total $50 million in 1975, with 75% of the applications being replacements for hard-wired logic. By the end of 1975, Gutman adds, one out of every four potential hardwired or relay applications will have gone over to microprocessors.

As for minicomputers, about 30% of those installed are to be found in control applications—process or flow control for gas transmission, pressure monitoring, data acquisition, and logging or control of equipment interfacing to other CPUs—and about 28% of these belong to the petro-chemical manufacturers.



Minicomputer growth. Gaining about 24% a year to 1982, minicomputer systems for industrial control will be at $170 million this year. Peripherals and software account for a growing share.

Over the 10-year span of 1973 through 1982, market research firm Gnostic Concepts Inc. of Menlo Park, Calif., claims minicomputer-system dollars in the industrial market will grow an average 24% per year. But more and more of these data-processing dollars will be spent on complete end-user systems, including peripherals and software, rather than on individual pieces of equipment. There will be increased standardization on the 16-bit mini during this period. Nevertheless, growth is forecast for the 32-bit machine.

McGraw-Hill's economic outlook

As 1974 drew to an end, weakness was showing up in nearly all segments of the economy so that the drop in business activity is now becoming more broadly based. It's not good, but it could be worse.

The economy, measured in real terms, will continue to decline over the next six months or so. From the fourth-quarter 1973 peak to the first-quarter 1975 low, the drop in real economic activity will come to 3.6%. Activity will begin to pick up again late this spring and should gain momentum by the end of 1975.

This forecast is based on three key assumptions, which may or may not pan out: first, the coal-strike settlement will not have a severe impact on the economy. Second, the Arab oil-producing countries will continue to supply enough oil for U.S. energy needs, an extremely volatile assumption. Third, the Ford Administration will develop a real economic policy and shift from restraint to ease early in 1975.

Gross national product in dollar terms will increase 8.5% in 1975 compared with 8% last year. While inflation will still be a key factor on the economic scene, unemployment will take over as the dominant issue early this year.

The pace of inflation will slow from about 10% in 1974 to 8.5% in 1975. By the end of the year, the inflation rate should be about 6.25%. On the other hand, the unemployment rate, which was at 6% in November 1974, should hit 7% by early spring. Real GNP will be down this year by about 0.1% compared with a decline of 1.8% last year.

Business capital expenditures, according to the McGraw-Hill 21st Annual Fall Survey, will rise 12% this year, but all of the gain will be due to inflation since capital goods and construction prices are keeping pace with the dollar increase in capital outlays. Any gain in capital spending will be in manufacturing. Manufacturers plan to boost investment in new facilities by 21%, or approximately 11% in real terms. Non-manufacturing enterprises, on the other hand, plan a 5% addition, which represents a 5% decline in real terms.

Because of currency revaluations and devaluations internationally, U.S.-made products have begun to compete favorably on foreign markets. However, unless there's an improvement in American productivity over the long run through new investment and technology, these gains will evaporate. The handwriting's on the wall, for worker productivity in this country declined at an annual rate of 3% in the third quarter of 1974.

Allan M. Kellner, Department of Economics
McGraw-Hill Publications Co.

Portables, automatics to gain

The 10% rise in test-instrument sales expected for this year will be due mainly to price increases caused by inflation, and real growth will be minimal. Nevertheless, instrumentation manufacturers are expected to make this a banner year for new products—particularly those that increase productivity in any way.

Amid last year's gloomy and confusing fourth quarter, when capital budgets for 1975 were being written, few executives were rash enough to commit large amounts of cash for new test equipment. Consequently, the job of convincing these companies that an eventual upturn justifies continued spending is being left entirely to the instrument makers, who will be trying to stimulate replacement business and open new markets with specifically earmarked products.

For instance, the strongest buying trend in instrumentation this year will be toward more favorable price/performance ratios rather than state-of-the-art performance. As a result, microprocessor-based instruments, though sometimes higher in price, will begin to play an important role because they may be able to replace several less expensive instruments or to save on operating expenses by cutting calibration requirements or test time.

The general economic outlook should also spur sales of equipment that increases output per man-hour. Automatic test equipment, with sales pegged at more than $200 million-plus this year, falls into this category, as do special-purpose test sets for production-line or field-service applications.

Indeed, as labor costs continue to escalate, firms with large field-service activities, like computer and telephone companies, may find it cost-effective to purchase higher-priced, special-purpose test gear that can be operated by lower-paid technicians with less training. Here again, microprocessor-based test sets that directly read out problems should become popular because they contrast so sharply with the more time-consuming method of hooking up test equipment and then interpreting readings to find a fault.

More portables

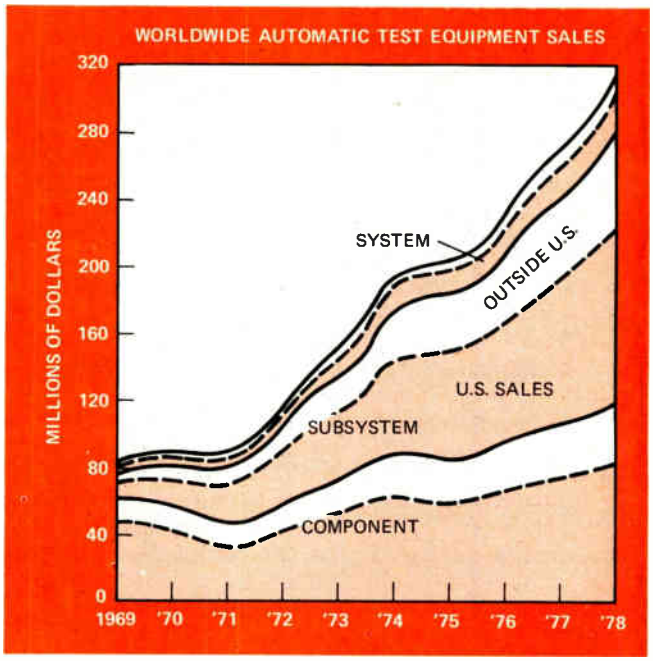
Field-service requirements will also play a part in increased sales of portable instrumentation. As the performance and circuit density of large-scale integrated circuits increase, there is a corresponding increase in performance and decrease in size, weight, and power consumption of the instruments that use them. This year, more emphasis will be placed on rugged, lightweight instruments, often battery-operated, that will service already-installed equipment. Signal sources, digital multimeters, oscilloscopes, and other test equipment that can be used on site should have healthy sales. Also, more instruments that combine such functions should be introduced.

In oscilloscopes, for example, types that don't use plug-ins should have a slightly better percentage increase in sales from $98 million to $108 million than plug-in scope mainframes, sales of which are projected to grow from $62 million to $68 million, according to the *Electronics* survey.

One special class of field-service equipment—calibration standards and test systems that can be carried to remote locations—will get special attention too. This sort of gear saves time and money by eliminating the need to shut down a system and bring parts to a central location for calibration. A prime application is in testing medical equipment which must operate with minimum downtime.

The outlook for medical instrumentation in general is good. This market should grow at a rate exceeding that of the instrumentation market in general, though not as astronomically as had once been expected. This year, the increase in sales should be about 16% over 1974. There is still a great demand for automated laboratory procedures and improved patient-monitoring, but medical-equipment buyers in general remain cautious and conservative, and the increasing stringency of safety standards will slow the flow of new entries into the market.

One particularly weak area of instrumentation sales in 1975 is communications and microwave. Sales of equipment for measuring at frequencies above 1 gigahertz are expected to grow from $126.3 million to $136.4 million, or only about 8%. This is due in great part to cutbacks or stretchouts in military spending for communications and a slowdown in buying by communications utilities. However, military spending may increase late next year if the Ford Administration budget carries the boosts in funding expected and if Congress approves.



Bright spot. Automatic equipment for testing components, subsystems, and systems should outpace the rest of the instrumentation market in sales growth. These figures, from Creative Strategies Inc., project an increase in worldwide sales of commercial automatic testing equipment to $320 million in 1978.

U.S. MARKETS

Packaging and production

Prospects are mixed

Manufacturers of automatic wire-wrapping and most automatic assembly equipment, printed-circuit boards, connectors, sockets, and packaging systems see 1975's sales picture as flat or only slightly down. A major exception, however, is in the area of semiconductor-production equipment—die bonders, beam-lead bonders, clean-room equipment, wafer-processing equipment, and the like. Makers of that kind of hardware are experiencing a serious slump by being tied directly to the economic state of the IC industry, In 1973 and 1974, when IC manufacturers invested heavily in new production machinery, the manufacturers of this equipment were riding high. Kulicke and Soffa, for instance, had a 20% increase in sales from 1973 to 1974. But the present glut of ICs has idled much of this new and expensive equipment, and 1975 will be a down year for the IC segment of the production industry, with no relief until possibly late in the year. At that time inventories will be in better balance, and capital-investment budgets should be less hobbled by high interest rates than today.

Other segments of the production-equipment industry are in better shape. Gardner-Denver, the largest maker of automatic wire-wrapping machines, had a 50% sales increase in them last year and is looking for a 75% increase this year. Demand for this automatic equipment should grow as manufacturers attempt to keep wiring costs down. The only hitch is that high interest rates may inhibit capital equipment investment.

Also increasing are sales of DIP and pin-insertion machinery used for loading pc boards. Since more and more companies are turning to automatic component insertion to cut production costs, sales will not only grow this year, but new companies can be expected to jump into this expanding field.

On the downside, the printed-circuit industry should suffer a 10% decrease in total sales in 1975 after an over-all increase of 15–20% last year. The reason for this decrease is slumps in the consumer and automotive electronics industries. Printed-circuit manufacturers do not look for a turnaround until the last quarter of this year.

Only a slight fall-off in sales is expected in the connectors, backplanes, sockets, and packaging systems sectors. In 1974 these firms sold 10% to 12% more than in 1973. Predictions for this year point to zero growth due mainly to overbuying and double ordering last year and the skyrocketing cost of gold (now approaching $200 an ounce).

In fact, everyone in the connector industry is attempting to lower costs either by going to selective gold plating (which uses much less gold) or by using a substitute material. The crisis could breed a new generation of connector contact materials and with it, a new spurt of marketing effort to enhance profits. □

Electronics problems surveyed

One question in *Electronics*' annual survey of U.S. electronics market conditions asked respondents what difficulties confront them in 1975. A tally of their responses reveals the three most important problems for each industry segment as:

- **Semiconductors.** 1. Rising prices, 2. profitability, 3. softening market. But these are nearly equal in importance, as the stalling of the 1974 market showed, too.
- **Components.** 1. Rising prices/inflation, 2. profitability, 3. general business recession. Surprisingly, inventory management/receivables management was way down the list, despite the fact that this problem was so crucial to sales and profits in 1974.
- **Consumer.** 1. Depressed economy/slower sales, 2. rising material and labor costs, 3. price competitiveness.
- **Communications.** 1. Reduced consumer spending in TV and recreational business, 2. lack of investment capital/high interest rates, 3. depressed economy. Communications respondents provided a profile that closely matches the general economic picture, which is not unusual considering the pervasiveness of this industry.
- **Data processing and office equipment.** 1. Increased costs, 2. lack of investment capital, 3. profitability. This response reflects the maturing of the industry as profit, rather than high growth rate, becomes more vital.
- **Industrial electronics.** 1. Rising costs, 2. profitability, 3. declining customer expenditures. Here, too, responses mirror the general state of manufacturing health.
- **Test and measurement.** 1. Declining capital expenditures/sales volume, 2. general recession, 3. rising costs of material and labor. A key indicator of the condition of the entire electronics industries, the test-equipment tally provides a clue that recovery may be longer in coming this year than many expect.

As for 1974, the top problems for all segments of the industries were rising prices of components and materials and profitability. Combined, these two problems equal inflation with declining demand, which just about sums up the state of the industry last year.

Surprisingly high on the 1974 list was shortages, but this choice was supported almost entirely by a high number of mentions from components and test equipment companies. Surprisingly low on the list was foreign competition, mentioned only by communications equipment and components manufacturers, not at all by consumer electronics firms. And that certainly reflects the fact that the electronics industries' problems of inflation and sales erosion were international in 1974.

A McGraw-Hill Publication
Electronics

INDUSTRIAL AND COMMERCIAL MARKETS

(millions of dollars)

	1973	1974	1975	1978
INDUSTRIAL AND COMMERCIAL, TOTAL	**19,553.0**	**22,227.7**	**23,603.1**	**32,522**
Test and measuring instruments, total	**895.2**	**986.5**	**1,091.7**	**1,434**
Non-microwave equipment, total	**781.2**	**860.2**	**955.3**	**1,261**
Spectrum analyzers	21.0	22.0	22.5	30
Frequency synthesizers	24.6	26.0	30.0	42
Function generators	10.6	12.0	13.3	18
Signal generators	33.6	36.0	38.6	47
Sweep generators	8.5	9.3	9.8	12
Pulse generators	12.6	13.0	13.3	15
Oscillators	3.1	3.5	3.5	4
Waveform analyzers and distortion meters	12.0	12.5	16.0	19
Counters, time and frequency	46.8	51.4	54.8	65
Panel meters, total	31.0	37.5	41.0	53
Analog	19.0	22.0	25.0	30
Digital	12.0	15.5	16.0	23
Noise measuring equipment	3.0	3.1	3.5	5
Analog voltmeters, ammeters and multimeters	20.7	20.2	20.3	20
Digital multimeters, total	41.3	46.5	51.7	64
≤3-½ digit	15.5	18.5	21.5	29
≥4-½ digit	25.8	28.0	30.2	35
Power meters	7.5	8.5	9.0	12
Calibrators and standards, active and passive	10.1	10.6	12.0	16
Oscilloscopes, total	166.2	177.0	190.0	232
Num-plug-in	91.2	98.0	108.0	129
Plug-in, main frame only	60.0	62.0	63.0	80
Accessories and plug-ins	15.0	17.0	19.0	23
Recording instruments, total	130.5	140.5	157.5	199
Magnetic-tape	57.5	61.0	72.0	90
Strip chart	53.0	57.0	61.0	75
X-Y	20.0	22.5	24.5	34
Automatic test equipment, total	143.6	168.7	200.5	317
IC testers	76.3	80.5	90.0	145
Component testers	7.3	8.2	10.5	12
Pc-board testers	60.0	80.0	100.0	160
Manual test equipment	13.0	15.6	18.2	27
Amplifiers, total	32.5	36.3	38.3	47
Lab-type	7.7	9.0	10.3	13
Signal conditioners	24.8	27.3	28.0	34
Phase measuring equipment	9.0	10.0	11.5	17
Microwave equipment, total	**114.0**	**126.3**	**136.4**	**173**
Phase-measuring	16.0	18.0	18.5	23
Impedance-measuring, total	8.3	9.3	11.3	14
Network analyzers	5.0	6.0	8.0	10
Other	3.3	3.3	3.3	4
Power-measuring	5.0	5.4	6.0	8
Computerized automatic measuring	7.0	8.5	9.0	15
Spectrum analyzers	16.5	17.5	19.0	24
Wavemeters	1.0	0.9	0.8	1
Frequency counters	9.0	10.0	11.0	14
Noise-measuring	1.4	1.6	1.8	3
Signal generators	12.7	13.3	15.0	18
Sweep generators	20.5	24.0	25.5	32
Microwave modulators	0.8	0.8	0.8	1
Field-intensity meters and test receivers	4.5	5.0	5.5	7
Antenna-pattern-measuring	5.0	5.5	5.5	6
Oscillators	6.3	6.5	6.7	7
Analytical instruments, total	**391.8**	**452.4**	**490.4**	**619**
Chromatographs, total	57.8	79.5	90.0	121
Gas	42.5	57.5	62.5	78
Liquid	15.3	22.0	27.5	43
Spectrophotometers, total	133.3	148.0	161.0	199
Infrared	30.0	32.0	34.0	36
Ultraviolet–visible	58.3	62.0	66.0	74
Atomic absorption	30.0	34.0	38.0	80
Others	15.0	20.0	23.0	29
Mass spectrometers	21.8	26.0	28.0	33
Nuclear magnetic-resonance spectrometers	27.0	30.0	32.0	39
Electron microscopes	15.5	17.0	18.0	24
pH meters and ion-selective electrodes	20.5	22.5	24.0	28
Spectrofluometers	11.5	13.5	14.0	19
Spectropolarimeters	1.0	1.5	1.8	2
Thermal analyzers, total	8.4	9.4	9.6	17
Differential	3.5	4.0	4.1	8
Thermogravimetric	1.1	1.5	1.5	2
Differential-scanning calorimetric	3.8	3.9	4.0	7
X-ray analysis equipment	30.0	35.0	39.0	51
Other	65.0	70.0	73.0	86
Power supplies, total	**348.0**	**373.0**	**420.5**	**534**
Lab and bench	85.0	88.0	90.5	104
Industrial heavy-duty	53.0	60.0	70.0	120
OEM and modular	210.0	225.0	260.0	310

(millions of dollars)

	1973	1974	1975	1978
Data-processing systems, peripherals, and office equipment, total	**13,776.5**	**15,609.4**	**16,353.0**	**22,778**
System shipments, total	6,718.0	7,102.8	6,475.0	8,580
Microcomputers	8.0	32.8	60.0	180
Mini (<$50,000)	500.0	600.0	815.0	1,000
Small ($50,000 to $420,000)	710.0	920.0	1,200.0	1,600
Medium (up to $840,000)	1,600.0	1,200.0	1,000.0	900
Medium/communication (up to $1,680,000)	1,390.0	1,450.0	1,000.0	1,100
Large (up to $3,360,000)	1,500.0	1,700.0	1,300.0	2,100
Giant (>$3,360,000)	1,010.0	1,200.0	1,100.0	1,700
Add-on memory, total	325.0	415.0	455.0	805
Core systems	175.0	165.0	145.0	115
Semiconductor systems	150.0	250.0	310.0	690
Data-storage devices, total	2,116.5	2,524.5	2,818.0	3,927
Disk	1,000.0	1,160.0	1,240.0	1,850
Flexible-disk	28.5	72.5	115.0	117
Drum	103.0	92.0	83.0	60
Magnetic-tape	985.0	1,200.0	1,380.0	1,900
Input/output peripherals, total	1,133.0	1,264.0	1,361.0	1,641
Card read/punch	220.0	235.0	240.0	275
Line printers, impact	460.0	480.0	500.0	575
Line printers, non-impact	16.0	18.0	20.0	35
Computer input/output microfilm	45.0	70.0	90.0	126
Optical character readers	285.0	350.0	400.0	525
Magnetic-ink character readers	37.0	38.0	38.0	20
Electromechanical plotters	48.0	47.0	46.0	47
Paper-tape devices	22.0	26.0	27.0	38
Key entry, total	518.0	509.0	447.0	410
Key punch/verify	295.0	265.0	215.0	150
Key-to-tape	108.0	95.0	80.0	50
Key-to-disk	75.0	79.0	72.0	60
Keyboard-to-cassette/cartridge	40.0	70.0	80.0	150
Data terminals, total	965.0	1,268.0	1,452.0	2,216
Keyboard printers	265.0	325.0	360.0	441
Video	215.0	245.0	260.0	400
Intelligent	255.0	276.0	416.0	660
Interactive graphic	42.0	68.0	75.0	130
Audio-response	8.0	10.0	12.0	15
Remote-batch	180.0	245.0	330.0	580
Source-data collection equipment, total	262.0	398.0	730.0	1,264
Point-of-sale systems, total	192.0	317.0	580.0	935
Electronic cash registers/terminals	175.0	285.0	525.0	800
Credit-authorization terminals	15.0	22.0	38.0	85
Electronic scales	2.0	10.0	17.0	50
Industrial systems (badge readers, portable units)	65.0	70.0	75.0	89
Banking systems, total	5.0	11.0	75.0	240
Cash dispensers	5.0	10.0	40.0	90
Teller terminals	–	1.0	35.0	150
Office equipment, total	1,739.0	2,128.1	2,615.0	3,935
Calculators, total	530.0	580.0	650.0	745
Programable	150.0	170.0	190.0	220
Non-programable	380.0	410.0	460.0	525
Dictation	90.0	98.0	100.0	150
Facsimile	64.0	74.1	80.0	130
Electronic typesetting	125.0	176.0	185.0	210
Accounting/bookkeeping	680.0	800.0	1,000.0	1,700
Other	250.0	400.0	600.0	1,000
Industrial electronic equipment, total	**911.9**	**1,086.4**	**1,225.5**	**1,703**
Motor controls (speed, torque)	100.5	106.5	110.0	150
Numerical controls, total	62.2	84.9	98.8	134
Point-to-point	15.0	15.7	13.0	9
Contouring	47.2	69.2	85.8	125
Inspection systems, total	28.1	30.7	33.5	47
Ultrasonic	9.7	10.0	11.0	14
X-ray	14.9	16.7	18.0	26
Infrared	2.6	3.0	3.3	5
Ultraviolet	0.9	1.0	1.2	2
Thickness gages and controls, total	58.0	62.3	71.3	104
Photoelectric	43.0	44.2	52.3	76
Radiation-based	15.0	18.1	19.0	28
Factory data-acquisition systems, total	165.0	250.0	290.0	442
Continuous process	75.0	100.0	118.0	182
Discrete process	90.0	150.0	172.0	260
Process controllers	56.4	68.8	68.8	91
Process recorders and indicators	46.0	51.0	55.7	64
Sequence controllers, total	104.8	115.6	137.0	208
Programable	19.8	35.6	69.0	158
Hard-wired	85.0	80.0	68.0	50
Ultrasonic cleaning	45.0	51.8	56.0	70
Pollution-monitoring, total	38.3	44.0	57.3	76
Air	21.5	25.0	31.5	41
Water	16.8	19.0	25.8	35
Induction and dielectric heating and sealing	27.6	28.3	29.5	35
Welding controls	12.5	9.8	11.5	17
Process-control computer systems, total	167.5	182.7	206.1	265
Digital	127.5	141.3	163.8	207
Analog	40.0	41.4	42.3	58

(millions of dollars)

	1973	1974	1975	1978
Communications equipment, total	**2,249.2**	**2,551.5**	**2,689.7**	**3,295**
Radio, total	894.2	960.5	1,014.6	1,098
Aviation mobile (including ground-support)	115.0	115.0	116.0	121
Marine mobile (including shore stations)	12.1	14.1	15.0	15
Land mobile (including base stations)	324.3	360.0	381.6	404
Microwave relay (including cable systems)	194.8	200.0	206.0	218
Satellite earth stations	226.0	248.0	272.0	310
Amateur	11.5	11.9	12.0	14
Citizens band	10.5	11.5	12.0	16
Navigation systems	136.2	140.4	148.0	160
A-m and fm station	30.8	38.5	42.6	50
TV station (excluding CATV)	155.6	156.0	152.0	160
Telemetry (industrial only)	21.5	23.6	26.0	40
Switching systems (including PABX)	225.0	260.0	280.0	360
Voice terminals (autodialers, autorecorders, etc.)	4.0	5.5	6.0	22
Paging systems	22.0	23.0	24.0	30
Intercoms	130.0	135.0	138.0	152
Laser communications systems	7.2	7.8	8.8	12
Non-broadcast TV, total	161.4	168.6	161.7	251
CATV, total	123.6	127.5	119.8	192
Studio and head-on	6.0	6.3	6.8	9
Distribution	69.0	60.0	50.0	100
Transmission lines and fittings	31.3	38.8	39.0	41
Converters	17.3	22.4	24.0	42
CCTV, total	37.8	41.1	41.9	59
Cameras	22.6	25.3	25.6	40
Monitors	7.3	7.8	8.0	9
Auxiliary	7.9	8.0	8.3	10
Video recorders and playback units (non-consumer)	16.3	18.6	19.0	22
Data communications, total	445.0	614.0	669.0	938
Modems	45.0	49.0	50.0	58
Remote concentrators	65.0	110.0	125.0	240
Message-switching systems	85.0	135.0	162.0	220
Front-end processors	210.0	270.0	282.0	330
Multiplexers	40.0	50.0	60.0	90
Medical equipment, total	**753.3**	**901.2**	**1,048.3**	**1,427**
Diagnostic, total	513.6	625.6	741.1	1,008
X-ray	368.0	460.3	557.0	780
Electroencephalographs	9.3	10.3	11.5	14
Electrocardiographs	21.5	24.5	28.0	40
Ultrasonic scanners	11.5	17.0	24.5	35
Automated blood analyzers	70.8	76.5	80.3	87
Scintillation cameras and counters	20.5	22.5	24.0	33
Audiometers	12.0	14.5	15.8	19
Patient-monitoring systems	64.0	75.0	90.0	140
Prosthetic equipment, total	115.3	131.7	139.0	170
Hearing aids	55.0	57.0	61.0	75
Pacemakers	58.5	72.5	75.0	90
Motorized limbs	1.8	2.2	3.0	5
Therapeutic, total	46.1	51.5	59.7	82
X-ray	22.0	24.6	28.3	39
Diathermy, shortwave and microwave	5.9	6.4	7.0	10
Ultrasonic generators	7.7	8.5	9.4	12
Defibrillators	9.5	12.0	15.0	21
Surgical support	15.3	17.4	18.5	27
Nuclear instruments and equipment, total	**33.4**	**39.2**	**44.3**	**63**
Spectrometers	12.2	12.6	12.9	16
Reactor controls	11.1	13.3	14.5	24
Radiation-detection and monitoring, total	10.1	13.3	16.9	23
Detectors, including ion equipment	5.5	6.2	6.9	9
Monitors, portable and fixed	1.6	2.1	3.0	6
Personal dosimeters	3.0	5.0	7.0	8
Lasers and equipment, total	**39.5**	**45.8**	**48.7**	**79**
Gas lasers	14.0	15.0	16.0	35
Semiconductor lasers	2.1	2.7	2.9	6
Other (including ruby, neodymium-doped, etc.)	15.0	18.5	19.0	21
Laser power supplies	6.4	7.2	7.8	11
Modulators	2.0	2.4	3.0	6
Automotive electronics, total	**154.2**	**182.3**	**191.0**	**590**
Voltage regulators	44.1	44.8	40.0	20
Anti-pollution systems	20.0	30.0	40.0	100
Electronic ignition systems	28.0	38.0	60.0	120
Fuel-injection systems	1.5	3.0	5.0	80
Safety systems, total	60.0	80.5	46.0	270
Anti-skid controls	5.0	25.0	33.0	150
Air-bag sensors and controls	0.6	2.5	6.0	80
Seat-belt interlocks	55.0	38.0	5.0	–
Radar collision-avoidance systems	–	1.0	2.0	40

U.S. MARKETS FORECAST 1975

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

A McGraw-Hill Publication

Electronics

FEDERAL ELECTRONICS

(millions of dollars)

	1973	1974	1975	1978
FEDERAL ELECTRONICS, TOTAL	**11,929**	**12,497**	**12,910**	**15,019**
Defense, total	**10,390**	**10,902**	**11,301**	**12,969**
Procurement, total	5,181	5,432	5,571	6,791
Communications and intelligence	997	981	991	1,348
Aircraft, related ground equipment	1,200	1,510	1,602	1,998
Missiles and space systems	2,101	2,083	2,090	2,400
Mobile and ordnance	238	233	247	300
Ships and conversions	645	625	641	745
Research, development, test, and engineering	2,848	3,010	3,040	3,110
Operations and maintenance	2,361	2,460	2,690	3,068
NASA, total	**825**	**790**	**800**	**910**
Transportation, total	**399**	**410**	**409**	**640**
FAA procurement	159	162	227	270
FAA research and development	123	120	85	100
Highway and transit systems	80	85	60	180
Health, Education, and Welfare, total	**315**	**395**	**400**	**500**
Education systems	133	130	100	170
Health-care electronics	182	265	300	330

CONSUMER ELECTRONICS

(millions of dollars)

	1973	1974	1975	1978
CONSUMER ELECTRONICS, TOTAL*	**7,014.2**	**6,768.5**	**7,186.8**	**9,586**
Television receivers, total	**3,734.4**	**3,219.2**	**3,348.8**	**4,232**
Black-and-white	610.8	558.4	553.6	560
Color	3,123.6	2,660.8	2,795.2	3,672
Audio equipment, total	**2,283.5**	**2,388.6**	**2,521.3**	**3,284**
Radios, total	769.3	761.3	804.8	997
Table, clock and portable	466.0	472.3	503.0	596
Automobile radios	303.3	289.0	301.8	401
Phonographs and radio-phonographs, total	324.6	319.6	315.1	355
Portable	148.3	148.3	147.6	171
Console	176.3	171.3	167.5	184
Tape recorders and players, total	657.3	722.4	808.1	1,049
Automobile players	224.3	241.7	277.3	369
Cassette & cartridge player/recorders	131.0	146.7	164.3	230
Reel-to-reel player/recorders	47.0	44.0	49.0	34
Tape player-radio combination	255.0	290.0	317.5	416
Hi-fi audio components	532.3	585.3	593.3	883
Other consumer products, total	**996.3**	**1,160.7**	**1,316.7**	**2,070**
Antennas, TV and radio	40.0	41.9	43.6	53
Home video player/recorders	3.0	5.0	7.0	15
Electronic organs, other instruments	252.5	277.0	315.0	437
Intrusion alarms, fire monitors	140.0	142.0	150.0	165
Electronic assembly kits	50.8	55.8	63.1	85
Microwave ovens	170.0	259.0	325.0	480
Calculators, four-function, personal	260.0	265.0	268.0	300
Electronic watches	70.0	100.0	125.0	500
Digital clocks	10.0	15.0	20.0	35

*Includes domestic-made equipment, domestic-label imports, and foreign-label imports.

(millions of dollars)

	1973	1974	1975	1978
COMPONENTS, TOTAL	**4,906.1**	**5,088.4**	**5,234.2**	**6,263**
Capacitors, total	**646.9**	**723.0**	**696.9**	**850**
Paper	76.9	85.2	78.2	84
Film	99.0	102.5	105.0	118
Electrolytic, total	241.8	282.6	267.0	345
Aluminum	114.8	136.3	131.0	169
Tantalum	127.0	146.3	136.0	176
Mica capacitors	36.0	39.3	31.3	40
Glass and vitreous enamel	6.9	6.6	6.0	4
Ceramic	144.6	161.0	164.3	201
Variable	12.2	12.6	13.1	15
Chip	17.0	20.0	21.0	28
Other	12.5	13.2	11.0	15
Connectors, total	**542.2**	**562.6**	**615.0**	**747**
Coaxial, standard size	38.5	33.3	42.8	55
Coaxial, miniature	17.6	20.0	24.3	29
Cylindrical, total	134.0	141.3	141.0	151
Standard	30.5	29.8	26.0	27
Miniature	60.0	59.0	57.0	56
Subminiature	43.5	52.5	58.0	68
Rack and panel	110.2	116.8	123.0	153
Fused	16.0	16.3	16.8	19
Printed-circuit, total	130.5	137.0	149.5	181
Card-insertion	63.0	65.0	65.0	84
Two-piece, metal-to-metal	33.0	35.0	39.0	46
Plate-module	34.5	37.0	45.5	51
Special-purpose	68.4	66.3	78.6	94
Device sockets	27.0	31.6	39.0	65
Electron tubes, total	**1,202.1**	**1,125.0**	**1,121.4**	**1,361**
Receiving	196.8	176.0	170.0	140
Power and special-purpose, total	295.6	313.0	335.9	345
High-vacuum	64.0	62.3	60.0	55
Gas and vapor	16.6	15.4	14.6	13
Klystrons	38.0	41.5	38.0	33
Magnetrons	42.0	42.5	41.0	40
TWTs, including backward-wave	48.0	58.0	83.6	92
Light-sensing	10.0	11.0	12.5	13
Image-sensing, including TV-camera and image-intensifier	30.3	31.7	33.7	41
Storage	15.8	14.5	15.0	15
Cathode-ray, except TV	22.4	26.6	28.5	35
Other	8.5	9.5	9.0	8
TV picture, black-and-white	43.2	37.0	36.0	20
TV picture, color	666.5	599.0	579.5	856
Filters, networks and crystals, total	**182.4**	**187.8**	**198.1**	**224**
Passive electric-wave filters	36.0	37.4	38.5	39
Crystal filters	29.0	30.0	32.0	35
RFI and EMI filters	38.0	40.0	42.0	48

(millions of dollars)

Filters, networks and crystals *(continued)*	1973	1974	1975	1978
Active filters	3.0	4.3	6.0	11
RC networks	9.4	9.5	10.7	18
Delay lines	15.0	14.0	14.3	14
Quartz crystals, mounts, and ovens	52.0	52.6	54.6	59
Magnetic, total	**304.5**	**321.0**	**336.5**	**370**
Computer memory cores	30.0	32.0	30.0	22
Transformers, chokes, except TV, total	198.5	211.9	228.5	273
Laminated	128.0	136.9	147.7	176
Toroidal	43.5	46.0	49.7	59
Pulse transformers	27.0	29.0	31.0	38
TV magnetic components	56.0	57.0	58.0	59
RF coils	20.0	20.1	20.0	16
Microwave hardware, total	**78.8**	**83.5**	**88.5**	**106**
Mixers	10.0	10.5	11.3	13
Detectors	3.4	3.4	3.7	4
Passive components, total	33.5	35.1	37.0	47
Waveguide type	8.5	8.0	9.0	11
Coaxial and stripline	25.0	27.1	28.0	36
Switches, total	10.0	10.9	11.8	13
Waveguide	3.0	3.7	3.8	4
Coaxial and stripline	7.0	7.2	8.0	9
Ferrite devices, total	18.9	19.9	20.7	25
Isolators	4.7	4.9	5.2	7
Circulators	10.2	11.0	10.7	12
YIG devices	4.0	4.0	4.8	6
Power limiters	3.0	3.7	4.0	4
Printed-circuit boards, total	**233.0**	**252.1**	**250.6**	**294**
Single-layer	21.0	21.3	20.7	19
Two-layer	136.5	145.0	143.8	158
Multilayer	64.0	72.3	72.3	95
Flexible	11.5	13.5	13.8	22
Readout devices, total	**134.3**	**153.9**	**173.5**	**260**
Discrete, total	38.7	43.6	45.8	70
Gas-discharge	4.5	3.8	3.0	2
Incandescent	10.0	11.0	12.3	18
Fluorescent	1.2	1.3	1.5	2
Light-emitting-diode	23.0	27.5	29.0	48
Multidigit, total	95.6	110.3	127.7	190
Gas-discharge	23.5	20.0	21.0	28
Light-emitting-diode	63.0	76.0	85.0	118
Liquid-crystal	1.6	3.5	8.7	19
Plasma panel	3.0	5.0	6.0	12
Other	4.5	5.8	7.0	13
Relays, total	**359.6**	**381.2**	**405.8**	**475**
General-purpose	110.3	102.6	105.6	106

(millions of dollars)

Relays *(continued)*	1973	1974	1975	1978
Telephone-type	34.0	38.0	38.5	45
Crystal-can	23.0	25.5	26.7	32
High-sensitivity	15.0	18.0	20.0	25
Reed	42.5	45.8	49.3	59
Stepping and impulse	7.0	6.5	6.5	4
Time-delay	18.3	22.5	25.8	35
Solid-state	14.5	20.3	24.3	41
Other	95.0	102.0	109.1	128
Resistors, total	**450.9**	**460.8**	**474.7**	**551**
Fixed, total	219.1	220.4	224.3	241
Composition	73.3	70.6	68.0	68
Deposited-carbon	22.5	23.5	26.0	26
Metal-film	61.3	62.3	65.0	76
Wirewound	62.0	64.0	65.3	71
Variable, total	169.9	173.1	176.1	205
Potentiometers, wirewound	29.0	28.5	27.8	30
Potentiometers, non-wirewound	73.9	76.1	77.8	91
Trimmers, wirewound	26.8	25.5	24.3	24
Trimmers, non-wirewound	40.2	43.0	46.2	60
Other	18.0	18.5	20.0	26
Resistive networks, total	43.9	48.8	54.3	79
Switches, total	**255.0**	**278.5**	**290.0**	**366**
Small-movement snap-action	50.0	51.7	53.7	65
Lighted	37.6	43.6	49.0	68
Push-button	25.0	25.0	27.5	37
Toggle	16.0	18.0	21.0	26
Slide	11.0	11.7	12.0	17
Rotary	33.2	34.0	31.8	34
Coaxial	10.2	10.8	10.5	10
Thumbwheel	12.5	12.0	12.5	17
Keyboard, single-key	13.5	14.0	14.0	20
Keyboard, assemblies	41.0	52.7	53.0	60
Solid-state, including Hall-effect	5.0	5.0	5.0	12
Transducers, total	**77.2**	**83.5**	**89.9**	**109**
Pressure	26.5	29.2	32.0	40
Position	10.7	11.8	13.1	18
Strain	18.3	19.0	20.0	20
Acceleration	8.9	9.7	10.6	14
Other	12.8	13.8	14.2	17
Wire and cable, total	**439.2**	**475.5**	**493.3**	**550**
Coaxial cable	113.0	120.0	123.0	130
Flat and flexible cable	12.7	15.0	15.8	22
Hook-up wire	104.5	120.0	114.5	133
Magnet wire	90.0	94.0	96.8	100
Multiconductor, shielded	59.0	60.5	64.7	70
Multiconductor, unshielded	60.0	66.0	78.5	95

	1973	1974	1975	1978
SEMICONDUCTORS, TOTAL	**2,097.7**	**2,466.5**	**2,558.4**	**3,539**
Discrete, conventional devices, total	**628.6**	**691.0**	**666.5**	**694**
Transistors, total	427.8	472.8	454.2	491
Silicon bipolar, total	365.8	404.0	390.2	416
Small signal (<1-W dissipation)	191.8	196.9	174.1	119
Power (≥1-W dissipation)	174.0	207.1	216.1	297
Germanium bipolar, total	30.0	28.0	21.5	12
Small signal (<1-W dissipation)	10.0	9.0	5.0	2
Power (≥1-W dissipation)	20.0	19.0	16.5	10
Field effect	32.0	40.8	42.5	63
Diodes and rectifiers, total	200.8	218.2	212.3	203
Signal diodes, total	48.3	48.3	42.2	32
Germanium	4.3	3.3	2.7	1
Silicon	44.0	45.0	39.5	31
Zener diodes, total	45.5	52.5	54.0	54
Voltage regulator	36.5	41.5	42.0	38
Reference	9.0	11.0	12.0	16
Rectifiers, total	107.0	117.4	116.1	117
Silicon	82.0	90.4	93.1	101
Selenium, copper oxide	11.0	12.0	10.0	7
Rectifier assemblies	14.0	15.0	13.0	9
Discrete, special devices, total	**147.8**	**169.7**	**177.9**	**201**
Thyristors (SCRs 4-layer diodes, etc.)	80.5	96.4	103.1	114
Tunnel diodes	4.0	3.6	2.0	1
Microwave diodes, total	18.4	19.9	21.2	28
Avalanche	0.5	0.9	1.0	2
P-i-n	6.0	6.0	6.5	8
Gunn	0.8	1.3	1.7	3
Varactor	7.3	7.7	7.5	10
Mixer and detector	3.8	4.0	4.5	5

Discrete, special devices *(continued)*	1973	1974	1975	1978
Microwave transistors	11.9	14.8	17.6	23
Tuner varactors (<1 GHz)	8.0	8.0	8.0	8
Multiple devices (duals, diodes arrays, Darlingtons, etc.)	20.0	22.0	21.0	22
Other special devices (temperature-sensing, strain gage, etc.)	5.0	5.0	5.0	5
Integrated circuits, total	**1,133.4**	**1,381.7**	**1,482.4**	**2,226**
Digital logic, total	642.1	740.3	719.5	841
RTL	4.5	3.7	2.5	1
DTL	56.0	52.0	46.0	30
TTL	310.0	377.3	380.4	353
ECL	43.3	58.0	61.0	76
C-MOS	41.0	81.3	99.6	231
Other	187.3	172.0	130.0	150
Semiconductor memory, total	197.1	266.8	340.3	630
Read-only, total	56.0	71.8	95.5	169
Bipolar	30.0	42.5	54.0	119
MOS	26.0	29.3	41.5	50
Random-access, total	110.3	161.8	209.0	422
Bipolar	39.0	45.8	55.1	126
n-MOS	9.0	32.8	61.5	221
p-MOS	60.5	78.7	82.5	40
C-MOS	1.8	4.5	9.9	35
Shift registers, total	30.8	33.2	35.8	39
Bipolar	1.0	1.7	1.7	3
MOS	29.8	31.5	34.1	36
Microprocessors, total	10.0	28.0	53.5	192
CPUs	2.5	5.0	17.0	54
Associated memory	4.5	15.5	26.0	105

Integrated circuits *(continued)*	1973	1974	1975	1978
Input/output	3.0	7.5	10.5	33
Calculator chips, total	79.0	102.7	124.0	196
Single chips	49.0	56.5	70.0	113
Multichip sets	30.0	46.2	54.0	83
Other digital functions	20.0	24.0	25.0	30
Analog ICs, total	185.2	215.9	220.1	337
Op amps	55.8	63.5	64.1	95
Other, total	129.4	152.4	156.0	242
Industrial	35.6	42.2	43.7	52
Communications	25.0	31.0	32.0	37
Consumer	39.8	43.7	43.8	80
Interface	29.0	35.5	36.5	73
Optoelectronic devices, total	**61.2**	**71.2**	**76.5**	**145**
Photovoltaic cells	7.2	7.4	7.8	10
Photoconductive cells	4.5	4.4	4.3	3
Light-emitting diodes	18.0	20.0	21.0	36
Photodiodes, including arrays	4.5	5.5	5.5	8
Phototransistors, including arrays	10.0	11.5	12.0	15
Couplers and isolators	13.0	17.0	20.5	64
Silicon targets	4.0	5.4	5.4	9
Multicomponent or hybrid circuits, total (two or more separate active or passive components or ICs in a single package)	**126.7**	**152.9**	**155.1**	**273**
Custom hybrid	45.0	61.0	62.0	163
Op amps	39.8	40.0	34.6	23
Power supplies and regulators	5.2	4.5	4.9	7
Data modules, total	36.7	47.4	53.6	80

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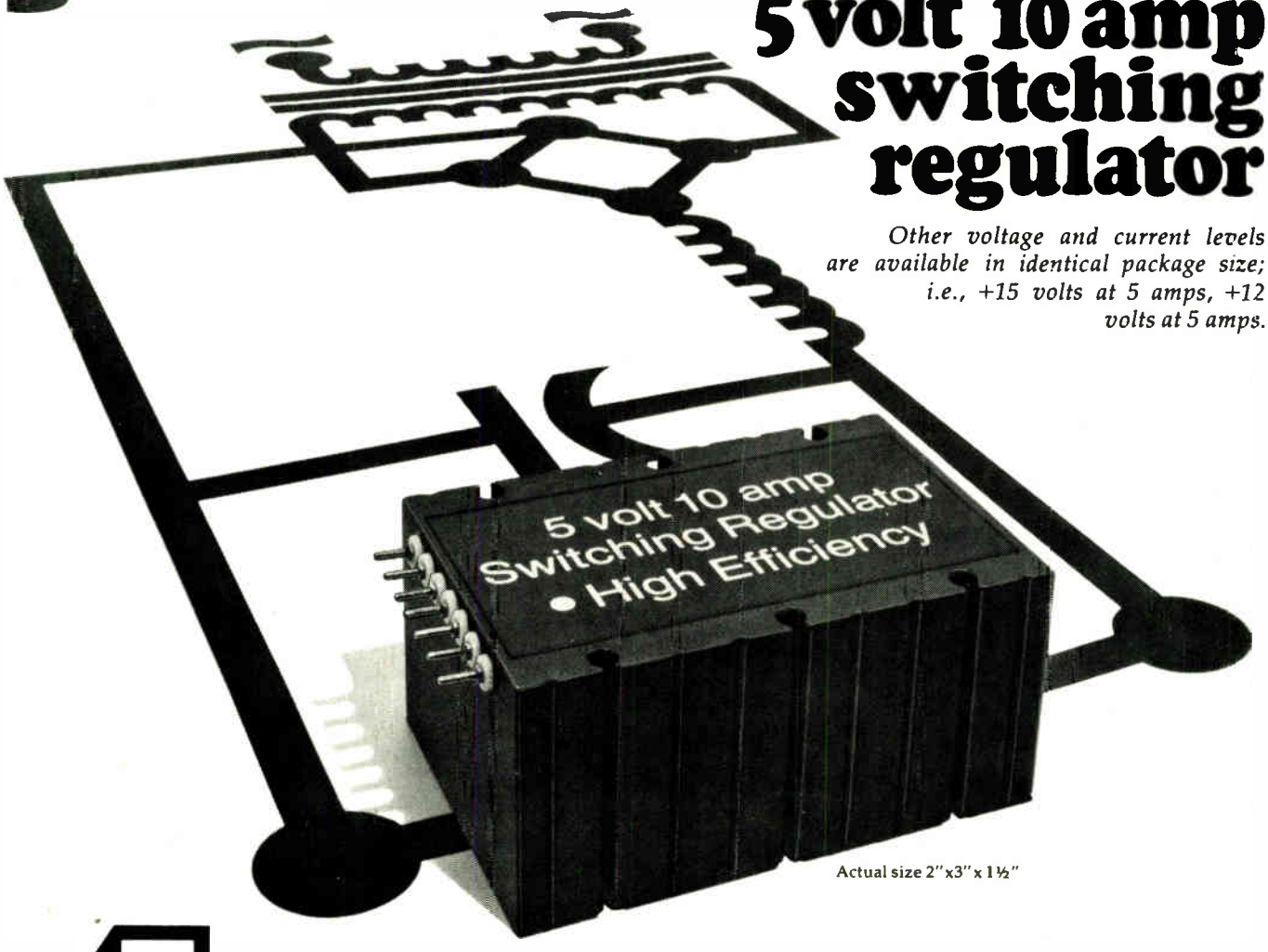

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C-MOS specifications: Don't take them for granted

Although most C-MOS parameters have standard definitions, several important ones, like noise immunity and worst-case propagation delay, are specified differently by various manufacturers

by Rob Walker, *Fairchild Camera and Instrument Corp., Mountain View, Calif.*

□ Complementary-MOS devices constitute one of today's fastest growing logic families because they offer several distinct advantages, two of the more important being low power dissipation and the capability to operate over a wide range of power-supply voltages. Unfortunately, many rule-of-thumb design techniques that are good for bipolar transistor-transistor logic just don't apply to C-MOS.

Also, with bipolar logic, there is a high degree of standardization of specifications between manufacturers, and between part types. In contrast, many key C-MOS specifications vary substantially from part to part, with different test conditions given, or even omitted in some instances.

This is not to say the disadvantages of C-MOS outweigh the advantages. Table 1 compares C-MOS to several other commercial logic families. Under static conditions, C-MOS consumes less power than standard TTL by a factor of 10^6. And while C-MOS is substantially slower than other logic ICs—except for diode-transistor logic and low-power TTL—its noise immunity is considerably higher. And C-MOS, to improve both its noise immunity and speed, can often be operated at supply voltages higher than the usual 5 V.

But the problem of nonstandard C-MOS specifications is a serious one. Table 2 provides an illustration of how serious. The maximum low-level output drive specifications are given here for several types of C-MOS devices from different manufacturers. The output-drive specification is important because it is a measure of a device's worst-case circuit speed into the load capacitance, and of the device's capability to drive bipolar logic.

As Table 2 shows, there is no real standardization among manufacturers on this point. More surprisingly, there is often no standardization between various devices from the same manufacturer. The same state of affairs applies to a number of other C-MOS parameters, forcing the designer to carefully examine the worst-case specifications of the particular C-MOS devices he will be using.

There are, however, a number of C-MOS specifications fairly standard within the industry, including current, voltage, and ac-switching parameters. These are defined in Table 3.

Noise immunity, a very important parameter, is one that does not have the benefit of a standard definition. Figure 1(a) shows typical transfer characteristics for a TTL gate, a buffered C-MOS gate, and an unbuffered (single-stage) C-MOS gate. The high noise immunity of C-MOS is due to the sharp transition of its characteristic.

Noise specs aren't standard

Since the input-threshold voltage of C-MOS tracks the drain-supply voltage, the "typical" noise immunity is normally 45% of the supply voltage. However, production tolerances and temperature effects can reduce this "typical" value to worst-case limits.

The logic-low and logic-high noise-immunity levels (V_{NL} and V_{NH}, respectively) that are specified by most C-MOS manufacturers are supposedly worst-case. In reality, they are simply the difference between the power-supply voltages and the worst-case inputs. The true worst-case noise-immunity levels are represented by:

$$V_{NL} = V_{IL(min)} - V_{OL(max)}$$

and:

$$V_{NH} = V_{OH(min)} - V_{IH(max)}$$

This is the definition commonly used with other logic families, such as TTL and ECL (emitter-coupled logic). By any definition, however, C-MOS has a larger voltage-noise margin than any other logic family.

There are other factors that enter into the considera-

TABLE 1: LOGIC FAMILY COMPARISON

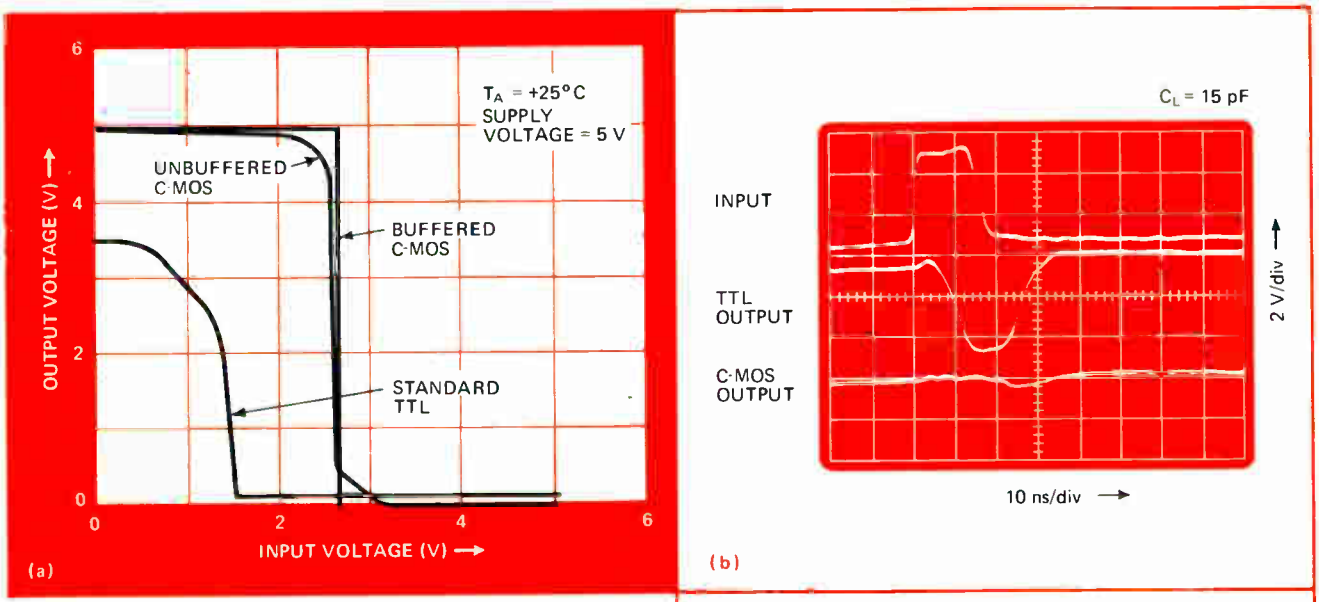
Parameter	Standard TTL	Low-power TTL (74L)	DTL	Low-power Schottky	C-MOS (5-V supply)	C-MOS (10-V supply)
Propagation delay	10 ns	33 ns	30 ns	5–10 ns	35 ns	25 ns
Flip-flop toggle frequency	35 MHz	3 MHz	5 MHz	40–80 MHz	5 MHz	10 MHz
Quiescent power	10 mW	1 mW	8.5 mW	2 mW	10 nW	10 nW
Noise immunity	1 V	1 V	1 V	0.8 V	2 V	4 V
Fanout	10	10	8	20	50*	50*

*Or as determined by allowable propagation delay

TABLE 2: VARIATION OF LOW-LEVEL OUTPUT DRIVE SPECIFICATION*

C-MOS Device	Fairchild	Motorola	National Semiconductor (4000)	National Semiconductor (74C**)	RCA (4000A)	RCA (4000B)	Solid State Scientific	Solitron	Texas Instruments	Harris	Signetics
Gates, commercial	0.4 mA at 0.4 V	0.2 mA at 0.4 V	0.24 mA at 0.4 V	0.36 mA at 0.4 V	0.24 mA at 0.4 V	0.36 mA at 0.4 V	0.28 mA at 0.4 V	0.24 mA at 0.4 V	0.25 mA at 0.4 V	0.095 mA at 0.5 V	0.05 mA at 0.5 V
Gates, military	0.4 mA at 0.4 V	0.4 mA at 0.4 V	0.28 mA at 0.4 V	0.36 mA at 0.4 V	0.28 mA at 0.4 V	0.36 mA at 0.4 V	0.28 mA at 0.4 V	0.28 mA at 0.4 V	0.3 mA at 0.4 V	0.175 mA at 0.5 V	0.085 mA at 0.5 V
Flip-flops, commercial	0.4 mA at 0.4 V	0.2 mA at 0.4 V	0.24 mA at 0.5 V	0.36 mA at 0.4 V	0.24 mA at 0.5 V	0.36 mA at 0.4 V	0.35 mA at 0.5 V	0.4 mA at 0.5 V	0.25 mA at 0.4 V	0.24 mA at 0.5 V	0.24 mA at 0.5 V
Flip-flops, military	0.4 mA at 0.4 V	0.4 mA at 0.4 V	0.4 mA at 0.5 V	0.36 mA at 0.4 V	0.35 mA at 0.5 V	0.36 mA at 0.4 V	0.35 mA at 0.5 V	0.24 mA at 0.5 V	0.3 mA at 0.4 V	0.35 mA at 0.5 V	0.35 mA at 0.5 V
MSI, commercial	0.4 mA at 0.4 V	0.2 mA at 0.4 V	?	0.36 mA at 0.4 V	0.048 mA at 0.5 V	0.36 mA at 0.4 V	0.3 mA at 0.5 V	0.048 mA at ?	?	?	?
MSI, military	0.4 mA at 0.4 V	0.4 mA at 0.4 V	?	0.36 mA at 0.4 V	0.085 mA at 0.5 V	0.36 mA at 0.4 V	0.3 mA at 0.5 V	0.085 mA at ?	?	?	?

*Worst-case drive at high temperature (V_{DD} = 5 V) **Measured at V_{DD} = 4.75 V for commercial devices, V_{DD} = 4.5 V for military devices



1. Voltage-noise Immunity. Sharp transfer characteristic (a) of a C-MOS gate accounts for this device's superior voltage-noise immunity over a TTL gate. C-MOS ac-noise immunity is better, too. As shown in (b), a C-MOS gate will reject a 15-nanosecond pulse, while a TTL gate will transmit it. A TTL gate will also pass 25-megahertz noise (b), whereas a C-MOS gate will not.

tion of noise immunity, like the ability to reject fast signals (ac noise immunity) and the susceptibility to external noise sources.

C-MOS, because it is slower than most other logic families, has greater ac-noise immunity. Figure 1(b) shows what happens when a 15-nanosecond pulse is applied simultaneously to a TTL gate and a C-MOS gate. Being faster, the TTL gate transmits the pulse, while the slower C-MOS gate rejects it. Figure 1(c) further illustrates the superior noise immunity of C-MOS. Here the low speed and typical 2.4-V low-level noise immunity of a C-MOS gate reject the 25-megahertz noise input, while the TTL gate passes it.

A discussion of noise immunity purely in terms of

TABLE 3: STANDARD C-MOS SPECIFICATIONS

PARAMETER	SYMBOL	DEFINITION
Input current	I_{IN}	Current flowing into device at specified input voltage and V_{DD}
Output high current	I_{OH}	Drive current flowing out of device at specified logic-high output voltage and V_{DD}
Output low current	I_{OL}	Drive current flowing into device at specified logic-low output voltage and V_{DD}
Quiescent power-supply current	I_{DD}	Current flowing into drain terminal at specified input and V_{DD} conditions
Source voltage	V_{SS}	Most negative power supply; used as reference level for other voltages; typically ground
Drain voltage	V_{DD}	Most positive potential on device; typically +5 or +10 V
Input high voltage	V_{IH}	Range of input voltages that represent high logic level
Input low voltage	V_{IL}	Range of input voltages that represent low logic level
Minimum input high voltage	$V_{IH\ (min)}$	Minimum allowed input high-logic level
Maximum input low voltage	$V_{IL\ (max)}$	Maximum allowed input low-logic level
Output high voltage	V_{OH}	Range of voltages at output terminal with specified output loading and supply voltage; device inputs are conditioned to establish high logic level at output
Output low voltage	V_{OL}	Range of voltages at output terminal with specified output loading and supply voltage; device inputs are conditioned to establish low logic level at output
Propagation delay time, low to high	t_{PLH}	Time between specified reference points (normally 50% points) on input and output voltage waveforms, when output changes from defined low logic level to defined high logic level
Propagation delay time, high to low	t_{PHL}	Time between specified reference points (normally 50% points) on input and output voltage waveforms, when output changes from defined high logic level to defined low logic level
Transition time, low to high	t_{TLH}	Time between two specified reference points (normally 10% and 90% points) on a waveform that is changing from low to high
Transition time, high to low	t_{THL}	Time between two specified reference points (normally 90% and 10% points) on a waveform that is changing from high to low

All voltages are referenced to V_{SS}
Positive current is conventional current flow into device
Negative current is conventional current flow out of device

voltage is, of course, an oversimplification. Inductive or capacitive crosstalk from external noise sources, like relays and motors, also introduces spurious signals through the effective impedance of a circuit. The higher the output impedance of a logic element, therefore, the easier it is for extraneous noise to be impressed on the element and for faulty operation to occur.

Table 4 illustrates typical noise-immunity voltages and output impedances for TTL and C-MOS. With these parameters, the noise current sufficient to cause false operation can be determined. The noise current from external sources required to switch a C-MOS device is actually quite low, making TTL superior in this respect. In regard to noise immunity, then, C-MOS is unbeatable from a voltage and ac noise standpoint, but susceptible to noise from outside sources.

Delay times should be worst-case

C-MOS propagation delay provides another trap for the unwary. It is usually specified at drain-voltage levels of 5 and 10 v, with a 20-ns input transition and a 15-picofarad output-load capacitance and at an ambient temperature of 25°C. In reality, any similarity between these conditions and actual conditions is purely coincidental. An output load of 15 pF seems to be standard for all logic families. In all likelihood, this value was probably set years ago by some marketing man trying to pass off resistor-transistor logic as being fast.

With C-MOS, a load of 15 pF corresponds to a fanout of 1 or 2—hardly a worst-case condition. Furthermore, as Fig. 2(a) illustrates, C-MOS is significantly more sensitive to capacitive loading than TTL. Because of the unlimited dc fanout of C-MOS, some logic designer is sure to try for a fanout of 30 or so. If he neglects the increased propagation delay caused by the larger load capacitance, his system can be slowed by an order of magnitude or more.

To obtain a true estimate of worst-case propagation delays, the designer must first determine the typical capacitance per fanout for his system. Then he may find the correct propagation delays for that factor from the curves of delay time versus the capacitance, supplied with every C-MOS device. When the design is complete, the capacitance estimates should be double-checked and final worst-case propagation delays calculated. (Most C-MOS manufacturers, including Fairchild and RCA, will soon be specifying propagation delay at the more realistic load-capacitance value of 50 pF.)

No matter the vendor, C-MOS propagation delay is consistently specified for an input transistion of 20 ns. Naturally, in a real system, transition times are almost always greater, causing propagation delays to be different than those indicated on the data sheet. There are several possible reasons for this difference. Figure 2(b),

TABLE 4: NOISE IMMUNITY, C-MOS VS TTL

Parameter	Standard TTL	Low-power TTL	C-MOS (V_{DD} = 5 V)	C-MOS (V_{DD} = 10 V)
Typical output impedance	100	10	400	200
Typical noise immunity	1.5 V	1 V	2.5 V	5 V
Noise current required to induce noise	15 mA	100 mA	6.25 mA	25 mA

for example, shows how the delay of a C-MOS gate depends on its driving source. The delay of a gate driven by a pulse generator is smaller than that of a gate driven by another similar gate.

Temperature and power-supply voltage also influence propagation delay. Curves for determining the effects of these two factors are supplied with each C-MOS device. Generally, propagation delay increases with increasing temperature and/or decreasing power-supply voltage.

In summary, then, to determine the worst-case propagation delay for a C-MOS device: start with the manufacturer's specified delays; derate these if the actual output capacitance exceeds 15 pF; derate again for input transitions in excess of 20 ns; correct for the lowest supply voltage that will be encountered; and, lastly, derate once again for an ambient temperature of greater than 25°C.

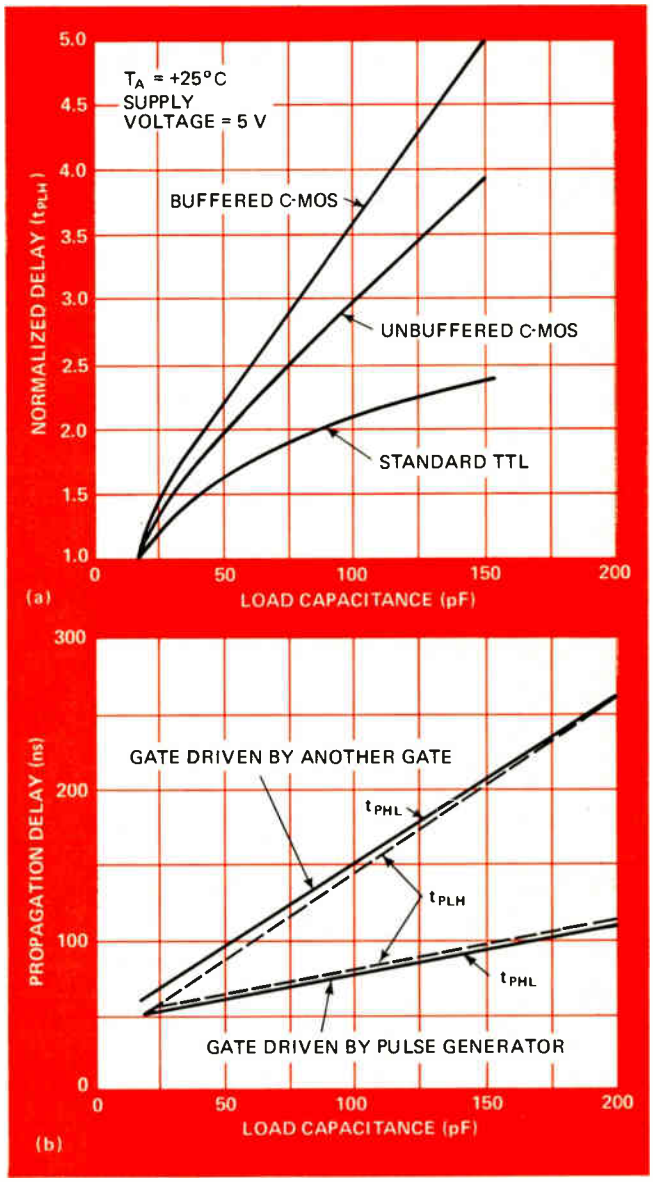
Power considerations

The power dissipation of C-MOS is almost entirely a function of input frequency, and ranges from essentially zero at dc to over 5 milliwatts at 5 V and 5 MHz. The power-comparison plot of Fig. 3 illustrates just how little power C-MOS dissipates, compared to other popular logic families.

Since low power dissipation is probably the most attractive feature of C-MOS, the designer must pay special attention to how he computes it. Total power dissipation can be broken into four components: dc or quiescent power; the charging and discharging of internal capacitances; the current transient that occurs during switching (when both the n-channel and p-channel C-MOS transistors conduct momentarily); and the charging and discharging of external load capacitance.

Dc power can quickly be determined by taking the value of the quiescent supply current (I_{DD}) from the data sheet and multiplying it by the drain voltage (V_{DD}) being used. The ac effects of internal capacitances and current spiking can be lumped together, and the value of this transient-power dissipation can be found on the data sheet. Finally, the effects of external load capacitance (C_L) can be computed as the product of $C_L \times V_{DD}^2 \times f$, where f is the operating frequency, and C_L is an estimated value. The total power dissipation is simply the sum of these individual dc, transient, and load components of power.

Because of the wide operating voltage range of C-MOS, the designer has considerable freedom in selecting his nominal supply voltage and the supply regulation, making possible cost savings unavailable with

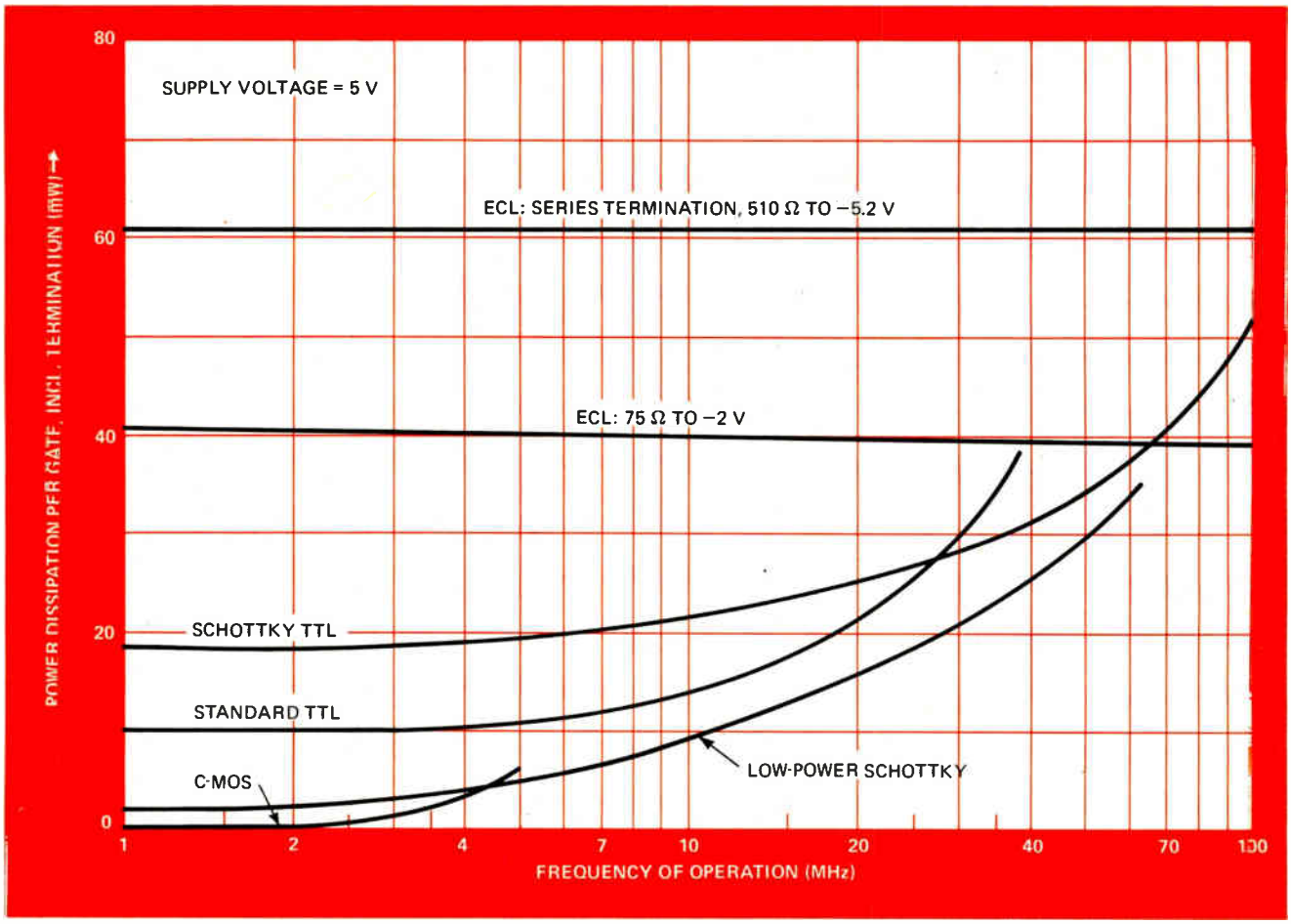


2. Propagation delay. Plot (a) shows that C-MOS delay time is more sensitive to load capacitance than TTL. Besides load capacitance, delay time also depends on the driving source (b).

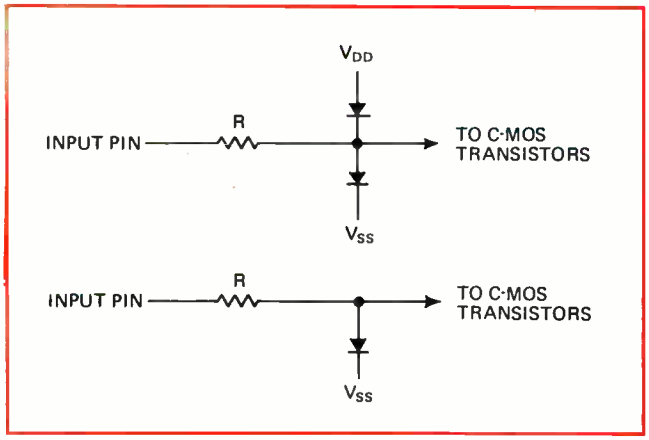
other logic forms. As his C-MOS power source, the designer can realistically consider using an unregulated supply, batteries, or an existing nonlogic power supply.

The power-supply-regulation requirements of C-MOS are relatively lax, compared to those of other logic families. For proper device noise immunity, propagation delay, power dissipation, and interface with other logic forms, the miniumum drain voltage must be 3 V or higher, while the maximum drain voltage must be 15 V or lower. Without external current-limiting protection, a C-MOS device can be permanently damaged if drain voltage ever exceeds 18 V, even momentarily.

Like all MOS devices, C-MOS devices require special input protection to guard them against damage from static charges. The various manufacturers use different protection circuits, like the typical one- and two-diode schemes drawn in Fig. 4. When static charge is present at the input pin, the diodes will either conduct in the



3. Power comparison. Probably the principal advantage of C-MOS is its exceptionally low power dissipation, which is significantly below that of any other commercial logic family. The power dissipation of a C-MOS device depends principally on operating frequency.



4. On guard. All C-MOS devices require input protection against damage from static charges during handling. Typical one- and two-diode schemes are shown here. The designer should not count on these diodes for his special circuits because different manufacturers use different protection schemes.

forward direction (at about 1 V) or breakdown in the reverse direction (at about 30 V). The resistor limits the peak current that can flow.

All such input protection schemes suffer from two limitations. They cannot take the very large voltages (some as high as 10,000 V) that are generated during handling under certain climatic conditions. Also, there is no standard measurement criterion to evaluate the effectiveness of the internal input protection of a C-MOS device.

Because of the handling sensitivity of C-MOS, certain precautions should be observed: never leave an input pin floating in a circuit. Connect all inputs to the source supply, the drain supply, or a device output, as required for circuit operation. Always store C-MOS devices in conductive foam or tubes. And remember to ground all test equipment, tools, and soldering irons.

In normal digital system operation, the input-protection diodes never conduct. But when C-MOS devices are used for special circuit applications, such as oscillators or integrators, the input voltages may exceed V_{DD} or V_{SS}, and the diodes may conduct. Although this is permissible, as long as maximum current levels (generally 10 milliamperes) are not exceeded, it can lead to problems because some manufacturers use two diodes while others use only one.

Additionally, the input-protection circuits can be restructured without the designer's knowledge. In other words, he must deal with all the dangers inherent in designing around an unspecified parameter. For special applications, it is probably worth the extra trouble and cost to use external discrete diodes and not depend on the internal-input-protection diodes. □

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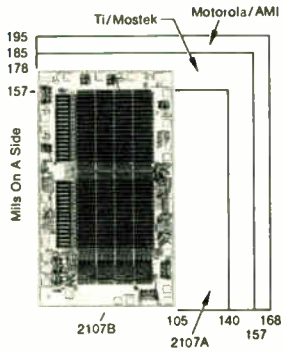

4K RAM CHIP SIZE COMPARISON WITH INTEL'S NEW 2107B.

The 2107B is already being shipped in quantities and replacing cores in many random access memory applications. Because of its low cost, it's also being used in serial memory applications. Intel distributors now stock two types: the basic 2107B accesses in 200 ns and cycles in 400 ns; the 2107B-4 runs at 270 ns access and 470 ns cycle times (all worst case from 0 to 70°C).

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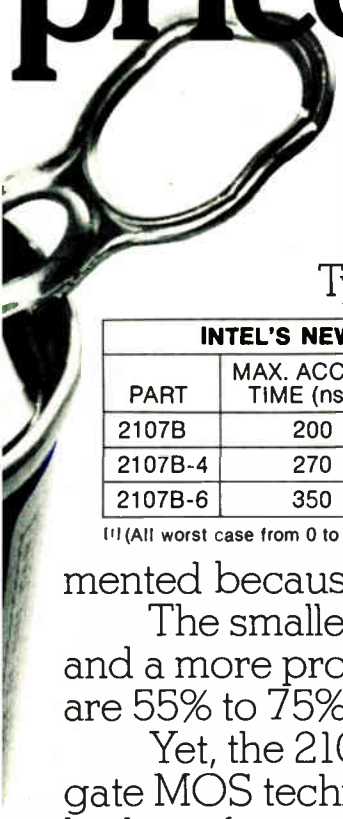

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2107B-6	350	800	Now

[1] (All worst case from 0 to 70°C.)

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Negative feedback keeps LED intensity constant

by Ken Erickson
Interstate Electronics Corp., Anaheim, Calif.

In applications where a passing object is detected as it partly obscures a light beam, a light source with a constant intensity may be desirable. A light-emitting diode, which has a longer life and switches faster than an incandescent lamp, would also be desirable, if it weren't for the fact that its light intensity may vary with temperature, especially as the device ages. But a LED's light intensity can be kept constant by the circuit shown here.

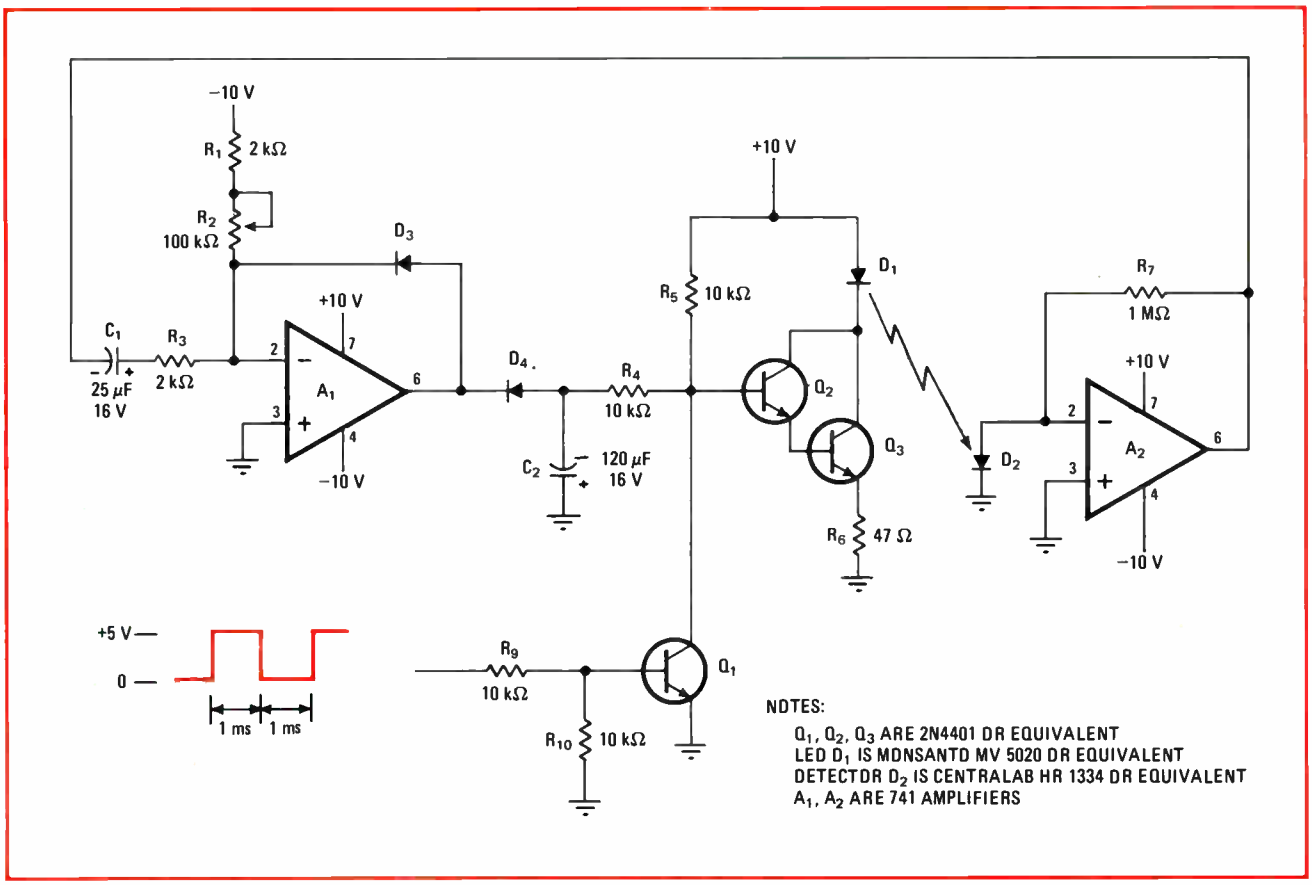
Light intensity is regulated by a silicon planar photovoltaic diode, D_2, the ac response of which is almost constant with temperature or time. Its current is converted to voltage by amplifier A_2 and resistor R_7. This diode is connected in a short-circuit mode to minimize its dark current.

D_1, a light-emitting diode, is driven by Darlington-connected transistors Q_2 and Q_3; its current is proportional to the voltage at the base of Q_2. Transistor Q_1, which is driven by a positive-going square wave, chops the dc level at the base of Q_2 so that it operates in an ac mode.

When the capacitively coupled output of amplifier A_2 is positive, amplifier A_1 charges capacitor C_2, when necessary, to maintain the current through R_3 equal to the current through R_1 and R_2. Because the current through R_1 and R_2 is constant, the amplitude of the square-wave signal at the junction of C_1 and R_3 is held constant.

When the output of A_2 is negative, the capacitively-coupled output of amplifier A_1 goes positive, but is clamped to 0.7 volt by diode D_3. This clamping maintains the output of the amplifier in the active region so that a virtual ground potential is maintained at its summing point. The light intensity level is adjusted by potentiometer R_2. The peak-to-peak voltage at the output of amplifier A_2 is held at $40/(R_1 + R_2)$ volts, where R_1 and R_2 are in kilohms.

Diode D_2 can be mounted near the LED, but to one side of the direct beam, so that it picks up enough light to generate the feedback signal but doesn't interfere with the primary detection function. □



Steady glow. Feedback loop senses variations in output of light-emitting diode, which may occur as temperature changes. Photodiode response is almost constant with temperature; it is amplified, and signal controls another amplifier whose output controls LED drive circuit.

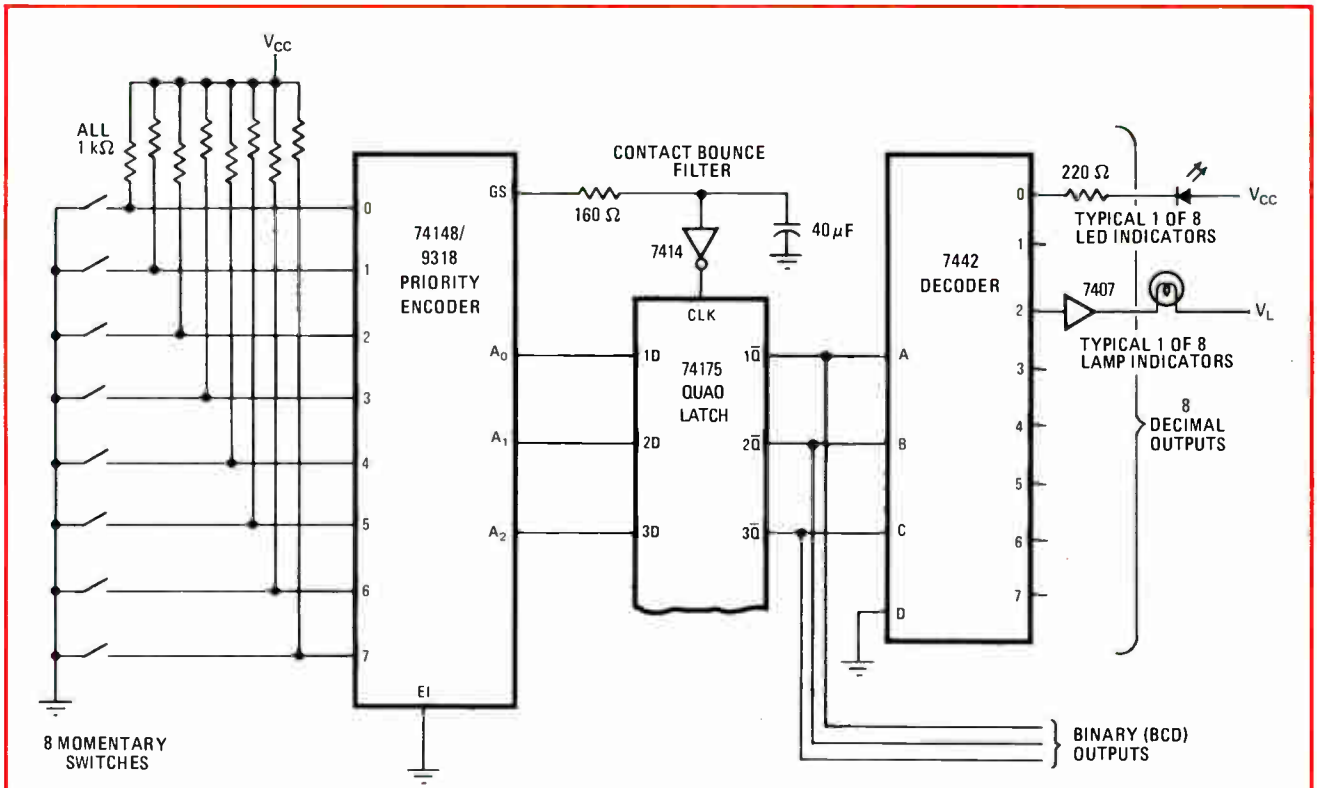
Latch circuits interlock remote switches electrically

by Jack Elias
Honeywell Inc., Fort Washington, Pa.

As many as eight momentary switches can be interlocked electrically even when they are physically separated from one another—an impossible task for mechanical interlocks. The keyboard-type momentary switches provide both binary-coded and individual outputs and are much more reliable than mechanically interlocked switches. The electrical interlock consists of an encoder, decoder and quad switch latch plus a Schmitt trigger and a few passive components.

The switches provide the inputs to a priority encoder, such as a TI 74148 or Fairchild 9318, which translates the identity of any actuated switch into a binary-coded output. The encoder also has an output, termed GS, for group-select, indicating when any one or more inputs are actuated; it provides a clock pulse for a 74175 quad latch, which stores the binary-coded output of the encoder. An RC filter and a Schmitt trigger remove uncertainty caused by switch bounce. The outputs of the flip-flops go to a 7442 decoder, which can drive either light-emitting diodes directly or incandescent lamps through buffers. Of course, the outputs can drive other circuits or systems that require the interlock.

If a second switch is actuated before the first is released, it has no effect because the Schmitt trigger has already generated its clock. Likewise, if the first switch is released while holding the second one down, the first switch's indication will be held until all the switches are released. The circuit can be expanded by cascading the encoders and using a larger decoder. □



Interlock. Momentary switches are interlocked from simultaneous operation by encoding them into a set of latches and then decoding the latch states to drive indicators or other apparatus. Circuit is more reliable than mechanical interlock, and switches can even be remote.

Common silicon diodes stabilize oscillator

by Dale Hileman
Sphygmetrics Inc., Woodland Hills, Calif.

Two ordinary silicon diodes connected front-to-back in the feedback path of a Wien-bridge oscillator stabilize the feedback without introducing hunting or distortion. Stabilization makes them superior to the more commonly used thermistors or incandescent lamps, which have thermal inertia that introduces hunting when power is turned on or the frequency is changed, and to zener diodes, which distort the waveform.

The front-to-back connection of the silicon diodes simulates a back-to-back series connection of zener diodes, which might otherwise be used at this point in the circuit. Resistor R_1 is added to soften the effect of the knee of the forward-conduction characteristic, which would otherwise introduce distortion.

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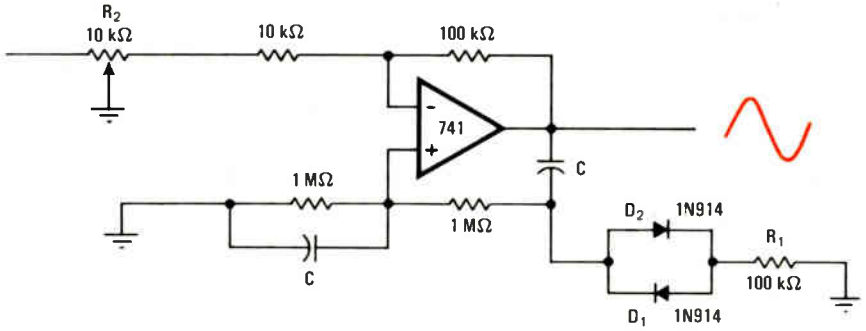
The best way to change the frequency of this circuit is to change the two capacitors, which must be closely matched. By this means, the output amplitude is always the same, regardless of the frequency. With the circuit values shown, amplitude is constant within ±0.3 dB over range of 100,000 to 1.

The setting of potentiometer R_2 establishes the amplitude, but it also affects the frequency somewhat. □



C	f
100 pF	5 kHz
1000 pF	500 Hz
0.01 μF	50 Hz
0.1 μF	5 Hz
1 μF	0.5 Hz
10 μF	0.05 Hz

Stabilizer. Front-to-back diodes in oscillator's feedback path acts as stabilizer, yet do not cause hunting or distortion, as lamps or zeners sometimes do. Capacitors, which control frequency, are matched; amplitude control is by potentiometer, which also affects frequency.

FET programs op amp for invertible gain

by Ken A. Dill and Mark Troll
Revelle College, University of California, La Jolla, Calif.

With only a few inexpensive components, an amplifier can be built with a gain of either +N or -N, depending on whether a field-effect transistor is turned off or on. Such a circuit is useful for programable inversion of analog signals or for programable phase-shifting of 180° for signals that are symmetrical with respect to ground. When a comparator is added to program the inverter, the circuit becomes a precision rectifier, the output of which is:

$$V_{out} = |V_{in} - V_{ref}|$$

When the FET is off, the input signal goes only to the inverting input terminal of the operational amplifier; the gain is:

$$V_{out}/V_{in} = -R_f/R$$

But when the FET is on, the gain is:

$$V_{out}/V_{in} = \eta A/[1+(ARR_1)/(R_1R_f+RR_f+RR_1)]\theta \times [f-)R_1R_f)/(R_1R_f+RR_f+RR_1)]$$

where A is the open-loop gain of the op amp, and

$$f = R_3/(R_2+R_3)$$

Since A is large, this reduces to:

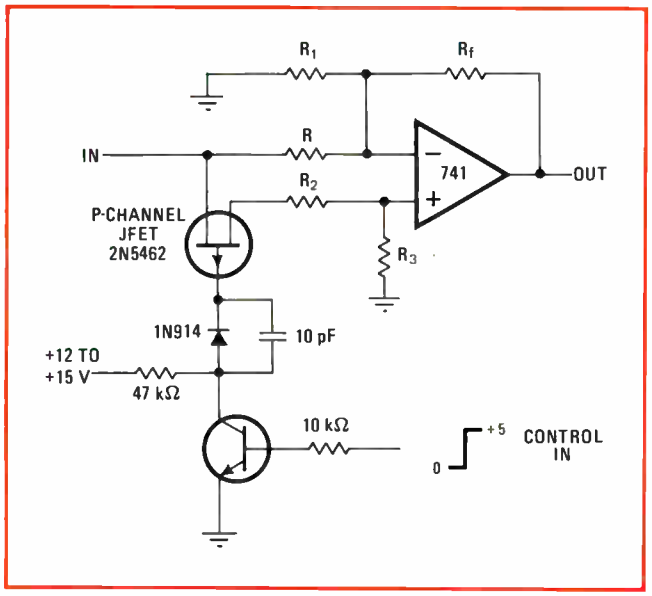
$$V_{out}/V_{in} = (f-1)(R_f/R) + f[(R_f/R_1)+1]$$

To make +N and -N numerically equal, choose the resistance values so that $R_f/R = N$. From that, it follows algebraically that:

$$N = (f-1)(N) + f[(NR/R_1)+1]$$
$$2N = fN + (fNR/R_1) + f$$
$$2NR_1 = fNR_1 + fNR + fR_1$$
$$2NR_1 - fNR_1 - fR_1 = fNR$$
$$R_1 = NRf/[2N-(N+1)f]$$

For the simplest case—a gain of ±1—all amplifier input and feedback resistors have the same value, except R_1, which is half that value.

The gate of the FET is controlled by a standard analog switch configuration, which allows the inputs to be 0 or +5 volts, compatible with TTL. □



FET inverts op amp. Amplifier gain can be programmed either positive or negative, depending on whether the field-effect transistor is conducting or not conducting. Gain is the ratio of R_f to R; for gains of ±1, R_f, R_2, and R_3 are all equal value, and R_1 is half the value.

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Dual-bandwidth loop speeds phase lock

by A.T. Anderson, D.E. Sanders, and R.S. Gordy
Electronic Communications Inc., St. Petersburg, Fla.

A phase-lock loop with two filters of different bandwidths, and the capability of achieving a gradual transition from one to the other, can satisfy the conflicting requirements of noise rejection and fast signal acquisition. Having acquired the signal, the loop then serves as a local source that matches the remote source of the incoming signal, which may be intermittent because of imperfections in the transmitting channel. Essentially, the loop is a voltage-controlled oscillator that forces the output into a fixed phase with the input.

If the input signal has noise or phase jitter riding on it, the loop will try to follow the disturbance as well as the signal. Noise effects on the loop can be reduced by low-pass filtering of the error. The narrower the filter, the less the noise affects the VCO, but the harder it is for the loop to achieve lock.

In fact, if the frequency-offset—the difference between input frequency and VCO rest frequency—is too large, the loop may never lock. In this case, an external voltage may be applied to sweep the VCO rest frequency over the range of input isgnals; the maximum sweep rate depends on the filter bandwidth.

Even if the frequency-offset is small, the slow transient response of the narrow filter slows the loop's signal acquisition. Loop-filter design must often compromise between large bandwidth for fast acquisition and small bandwidth for noise-free tracking.

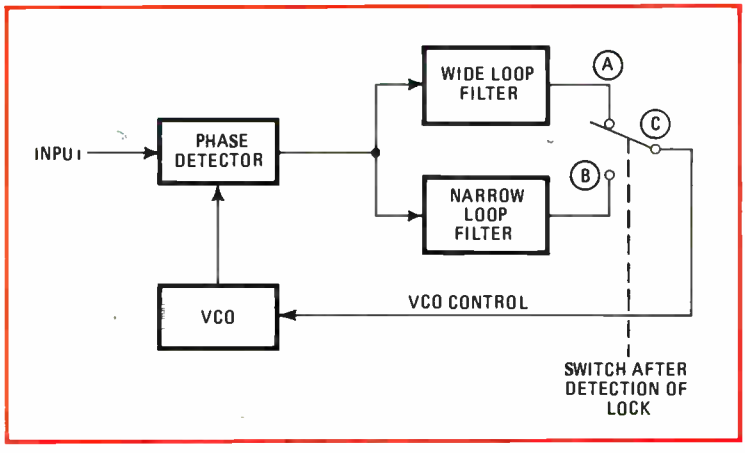
To avoid this compromise, two discrete bandwidths can be used. A large bandwidth is used until the signal is acquired; after acquisition, a small loop bandwidth is switched in. This technique, which is shown in Fig. 1, has three significant disadvantages.

First is the voltage step which results from switching the VCO control line, point C, from point A to point B. The step change in voltage at point C which results from switching the VCO-control line from point A to point B can cause loss of lock.

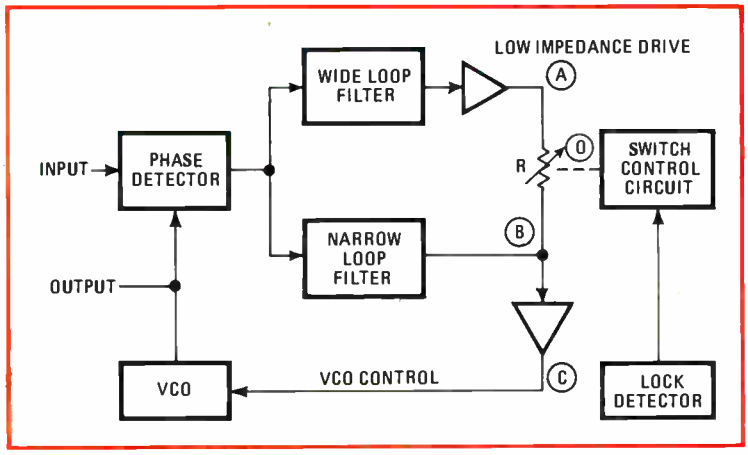
The second disadvantage is the voltage transient that can result from abrupt switching with real circuit devices even when the voltages at the two inputs are equal. This transient can also cause the loop to lose lock. A third disadvantage is that the ratio of large to small filter bandwidth is limited if a frequency-offset exists in the phase-lock loop.

A slow bandwidth-switching technique shown in Fig. 2 eliminates these disadvantages. Switchover from point A to point B is accomplished gradually by varying resistance R from zero (or a low value) initially, to a high value at the end. When the R is low, the VCO-control line is essentially connected to A because of the low impedance drive at A. The output of the narrow (slow) filter is also connected to A initially. The low impedance of A forces the narrow filter output to follow the fast response of the wide filter, effectively giving the narrow filter a fast response time while also forcing the voltages at points A and B to be equal. The slow, controlled switchover, together with the equal voltages, prevents transients at point C which might cause loss of acquisition.

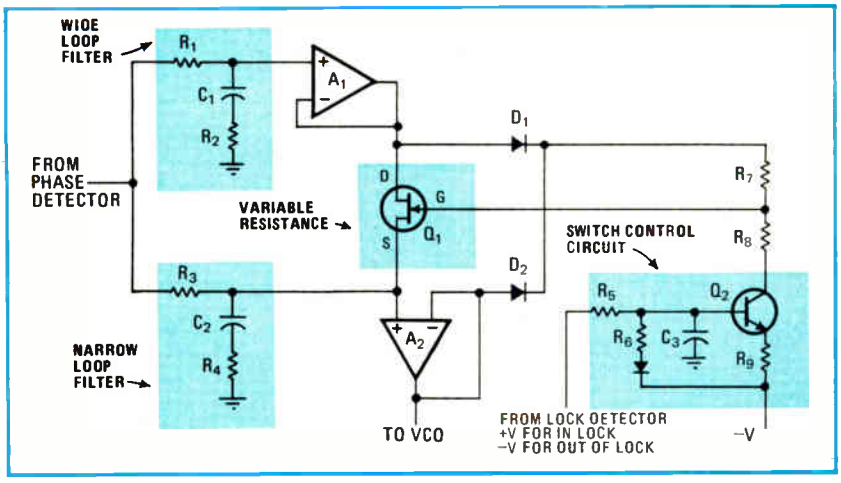
During switchover, the VCO-control line, point C, is effectively connected to a combination of both filter outputs, resulting in



1. Switchable bandwidth. A phase-lock loop requires two different switched loop filters for acquisition (lock) and tracking (narrow).



2. Slow switching technique. Slow bandwidth switching with a variable resistor eliminates the disadvantages of conventional bandwidth-switching.



3. FET control. Signals from a lock detector gradually vary resistance of Q_1 from a low to high value. This smoothly changes the loop filter bandwidth.

gradual reduction of bandwidth from large to small. The shape of the switch-control waveform, at point D, can be designed to optimize acquisition under given conditions such as signal-to-noise and frequency offset, and can easily be changed as these conditions change. The gradual change forces the loop to remain in lock at all times so that the ratio of large to small bandwidth can be much higher than with conventional switching. Actual circuitry for Fig. 2 is relatively easily realized, with the exception of the slow switch and its switch-control circuitry. A desired feature of these two elements is that the R should be strictly controlled by the switch-control line and not be affected by the voltage at A or C.

An example of a circuit that meets this criterion is given in Fig. 3. In this circuit, a junction FET, Q_1, is the variable resistance. Initially, no current flows in Q_2, so Q_1 is closed (low resistance). This forces the voltage on C_2 in the narrow filter to follow C_1 and charge to approximately the correct value during acquisition.

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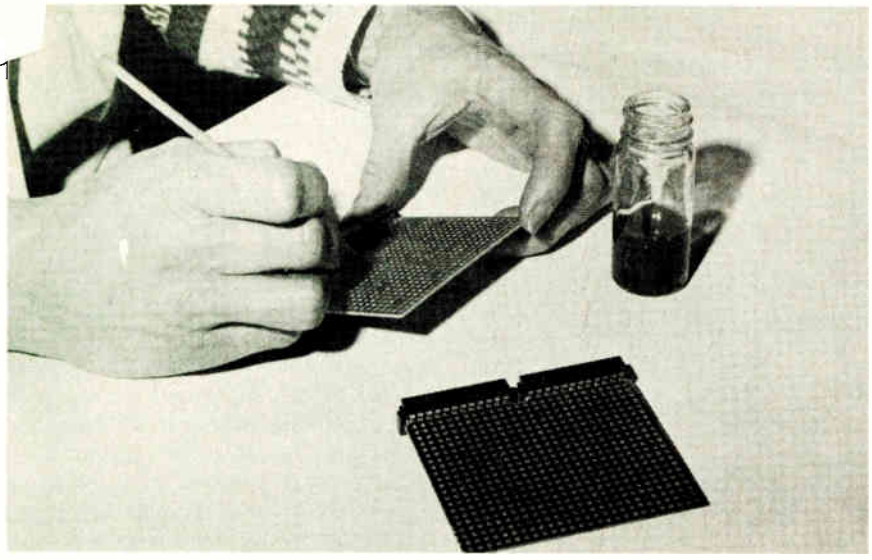
Water-soluble masks are also useful for protecting large tab areas or other large areas of copper that are not to be soldered. Masking prevents solder from bridging between circuit lines on a printed-circuit board, even when hand-soldering or non-wet components are not involved. And, when parts of a board are to be coated with something, water-soluble masks can protect the areas that are not to be coated when the coating itself is not water-soluble; otherwise its application would wash off the mask material.

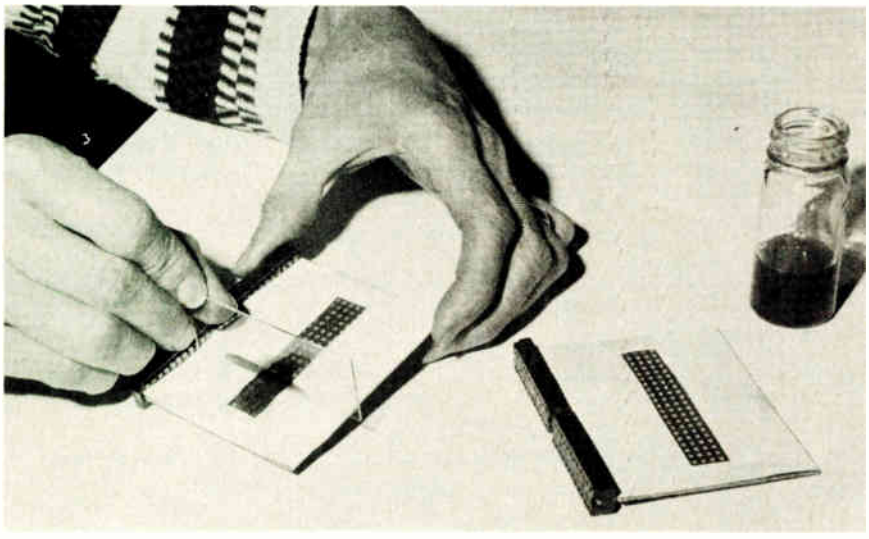
However, water-soluble masks do not work well on tin-lead plated parts, especially when large areas have to be masked, because the alloy reflows and lifts the mask from the circuit board.

The two new materials are based on sodium silicate and gum arabic, or acacia, both in water solution and both with small quantities of other materials added. The materials have different characteristics and react differently in any production process. However, both meet the primary objective—to prevent solder from wetting the masked areas, whether soldered as soon as the mask has dried, or days or weeks later. And neither material hampers any subsequent production process, nor permits solder reflow, which could cause bridging between masked circuit lines.

Like most other water-soluble masking materials, the new ones meet current regulations of the U.S. Occupational Safety and Health Administration and state agencies; they are, in fact, pollution-free. Even if large quantities of mask materials were accidentally spilled, no pollution limits would be exceeded because all of the ingredients have extremely high tolerance levels in waste water. They are also relatively nontoxic; continued exposure of production workers to either of the two



Mask-maker. Brushing and screening are two of several methods by which new water-soluble masking materials can be applied to printed-circuit boards. The materials keep solder away from selected areas as the board moves through a wave-solder machine.



materials has no serious or long-lasting effects.

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The new water-soluble masks can be left on the surface for several months at ambient or elevated temperatures without corroding, as some materials do. Furthermore, they actually improve the insulation-resistance, which on a series of test boards averaged an order of magnitude higher than on boards made with the IBM standard mask. The lower resistance encountered with the standard mask—still well up in the thousands or even millions of megohms—is caused by minute traces of the mask material, too small to affect soldering, but nevertheless sufficient to establish a tiny current path.

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Engineer's newsletter

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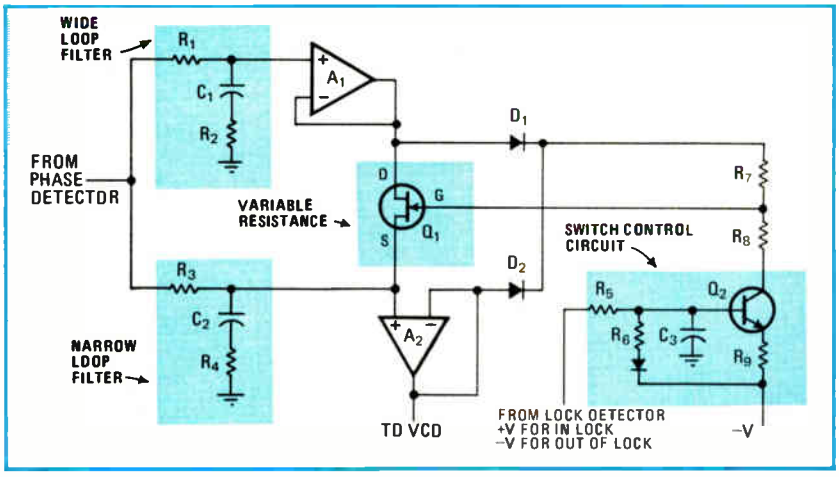
Microprocessors cut data-acquisition analog part costs

Designers of data-acquisition systems are finding that cheap computing power with a few easy-to-use matched LSI processing chips can radically change the way they handle their data. **They can practically eliminate all the expensive analog components in the system.** In today's typical system, a signal that's sensed by a transducer passes through a series of analog signal-conditioning and enhancing devices (op amps, log amps, comparators, sample-and-holds) before being converted into digital form suitable for computer processing.

Enter the microprocessor. **Now, rather than processing analog measurement signals before finally converting to digital signals for processing and logging, the signal can be converted at the transducer's output** (or in semiconductor transducers—perhaps right on the chip). Then, with a stored program to compensate for the transducer's characteristics, the rest of the processing will be done digitally. **Thus, the balance of the economics will shift to low-cost transducers with less-than ideal characteristics, combined with widely available, inexpensive digital microprocessor.**

—Laurence Altman



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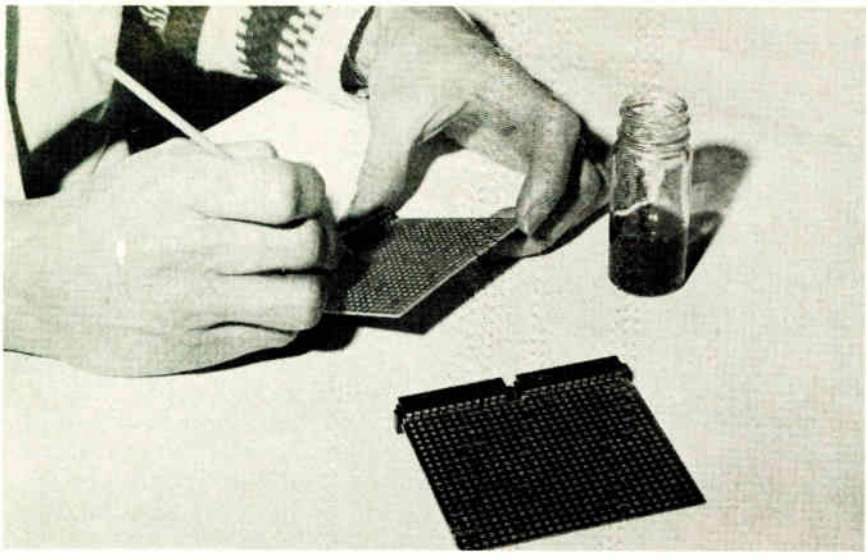

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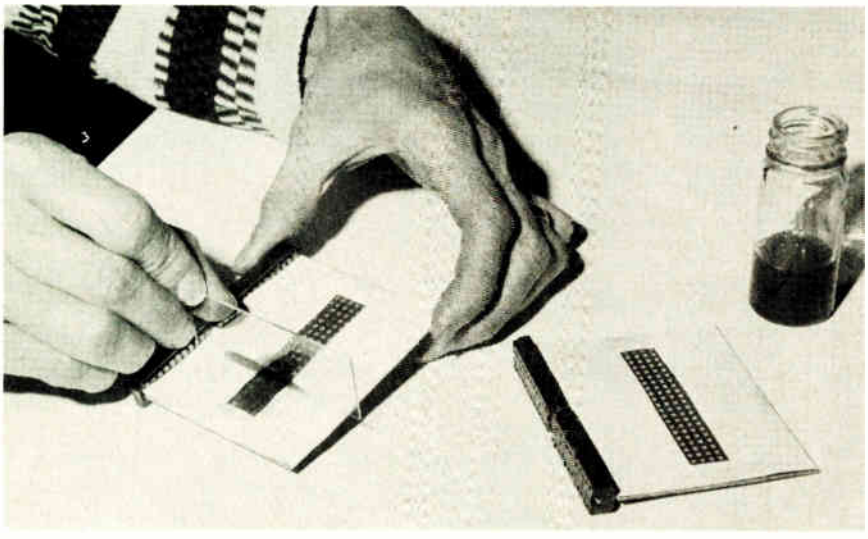

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Engineer's newsletter

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Philips offers design guide for digital instruments

If you're still having trouble getting into the new world of digital-instrument techniques, check out the first two volumes of a five-part home-study course in digital-instrument design. First used by Philips test and measuring instrument technical personnel around the world, the course is now being made available to others. **The price is $3.50 each for part one, a 60-page soft-cover book covering basic binary theory and logic circuits, and part two, a 64-page book on digital timers and counters.** You can order them from Philips' Publications Department, 400 Crossways Park Dr., Woodbury, N.Y. 11797, and automatically get on a mailing list for subsequent volumes on digital voltmeters, data-logging, and automatic measuring systems.

Microprocessors cut data-acquisition analog part costs

Designers of data-acquisition systems are finding that cheap computing power with a few easy-to-use matched LSI processing chips can radically change the way they handle their data. **They can practically eliminate all the expensive analog components in the system.** In today's typical system, a signal that's sensed by a transducer passes through a series of analog signal-conditioning and enhancing devices (op amps, log amps, comparators, sample-and-holds) before being converted into digital form suitable for computer processing.

Enter the microprocessor. **Now, rather than processing analog measurement signals before finally converting to digital signals for processing and logging, the signal can be converted at the transducer's output** (or in semiconductor transducers—perhaps right on the chip). Then, with a stored program to compensate for the transducer's characteristics, the rest of the processing will be done digitally. **Thus, the balance of the economics will shift to low-cost transducers with less-than ideal characteristics, combined with widely available, inexpensive digital microprocessor.**

—Laurence Altman

Better looking Beckman Displays are a natural for clocks and clock-radios

There are several big reasons why Beckman Displays are being used in more and more electronic clocks and clock radios. First, there are special 12 and 24-hour clock modules which help make application and production assembly easier. Secondly, the better looking Beckman Displays help attract buyers, help build sales. Next, in addition to multiplex mode, the displays can be DC driven to reduce RFI to a minimum.

For electronic clocks and clock radios you can choose from a variety of ½" clock display combinations from Beckman: hour and minute readouts; hour, minute, second displays; even with AM and PM indicators. Beckman Displays produce crisp, clear, unbroken numerals that add "buy appeal" to any product. They have a pleasing neon orange color (filterable to red) and are bright enough (210 foot lamberts) to be read in all ambient light conditions including direct sunlight.

Add to this the low cost (as low as $.70 per digit in large OEM quantities), the proven reliability, and you have the ideal display for today's new designs. See for yourself. Compare Beckman Displays side-by-side with LEDs or any other readout. You'll choose Beckman because they look better, are better.

For the telephone number of your Beckman/Helipot sales office, or the name of your Beckman stocking distributor, call toll free (800) 437-4677. Or write, Beckman Instruments Inc., Information Displays Operations, P. O. Box 3579, Scottsdale, Arizona 85257.

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There's more eye appeal in Beckman Displays!

Circle 121 on reader service card

Why are other computer companies refusing to run benchmarks against the Eclipse?

Apparently, they've seen some of the results.

Eclipse has been running Fortran benchmarks faster than an IBM 370/155.

And more than twice as fast as the PDP-11/45.

It's even beaten out a Xerox Sigma 9.

And those benchmarks were not ones we designed to make Eclipse look good. We only ran programs that prospects asked us to run.

Not only that, the Eclipse they were run on was using core memory. If we had used semiconductor memory with cache, you can imagine what would have happened.

Eclipse may have caught the competition off guard, but that's just what we expected it to do.

That's why we built Eclipse around a new microprogrammed architecture and an instruction set designed for high level languages and real time operating systems.

And that's why we gave it the fastest Floating Point Processor in the industry.

But making a computer fast is one thing. Getting all that speed out of it is another.

So we also came up with a sophisticated new set of Eclipse software: A Fortran 5 package, and a new Mapped Real Time Disc Operating System with features like virtual overlays and window mapping. (Which you may not have heard about because we just invented them.)

Which means if you don't want to end up with a computer that's been eclipsed, you're going to have to do something about it.

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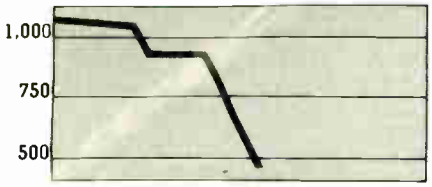


For years, we've been bullish on high-priced sweepers. Sure, there were plenty of low-priced offerings, if you wanted to speculate with hobbyist quality. But if you really wanted to make a clean sweep, you looked to the blue chips—and to spending about a grand. But now Wavetek has issued the Model 1050, an instrument that everyone can afford (even those in a tight capital equipment spending predicament). It sweeps from 1 MHz to 400 MHz with the signal quality needed for both lab and production use. The instrument features ±0.25 dB output flatness, 2% display linearity, spurious signals 30 dB below output, and a maximum amplitude of +10 dBm. It's available in 50-ohm and 75-ohm versions, and the price for either is just $495. In our opinion, this is the time to buy. Write or call us for a complete statement of the Model 1050's performance. Wavetek Indiana, Inc., P.O. Box 190, Beech Grove, Indiana 46107. Tel. (317) 783-3221. TWX 810-341-3226.

WAVETEK®

Circle 124 on reader service card

The bottom just dropped out of the sweeper market.

$495

Chip capacitors are adjustable

Adjustment points on the sides of these devices permit their capacitance values to be varied in controlled increments

by Lucinda Mattera, *Components Editor*

In the past, chip capacitors were strictly fixed-value devices. Now, however, a new series of chip capacitors from Vitramon Inc. of Bridgeport, Conn., can be adjusted in value without affecting the integrity of the part.

The capacitance of these new chips can be adjusted up or down and then readjusted, if desired, at some later time. The chips can also be connected and disconnected repeatedly without impairing their electrical or mechanical properties.

The units measure 0.18 inch by 0.05 in. by 0.05 in., and have adjustment points on their sides. The capacitance is adjusted by connecting these points to each other with a conductive material or by disconnecting these points by removing the conductive material. A conductive ink can be painted on the chips to connect the adjustment points.

Depending upon the nominal value of a chip, capacitance can be adjusted from less than 1 picofarad per increment to more than 13 pF per increment. And a single chip can have as many as 12 increments of adjustment. For example, the capacitance of a chip having a nominal value of 5 pF and 10 adjustment increments can be increased up to 15 pF in 1-pF increments.

These series Vee Cal chip capacitors are made with a stable NPO dielectric having a maximum temperature coefficient of ±30 ppm/°C. All internal electrodes are encased in the dielectric material so that no plates are exposed and the devices are environmentally protected.

Capacitance ranges from 5 to 500 pF nominally, with tolerances of ±5% or ±10%, and the voltage rating is 50 v dc. The units cost 50 cents each in quantity, and delivery time is 90 days.

Vitramon is also introducing a line of chip capacitors for microwave applications. These series VY73 units are made of porcelain and have silver-palladium terminations to achieve the high stability needed for stripline work.

The chips can operate in the 10-gigahertz frequency range. They have a temperature coefficient of ±30 ppm/°C and can handle up to 70 watts of reactive power. Capacitance values range from 1 to 330 pF. Three body sizes are available, from 0.10 by 0.07 by 0.05 in. to 0.20 by 0.14 by 0.05 in. Price varies from 25 cents to $1.50 for quantity orders, and delivery time is stock to six weeks.

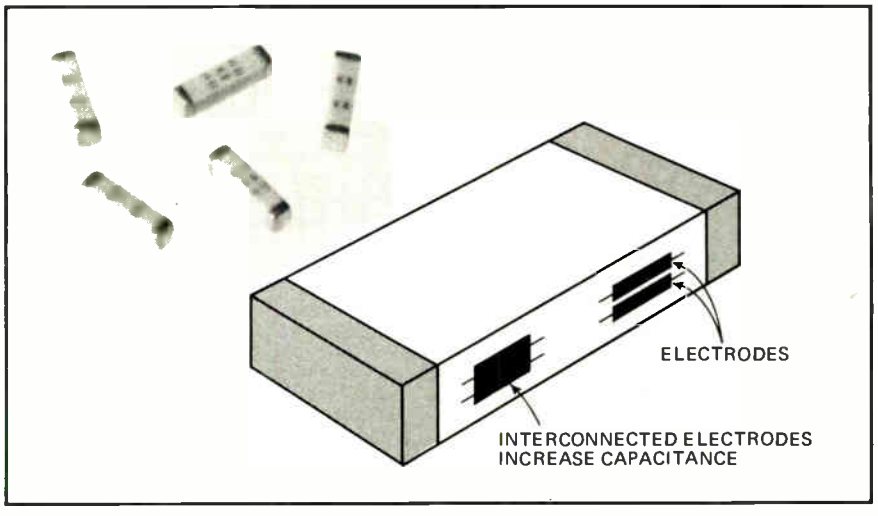
For added user convenience, Vitramon is offering these microwave chip capacitors in kit form. The $29.95 kit contains 90 chips, ranging in value from 1 to 30 pF.

Additionally, the company is extending the range of its type NPO and EIA X7R chip capacitors. Both of these product lines are being offered with capacitance values that are two to three times higher than previously available.

The X7R chips now have nominal values ranging from 100 pF to 1 microfarad, with standard tolerances of ±10% and a voltage rating of up to 50 v dc. The other newly extended series, the NPO line, covers the capacitance range of 1 to 18,000 pF, with a standard tolerance of ±5%. Maximum dissipation factor is 0.1% at both room temperature and 125°C. Both of these series are priced at 6 cents to $1 each in quantity, and delivery is from stock to six weeks.

Vitramon Inc., Box 544, Bridgeport, Conn. 06601 [338]

Fixed, yet adjustable. The capacitance value of a new series of chip capacitors can be adjusted without degrading device performance. Once set, capacitance value will not change.



Instruments

Sweep generator sells for $495

Economy unit has range from 1 to 400 megahertz; flatness is within ±0.25 dB

Because capital-equipment buyers are expected to be few and tight-fisted for the next quarter or more, instrumentation makers are looking to open up customers' pocketbooks with lower-cost solutions to test and

measurement problems.

The model 1050 sweep generator from Wavetek Indiana Inc. is in that class of equipment. At $495, it is less than half the price of the company's comparable model 1002 [*Electronics*, Dec. 12, 1974, p. 141], yet performs almost as well as the more expensive model.

The lower price was achieved by combining a wrap-around vinyl-clad sheet-metal case with plastic front and rear panels and by deleting features not used in most sweep-generator applications—variable sweep rate and marker tilt (which permits the marker to be displayed horizontally rather than vertically on an oscilloscope screen).

The frequency range of the model 1050 is narrower, too, extending from 1 megahertz to 400 MHz, as opposed to the 1-to-500 MHz range available with the model 1002.

Most of the primary specifications, though, are the same: sweep width from 200 kilohertz to full scale, display linearity within 2%, and drift less than 100 kHz/5 minutes (after warmup). Spurious signals, harmonic and nonharmonic, are rated 30 decibels below output, and output flatness is within ±0.25 dB.

The model 1050 has provision for up to six crystal-controlled plug-in markers with amplitudes adjustable from 4 millivolts to 4 volts peak to peak and widths adjustable from approximately 100 kHz to 400 kHz. Marker accuracy is 0.005%.

Output impedances of either 50 or 75 ohms are available. Output amplitude is +10 dBm maximum, and attenuation is up to 50 dB in 10 dB steps, plus 20 dB through a p-i-n diode attenuator.

Remote programing of the center frequency, sweep width, and the 0-to-20 dB vernier level control are available with an internal wiring change.

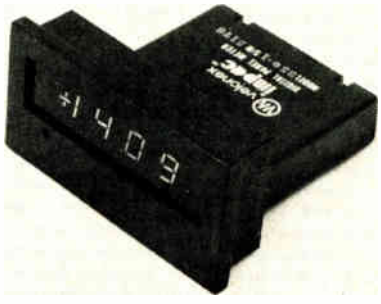
The model 1050 measures 4⅛ inches high, 9 in. wide, and 9¼ in. deep and weighs 7 pounds. Delivery time is 30 days.

Wavetek Indiana Inc., P.O. Box 190, Beech Grove, Indiana 46107 [351]

Digital panel meters offer 0.33-inch-high readouts

While digital panel meters offer advantages over mechanical, analog types—greater accuracy and resolution, for example—they are often too large to fit particular applications. A series of DPMs from Varian Associates' Velonex division [*Electronics*, March 1, 1973, page 111] was designed with this problem in mind by trading off display size for compact dimensions.

The new Impac B Series from Velonex maintains the behind-the-



panel features of the earlier models, but offers a more readable LED display that is 0.33 inch high—more than twice the size of those in Velonex' earlier compact models.

Impac meters are available in models displaying 3, 3½, 4, or 4½ digits. On all versions, front panel area is less than 4.4 square inches and behind-panel volume is less than 5.3 cubic inches.

The units respond to and display a change in the measured voltage from zero to full scale within 150 to 200 milliseconds, and offer normal-mode rejection of greater than 40 dB. Only one calibration—full-scale range—is required; an automatic zero circuit calibrates the DPM against offset or drift errors.

Maximum error is 0.1% of reading for the 3- and 3½-digit units, and 0.05% of reading for the 4- and 4½-digit models, ±1 count for all four cases. Temperature coefficient is 0.01%/°C from 10° to 40°C, and sample rate is seven per second for 3- and 4-digit models, five per second for the 3½- and 4½-digit units.

The Impac B Series DPMs operate from +4.8 to +6.0 V dc and −9.0 to −16.0 V dc power supplies. Input power conversion modules that may be mounted separately from the meters or piggy-backed on the meters are available for 115 V ac, 230 V ac, or +5 V dc power bus applications.

In under-10 quantities, the 3-digit model is priced at $119, the 3½-digit at $132, the 4-digit at $177, and the 4½-digit at $234. All are covered by Velonex' three-year DPM warranty.

Velonex division of Varian Associates, 560 Robert Ave., Santa Clara, Calif. 95050 [352]

System performs real-time vibration analysis

Designed specifically for the on-line measurement of vibration and noise in rotating machinery, the model UA-500A-1 Ubiquitous real-time spectrum analyzer/averager by Nicolet Scientific (formerly Federal Scientific) contains a built-in calculator to make it easy to use. With the calculator, the instrument dis-

Over 50,000 people now own our 8000A. It's the best selling DMM in the world.

Read why:

The average DMM lets you down in one performance area or another. By contrast, the Fluke 8000A 3½ digit multimeter offers you the industry's broadest and best combination of outstanding specs, including some that are unmatched anywhere.

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- ***26 ranges*** of volts, amps and ohms.
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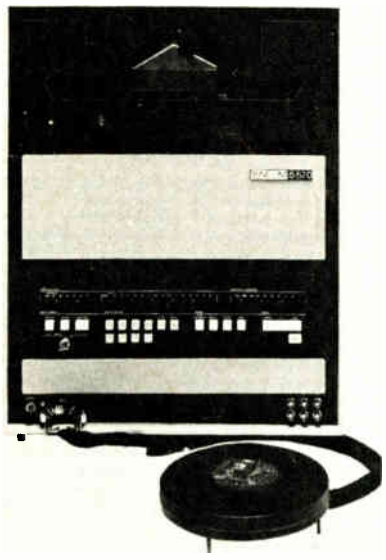
play can be normalized with respect to, say, the rotational speed of a gas turbine so that all frequency data is shown in terms of multiples of the basic shaft speed. Further, a unique harmonic marker puts bright dots on all harmonics of a fundamental frequency selected by a movable cursor; thus, harmonically related components are quickly identified and separated from other signals. Used with the model 51 accelerometer, the system becomes a calibrated real-time vibration analyzer. The model 51 contains a signal-conditioning amplifier so that the system calibration is not affected by the length of the cable between the accelerometer and the analyzer. The accelerometer is usable over the range from 1 hertz to 5 kilohertz, for accelerations from 0.01 to 50 g, and over the temperature range from −100 to +250°F. It weighs 21 grams and has a mounted resonance of 45 kHz. Price of the analyzer/averager is $10,000; delivery time is 30 days. The accelerometer sells for $850 and also has a 30-day delivery time.

Nicolet Scientific Corp., 245 Livingston St., Northvale, N. J. 07647 [353]

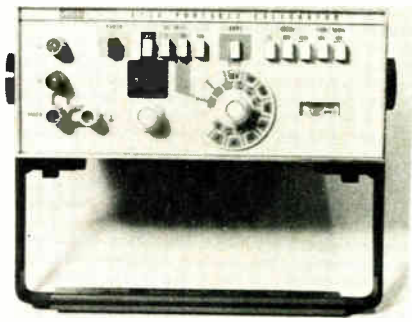
$25,000 IC tester makes parametric measurements



Capable of testing both digital and analog integrated circuits, the model 5570 is a fast, fully automatic, parametric tester with a $25,000 price tag. It measures voltages as large as ±80 volts and current from ±40 nanoamperes to ±500 milliamperes. The machine features stored-program operation, data-bus organization, and a front-panel keyboard for interactive operation. Programing is done by means of fanfolded punched paper tape which can be generated on any Ascii keypunch. The desk-top unit measures 20 inches wide by 26 in. high by 26 in. deep and weighs 100 pounds. Delivery time is 60 days.

Xincom Corp., P. O. Box 648, Chatsworth, Calif. 91311 [354]

Portable ac-dc calibrator drifts less than 30 ppm/year



Weighing only 13 pounds, and able to maintain its specifications over the temperature range from 18°C to 28°C, the model 515A calibrator is stable to within 30 parts per million per year. The unit, which was especially designed for the inspection, testing, and calibration of digital multimeters, provides precision dc and ac voltages and precision resistances. The dc voltages are available in three ranges: 0 to 999 microvolts, in 0.2-μV steps; 0 to 1.0 V in 0.1-V steps; and 0 to 10 V in 1-V steps. In addition a precise 100-V dc output is provided. Three ac voltages—1, 10, and 100 V rms—are produced at 400 hertz. In addition a 10-V sinusoid is produced at 4 kilohertz and at 50 kHz. The ac voltages are all accurate to within 0.04%. Resistance ranges

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1. The complex circuits of today and tomorrow cannot be handled by rubylith cutters or the old mechanical P.G.'s like the simple circuits of yesterday.

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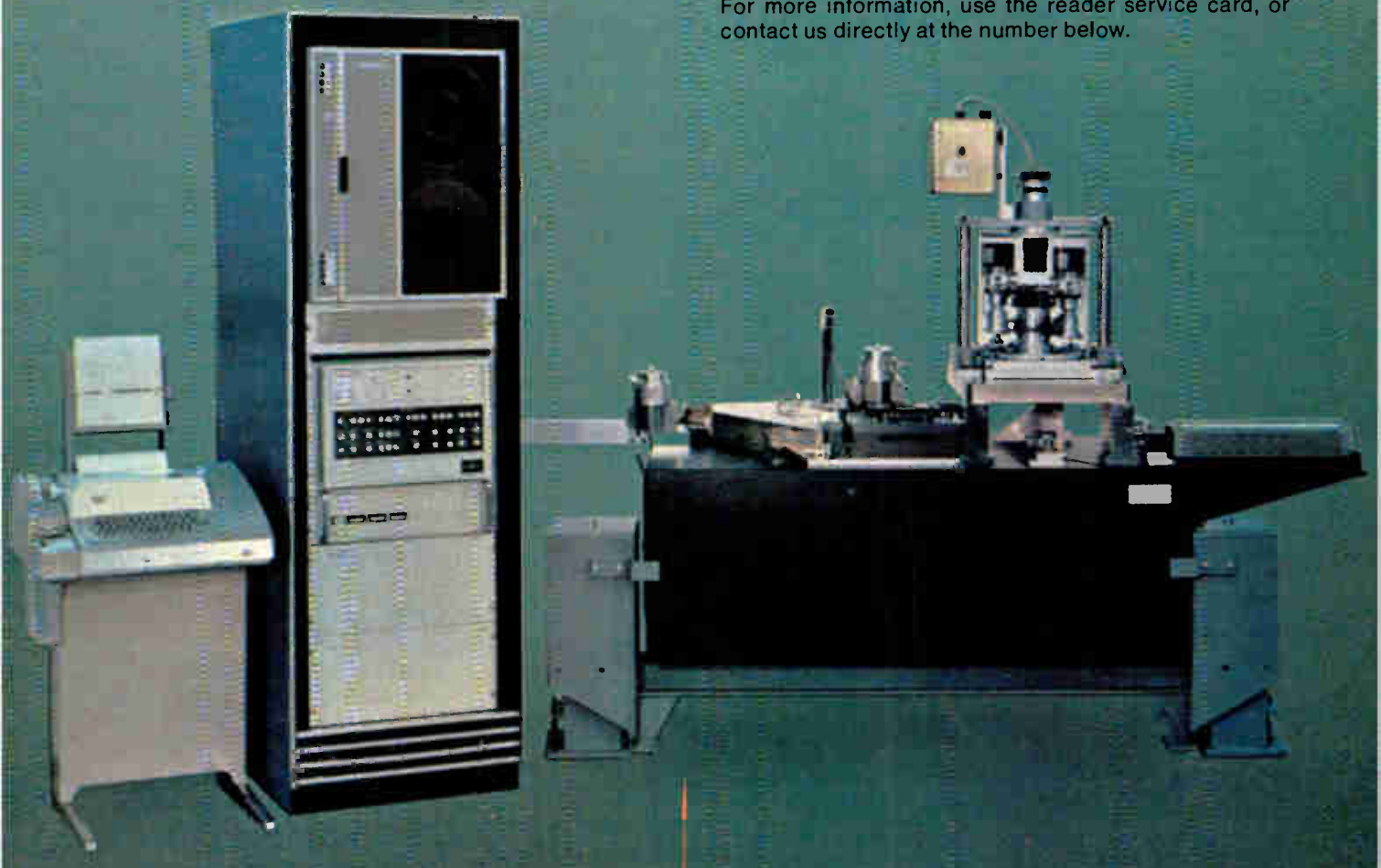
5. When you swing to an Electromask P.G. today, you know that the new technologies won't make it obsolete tomorrow.

For more information, use the reader service card, or contact us directly at the number below.



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Circle 139 on reader service card

are 10 ohms to 10 megohms, in decade steps, with a midrange error of no more than 0.015%. Price of the 515A is $1,995; delivery time is 45 days.

John Fluke Mfg. Co., P. O. Box 7428, Seattle, Wash. 98133 [355]

Character generator aids in design of CRT displays

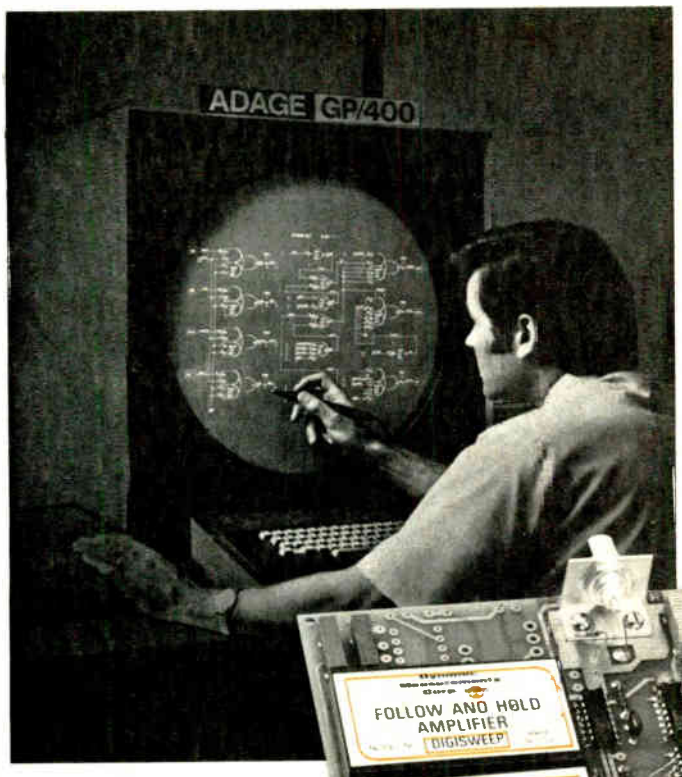
Capable of simulating virtually any type of raster-scan character-generating equipment, the model DG100 is intended for applications in the design, development, and testing of cathode-ray-tube displays. Interlaced and non-interlaced signals can be generated, at character rates from 8 to 20 kilohertz. The number of characters per row and of lines per field are both selected by front-panel switches. The unit has a built-in variable-frequency oscillator that

covers 1 to 25 megahertz in four ranges. Character-rate and vertical and horizontal blanking signals are provided through two rear connectors to permit interfacing the instrument with character-generating read-only memories and other user-supplied equipment.

Motorola Inc., Display Products, 455 East North Ave., Carol Stream, Ill. 60187 [356]

Instrumentation recorder is battery-powered

The model T5-2 instrumentation tape recorder is a portable two-channel unit that can run on dry



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A sequence of vectors may be followed by marks and alpha-numerics without misplacement . . . with DIGISWEEP's fast and clean major position settling.

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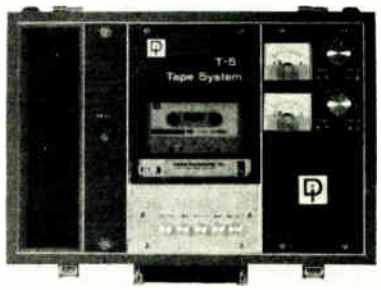
For more information on model 203AM circle 248 on reader service card.

Circle 131 on reader service card

New products

cells or from an external power source. Meant for the recording and playback of such analog signals as shock and vibration data, medical potentials and noise levels, the recorder uses cassette tapes and has both fm and direct recording modes.



In the fm mode its passband extends from dc to 1,000 hertz; in the direct mode it covers 100 to 10,000 Hz. The T5-2 sells for $2,700; delivery time is six to eight weeks.

Dallas Instruments Inc., 10205 Plano Rd., Dallas, Texas 75238 [357]

Logic probe tests TTL and C-MOS circuits

A hand-held digital-logic probe, the model 1500, has a selector switch for easy setting of its logic thresholds to either transistor-transistor logic levels or to complementary-metal-oxide-semiconductor logic levels. Although TTL and C-MOS levels are standard, the probe can be supplied with other thresholds on special order. The 1500 can detect single pulses as narrow as 10 nanoseconds, and can respond to pulse trains as fast as 50 megahertz. It is a dual-threshold device, and will detect voltages that fall between its thresholds. The TTL levels are 0.8 and 2.0 volts, while the C-MOS levels are 30% and 70% of the supply voltage. Input impedance is greater than 2 megohms, and the input is protected against overloads up to 250 V. The unit has a nominal supply-current requirement of 30 milliamperes. Price of the probe is $89.

Alert Technology Inc., 2901 MacArthur Blvd., Northbrook, Ill. 60062 [358]

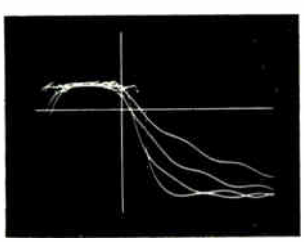
Missing some test data?

Are you missing some test data because you don't have an instrument that can capture it . . . or one that can adequately read it out?

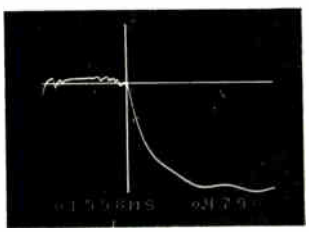
The missing link may well be a Nicolet 1090 digital oscilloscope.

There are many good laboratory measuring instruments that suffer either from lack of adequate speed or from their inability to retain a signal for detailed analysis. For instance, an X-Y recorder may not react quickly enough to record all the transitions in your signal of interest. By the same token a voltmeter or analog oscilloscope typically makes only a fleeting readout. Even those instruments that have the ability to hold a reading usually cannot read it out as a permanent record, nor can they present it for more detailed analysis.

This is one area where the 1090 really shines. You can record two waveforms simultaneously, and display up to four waveforms simultaneously for easy comparison. Since waveforms are stored digitally you may retain them until you wish to store new information.



The 1090 offers numerical readout of any selected data point. Selection is made with an easily moved cursor. Wherever the vertical cursor intercepts the waveform the alphanumeric readout on the CRT displays time from trigger and voltage recorded at that point in time. Both values are calculated by the 1090 so that the CRT alphanumerics are in actual time and voltage. (You don't have to multiply a number times a switch setting.)

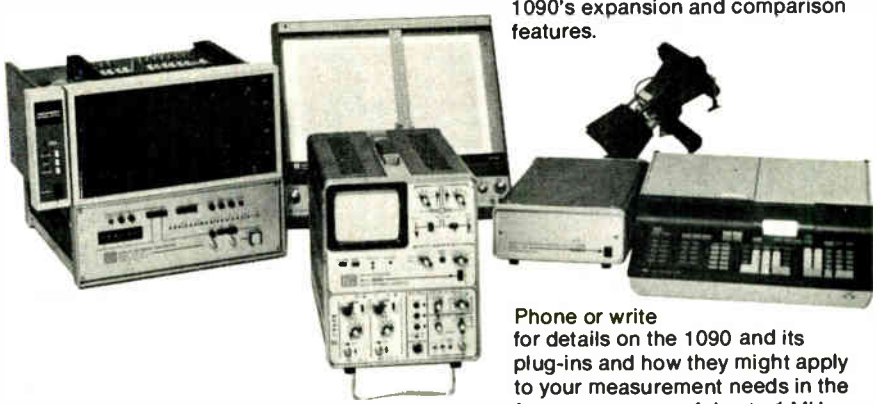


So you can closely inspect any particularly interesting portion of your signal the 1090 offers expansion of the stored waveform up to 64 times on both X and Y axes revealing selected detail of the 4096 x 12-bit word memory.

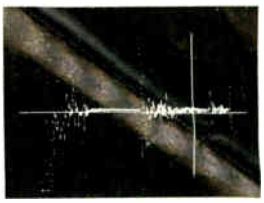
The 1090 also offers mid-signal trigger capability so you can "look backwards" in time as well as forward from the trigger. This feature permits you to inspect the events leading up to, and following, a trigger.

Besides being much easier to use than an analog 'scope, the digital 1090 also offers hardwired interface to magnetic tape recorders, programmable calculators, and X-Y recorders. Some customers have interfaced it to a minicomputer.

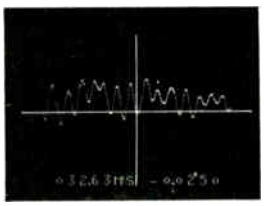
Waveforms previously stored on digital magnetic tape may be recalled from your tape library and examined using the 1090's expansion and comparison features.



Phone or write for details on the 1090 and its plug-ins and how they might apply to your measurement needs in the frequency range of d.c. to 1 MHz.



A. An unexpanded view of a signal from an accelerometer. Vertical marker shows center of region which will be shown when display is expanded.



B. Fig. A with X and Y scale magnification of 8.

C. Fig. A with X and Y scale magnification of 32.

D. Fig. A with X and Y scale magnification of 64.

NICOLET INSTRUMENT CORPORATION

5225 Verona Road
Madison, Wisconsin 53711
Telephone: 608/271-3333

Industrial

IR scanner sees inside packages

Pulsed detection system for production environment uses LED, phototransistor

Industrial photoelectric devices that are compromised by distance or adverse environments are likely subjects of application for a pulsed infrared detection system that "sees" through fog, steam, canvas, denim, paper and other normally opaque materials. The unit, which operates at distances up to 250 feet, can detect the presence of objects inside a colored plastic wrapper, identify the position of a cutting tool behind a cloud of sawdust, or indicate the presence of rubber on a canvas backing.

In the latter case, the sensor looks through the canvas backing at a rubber sheet as it unwinds from a roll. When the end of the roll is reached, the sensor detects that only the canvas leader is present. It then shuts down the machine so that a new roll can be spliced in.

The light source is a light-emitting diode that operates in the infrared. Depending on temperature, the output wavelength varies from 900 to 950 nanometers, the most efficient operating region for a light-emitting diode, and a region which coincides with the peak spectral response for the silicon phototransistor receiver.

Because the light source functions in an invisible portion of the spectrum, the IR signal can be easily filtered optically to eliminate false signals from visible light sources. The invisible source is also an advantage in security applications.

The LED is pulsed at 2 kilohertz so that light is emitted in high-power pulses of high penetrating ability. Yet the duty cycle is relatively short so that average power is low. As a result, the LED is assured of long life—100,000 hours conservatively, the company says.

Modulating the light beam at 2 kHz simplifies signal amplification and increases noise rejection. By using a narrow-bandpass filter to tune the receiver to the modulating frequency, the unit is made insensitive to noise and lower-frequency interference such as 60 Hz, 120 Hz, or dc levels.

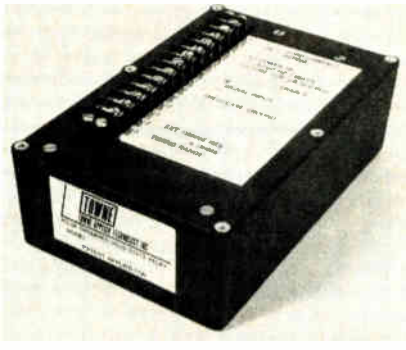
The emitter and receiver each measure less than 3½ inches high, 1½ in. wide, and 2⅜ in. deep, including the lens. On the back of each is a visible red LED, which indicates whether the invisible LED is functioning.

The MLS5 may be interfaced directly with logic circuits or wired to a 12 V dc relay. It requires a supply voltage of 12 to 18 V dc with 20% maximum tolerable power-supply ripple. The emitter pulls a maximum current of 70 milliamperes, while the receiver draws 40 mA max. Response time is 15 milliseconds for both ON and OFF states operating at a maximum rate of 33 operations per second within a temperature range of -40° to 70° C. The MLS5 is priced at about $150 in quantity orders.

Micro Switch Division of Honeywell, 11 West Spring St., Freeport, Ill. 61032 [371]

Solid-state relay handles up to 25 amperes

A pulse-triggered solid-state relay has a built-in field-adjustable time delay and can handle up to 25 amperes of continuous load current. The device, which is compatible with IBM System 7 and standard transistor-transistor-logic levels, has a minimum OFF-state leakage current of 4 milliamperes for its 100-to-140-V ac version, and 5 mA for its 200-to-280-V ac version. Minimum ON-state current, for both versions, is 20 mA. Three externally adjustable output time-delay ranges are available: 50 milliseconds to 5 seconds, 1.0 s to 100 s, and 1 minute to 30 min. In addition, any fixed-time delay from 5 ms to 30 min can be set at the factory. The relay can operate over the temperature range from -30° to +70°C and costs less than $100 in quantity.



Towne Applied Technology Inc., 228 Central Ave., Buffalo, N. Y. 14206 [373]

System is designed for continuous-path control

Aimed at such fast, closed-loop control applications as high-speed machine-tool milling, film transport, and web control, the system 550 series of controls is characterized by extremely large bandwidth and small following error. CSR's patented two-state modulation technology gives the system 550 a response speed at least 10 times faster than the speed of SCR types of servo drivers based on conventional phase-lock technology. Standard 550 systems are available in both single- and multi-axis versions, with up to three axes considered standard.

Control Systems Research Inc., 632 Fort Duquesne Ave., Pittsburgh, Pa. 15222 [374]

Conditioning module works with motion transformers

Useful in pressure, displacement, and similar measurement systems, the CTM-401 is a fully encapsulated, two-wire conditioning module for linear variable differential transformers. The unit needs no special external power since it runs off dc available from process controllers, recorders, or readout devices. Intrinsic safety is a feature of the unit's design because its current can be

There's a little tiger in every Cherry switch

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Our products are tough, but our people aren't... and that's the beauty of dealing with Cherry.

You see, we can control the quality of our switches because we fabricate most of our own parts (moldings, stampings, springs, printed circuits, etc.) And we can keep the price down because we're loaded with automatic equipment to handle high volume.

But the real difference is in the *people* you work with at Cherry... from your first contact with a technically trained sales representative... through careful analysis and recommendations by engineers who are really concerned about *your* problem... to production scheduling and customer service men who follow-up and expedite to make sure we keep our delivery promise to you.

Of course we're proud of our modern facilities and equipment... but what we're proudest of is our reputation for customer service. Try some.

Test a free sample "tiger" from the pussycats at Cherry. Ask for our latest catalog which contains complete information on all our switches and keyboards, and we'll include a free sample switch. Just TWX 910-235-1572... or PHONE 312-689-7700... or circle the reader service number below.

Circle 135 on reader service card

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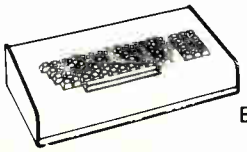


CHERRY ELECTRICAL PRODUCTS CORP. • 3608 Sunset Avenue, Waukegan, Illinois 60085

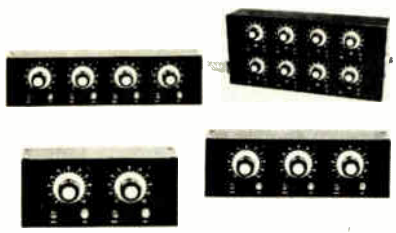
ELECTRONIC DATA ENTRY KEYBOARDS • ELECTRONIC DESK TOP CALCULATORS

limited to 50 milliamperes even if it is internally shorted. Performance highlights include a 1-dB frequency response of dc to 100 hertz, hysteresis of less than 0.1% of full scale, and drift (after a 15-minute warmup) of less than 0.25% of full scale. Small-quantity price is $272.90; delivery is from stock.

Schaevitz Engineering, P.O. Box 505, Camden, N. J. 08101 [376]

Line-voltage controllers handle 15 A per channel

Called the Pow/r Stat, a solid-state line-voltage controller has a current rating of 15 amperes per channel, or up to 30 A per controller for multichannel units. Able to vary the output voltage from 10% to 95% of line,



the device is overload-protected and has load and failure lamps that quickly indicate the status of any channel. If an overload occurs, the failure lamp lights, and the unit shuts itself off until a reset button is pushed. Prices start at $85, and deliveries take three weeks.

Alton Corp., 223 Crescent St., Waltham, Mass. 02154 [378]

Temperature indicator resolves 1°F or C

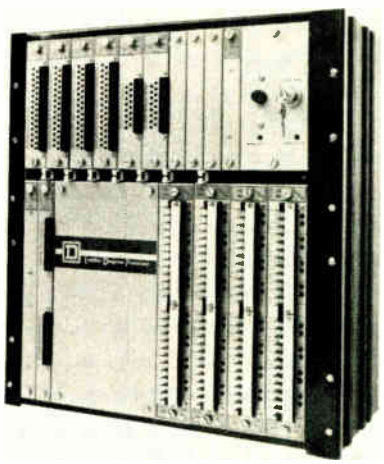
Easily changed by the user to read in either degrees fahrenheit or degrees celsius, the series 400 digital temperature Trendicators have resolutions and repeatabilities of 1°. Available in six versions, to work with any of six standard thermocouples (types J, K, T, R, S, or B), the series 400 units are built around an ion-implanted p-MOS LSI chip. Among the advantages of this design approach are: low power consumption of only 1 to 3 watts, a low parts count with its attendant high reliability (100,000 hours mean time between failures), and flexibility—changing a single, inexpensive, plug-in component is all that's needed to change the meter from one type of thermocouple to another. The indicator is housed in a package that is 72 millimeters high, 144 mm wide and 173 mm in diameter. Price is $299, and delivery time is 45 to 90 days.

Doric Scientific, 3883 Ruffin Rd., San Diego, Calif. 92123 [377]

Programable controller replaces 32-relay systems

The Ladder Diagram Processor is a small programable controller designed to replace control systems that use up to 32 relays. It can handle up to 32 inputs, 32 outputs, and up to 120 lines of relay-ladder diagram. Programed by means of either a fusible-link p-ROM or a diode pin matrix board, the Ladder Diagram Processor is comparable in cost with hard-wired electromechanical relay systems. All system logic is C-MOS for high noise immunity, and the entire Class 8873 processor is designed to withstand hostile industrial environments.

Square D Co., Dept. SA, Milwaukee, Wis. 53201 [380]



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That's the way to increase the legibility of your display. With our CRTs you can have a flat surface as large as 22", superior brightness, exceptional contrast and an optional dual persistance capability as well.

That means you can display such rapidly-moving information as aircraft identification labels and position symbols next to the display of low repetition-rate video—without confusion. Phosphor persistance and color can be selected by voltage switching to present radar targets in one color and to write computer-generated characters and air routes in another color.

By varying the voltage of a single electron beam scanning a multiphosphor screen, we've achieved outstanding brilliance and contrast. And resolution that's comparable to that of high quality monochrome CRTs.

For complete information on our color CRTs, circle the appropriate number on the reader's service card, or contact us directly.

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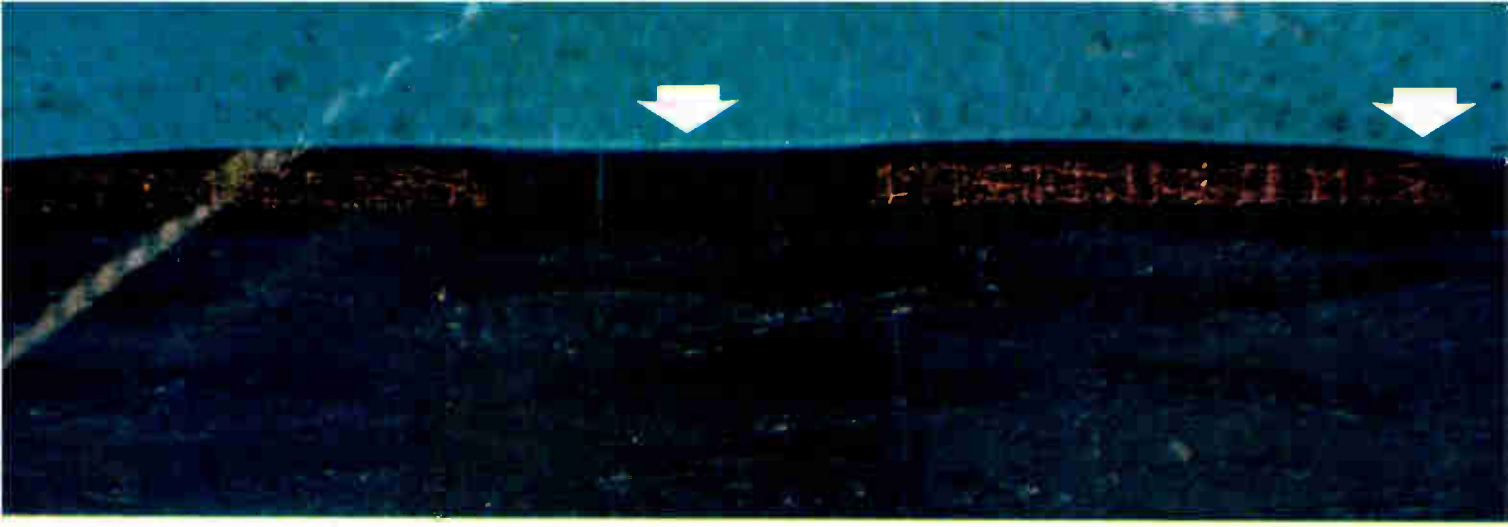
Circle 137 on reader service card



When spray or dip coatings fail...

Parylene works.

You are looking at magnified cross-sectional views of copper conductors on a circuit board . . . and why parylene protection brings the highest reliability to electronic circuitry.

The spray-applied urethane coating (top photo) bridges the channel between conductors, and offers scant protection at the edges. Urethane, silicone, epoxy . . . liquid coatings are uneven, and can produce potential failure points.

Parylene forms a thin and even coating, whatever the configuration, however complicated or delicate or densely populated. Without bridging. Without pinholes, voids, bubbles. We call it a conformal coating. From conformality comes reliability.

Parylene conformal coatings can be applied in precisely controlled thicknesses from 0.002 to 3 mils. *In one step.*

Parylene is applied at *room temperature.* No heat, no melting, no cure. No coating shrinkage. In other words, no discomfort for delicate components.

Parylene provides better barrier protection than urethanes, silicones or epoxies. It is extremely resistant to chemical attack, exceptionally low in trace metal contamination, and compatible with all electronic solvents. Dielectrics are excellent.

Parylene has qualified under the stringent requirements of MIL-I-46058C; it does so with a 0.6 mil coating—parylene excels in the micro-electronic virtue of thinness.

Parylene conformal coatings have shown excellent cost effectiveness in many applications. On delicate, sophisticated and complex circuitry, in hybrid circuits and components, they may be the most cost effective answer for long term reliability.

Union Carbide invented the parylene system. The method is gas phase deposition, which is the only route to the reliability of conformal protection. Various patents apply; commercial use of the patented technology is licensed.

You can get complete information on parylene by writing for our 16-page brochure: Union Carbide Corp., 270 Park Ave., Dept. RB36, New York, N.Y. 10017. Further investigation will no doubt indicate a trial run, which we can perform at reasonable cost. If you would like to discuss that or any other related matters, please call Bill Loeb at (212) 551-6071.

UNION CARBIDE **PARYLENE**

Circle 138 on reader service card

Subassemblies

Converters have high reliability

12-bit a-d and d-a units are fully documented and operate from −55 to 125°C

Those who are willing to pay for it can now get military reliability in a line of standard converter products. Intended for military, aerospace, and critical industrial and scientific applications, the modular units are

the first standard products of their quality, according to Analog Devices Inc., the manufacturer.

The line consists of four products—a 12-bit analog-to-digital converter, two 12-bit digital-to-analog converters, and a sample-and-hold amplifier, and all of which operate from −55°C to +125°C. Each of the modules is made of components that meet appropriate military standards. Monolithic integrated circuits, for example, are qualified to MIL-M-38510, Class B, processed to MIL-M-38510, Class B, or processed to MIL-STD-883, Class B. The modules themselves are inspected in accordance with MIL-I-45208. The testing procedure includes temperature cycling per MIL-STD-883, Method 1010, Condition B, and a 168-hour burn-in under power at 125°C.

The line of modules is reliable and expensive, but not as expensive, Analog Devices points out, as custom-designed units of similar quality. Moreover, the modules are available in small quantities in a maximum of a few weeks.

Perhaps even more significantly, the high-reliability modules are fully documented. Each is provided with complete specification drawings, averaging 17 pages in length, containing all the information needed to specify and use the modules. In addition to summaries of quality-conformance inspections, environmental testing, and electrical specifications, the drawings include hook-up information and marking requirements, pin designations, a block diagram of circuits, a physical-outline drawing, and calculated mean time between failures.

The model ADC1111 a-d converter has a maximum conversion time of 25 microseconds, has its own clock and reference supplies, and costs $895 each in lots of one to nine. The DAC1112 is a self-contained d-a converter that settles to within ±½ least-significant bit in a maximum of 8 μs after the application of a digital signal that will result in a 10-volt change in the analog output. It is priced at $475.

The DAC1117 is a current-output d-a converter, intended to drive the virtual-ground summing junction of an external op amp. It has a maximum settling time of 7 μs (4 μs typical). Small-quantity price is $555 each. The SHA1114 sample-and-hold amplifier can acquire an input signal to within 0.01% of its true value in a maximum of 500 nanoseconds, or to within 0.1% in 300 ns. It accepts analog input signals from −10 V to +10 V, and costs $425.

Analog Devices Inc., P. O. Box 280, Norwood, Mass. 02062 [381]

Instrumentation amplifier draws less than 100 μW

Intended for applications such as premultiplex signal conditioning, thermocouple-output amplification, medical telemetry, and battery-powered instrumentation in general, the LH0036G is an instrumentation amplifier that can run on as little as 90 microwatts. The hybrid device requires supply voltages anywhere from ±1 volt to ±18 v, with the

New products

90-μW power figure pertaining to the low end of that range. The amplifier's gain can be programed to any value from unity to 1,000 by means of a single resistor. The output bandwidth is also adjustable—from 350 kilohertz (small-signal) to 5 kHz (full-power). The LH0036G is specified for operation between −55° and +125°C. A lower-cost version, the LH0036CG, covers the range from −25 to +85°C. Both parts are encapsulated in hermetic, 12-lead, TO-8 metal cans. In lots of more than 100, price of the LH0036G is $43.90; and of the LH0036CG, $23.55. Delivery is from stock.

National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, Calif. 95051 [383]

10-kHz frequency-to-voltage converter sells for $39.50

Costing approximately two thirds as much as comparable units, the model 4714 frequency-to-voltage converter accepts input frequencies from 1 hertz to 10 kilohertz and produces voltages from 1 millivolt to 10 volts. Maximum nonlinearity of the unit, which costs $39.50 in unit quantities, is 0.08% of full scale,

making it suitable for use in low-cost fm demodulation equipment as well as in wide-range frequency monitors. The input, which is compatible with transistor-transistor and diode-transistor logic, represents less than one TTL load and requires pulse widths of at least 20 microseconds for the converter to achieve

its rated accuracy. Delivery of the converter is from stock.
Teledyne Philbrick, Allied Drive at Rte. 128, Dedham, Mass. 02026 [384]

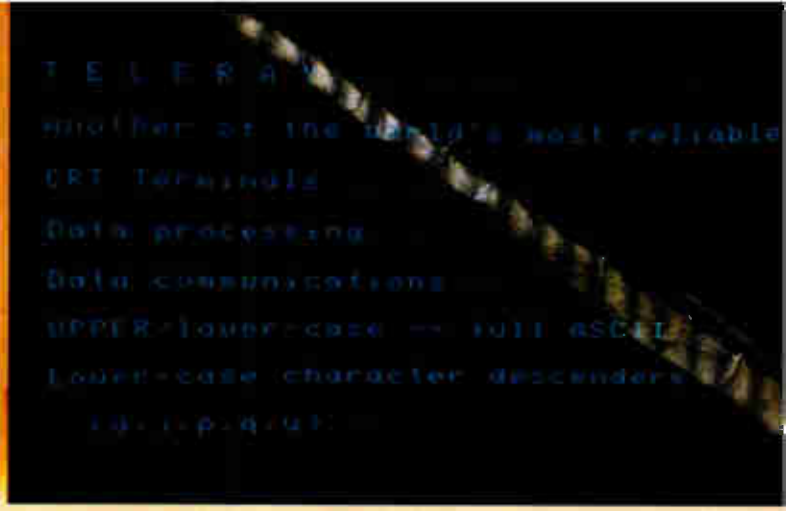
Voltage reference has tempco of 1 ppm/°C

A series of "Certavolt" solid-state voltage references is available with temperature coefficients as low as 1 part per million per degree celsius over the range from 15° to 55°C. Designed for use in systems where a combination of good stability and ruggedness are required—military inertial-guidance systems, for example—the 10-volt units are protected internally against short circuits. Prices, for quantities of from 10 to 49 pieces, vary from $55.20 to $330 depending upon the tightness of the stability specification.

CODI Corp., Pollitt Drive, Fair Lawn, N. J. 07410 [385]

Power supply designed specifically for 4-k RAMs

Designed specifically for use with 4,096-bit semiconductor random-access memories, the RAM-PAC line of power sources each require only a +5-volt input to generate the various voltages needed to operate the RAMs. The RAM-PAC sources provide +12 V at 550 milliamperes and a negative bias voltage of −3, −5, or −9 V at 10 mA. In addition, a clock-boost voltage of +15 V at 25 mA is available as an option. The units are short-circuit-protected and have an efficiency of about 70%. Measuring 2.8 by 2.8 by 0.4 inches, they are meant to be mounted on the same



Our Teleray 3700 rests on its laurels!

We've kept the TELERAY tradition with the 3700. MSI circuitry and top grade components cut down the things that can go wrong and give you another TELERAY Uptime terminal with the quick repair feature of having all logic, character generation, drives and interface on **one plug-in board** with **every chip** a plug-in.

As one TELERAY user puts it, "We can work around a down tube for a while, but our operators aren't low paid clerks. They're high paid programmers, scientists and skilled personnel. Their lost time really hurts." TELERAY is, in fact, rarely down, but is quickly and easily repaired — by our nation-wide service network.

Standard features include:

- UPPER/lower case, 128 character ASCII set — 95 displayable
- 1920 character, 12" CRT display (80 x 24)
- Dual data rates, to 9600 Baud
- Multiple interfaces — RS-232, Current Loop, TTL
- Wide character (40 x 24) format, switchable
- Character-mode, bottom line entry, scroll-up operation
- Bottom-line cursor control and screen clear
- Space-over-data, switchable — for fill-in-the-blanks (CAI)

Optional features include:

Printer Output, TTL parallel, Composite Video, Numeric Keypad, 15" display, 50 Hz, Incremental Horizontal tab, Receive Only, Detachable keyboard . . .

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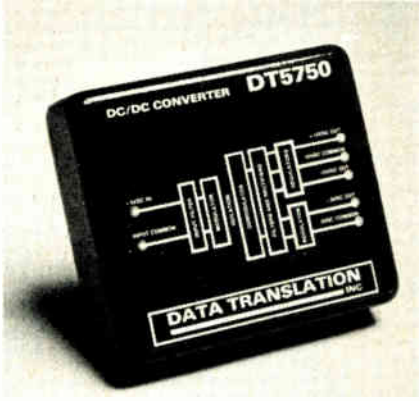
Circle 143 on reader service card

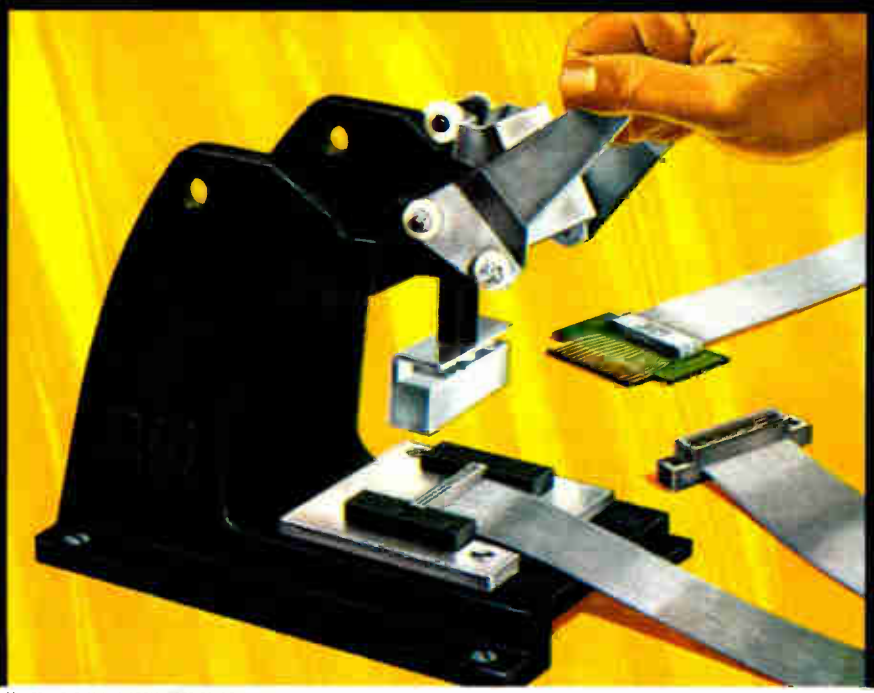
circuit boards as the memories they power. As many as 17 memories can run off a single supply. A typical unit has a single-quantity price of $65 and a delivery time of 45 days.
Reliability Inc., P. O. Box 35733, Houston, Texas 77035 [386]

Dc-dc converter can take 500-V common-mode voltage

A dc-to-dc converter designed for use in data-acquisition systems in which high common-mode voltages are expected, converts a +5-volt input into an isolated +5-v output and an isolated ±15-v output. The model DT5750 is a completely floating module, and can withstand up to 500 v between its input and output ports. Input/output isolation is more than 1,000 megohms in parallel with less than 150 picofarads. The converter can supply up to 165 milliamperes from each side of the 15-v output, and up to 750 mA from the 5-v. Line and load regulation



"Scotchflex" Flat Cable Connector System makes 50 connections at a time.



"SCOTCHFLEX" IS A REGISTERED TRADEMARK OF 3M CO.

Build assembly cost savings into your electronics package with "Scotchflex" flat cable and connectors. These fast, simple systems make simultaneous multiple connections in seconds without stripping or soldering. Equipment investment is minimal; there's no need for special training. The inexpensive assembly press, shown above, crimps connections tightly, operates easily and assures error free wiring.

Reliability is built in, too, with "Scotchflex" interconnects. Inside of connector bodies, unique U-contacts strip through flat cable insulation, grip each conductor for dependable gas-tight connections.

"Scotchflex" offers you design freedom, with a wide choice of cable and connectors. From off-the-shelf stock you can choose: 14 to 50-conductor cables. Connectors to interface with standard DIP sockets, wrap posts on standard grid patterns, printed circuit boards. Headers for de-pluggable connection between cable jumpers and PCB. Custom assemblies are also available on request.

For more information, write Dept. EAH-1, 3M Center, St. Paul, Minn. 55101.

"Scotchflex." Your systems approach to circuitry.

3M COMPANY

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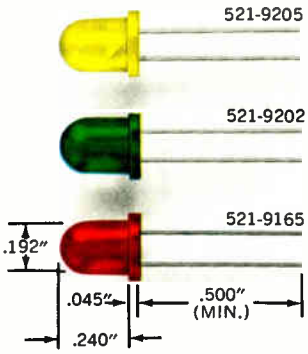
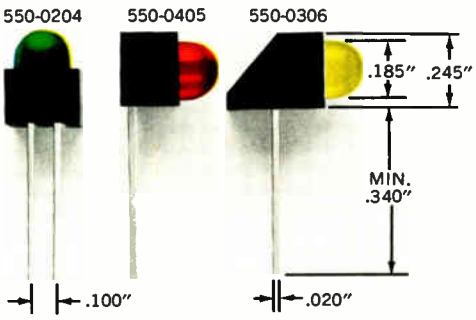
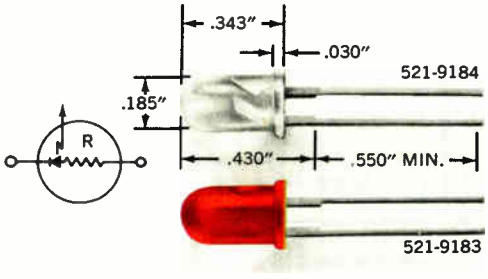
(**Need:** The widest choice for your every application.)



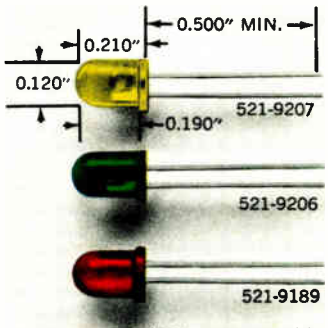
Now available in green, yellow and red. Mini-sized for maximum front panel density and easy panel mounting. High luminous intensity, low cost. Vibration/shock resistant. Solid state for long life. Wide viewing angles. Ideal for applications like panel lighting, film annotation and alpha-numeric displays.



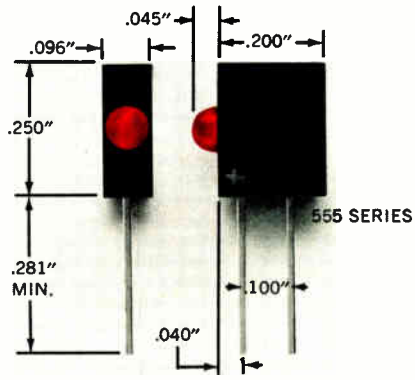
Mix 'em or match 'em. LED logic state fault indicators are available in red, yellow and green, in a variety of shapes, some with a built-in integral resistor. Can be driven from DTL and TTL logic. Designed for easy alignment on PC boards so that multiple functions can be displayed.



Available in red or clear LED packages with or without a built-in current limiting resistor. Red LED is also made without resistor. Suitable for circuit status indication, alpha-numeric displays and visual indicators. Features long wire-wrappable leads. IC compatible with solid state reliability. High luminous intensity, low power consumption, low cost.



Your choice of green, yellow and red, with axial leads for dense packaging requirements. Wide viewing angle for easy readability. Low power consumption, low cost, IC compatible. 10mA operation for typical brightness. Size is identical to the most popular red LEDs.



LED logic state fault indicators available in 14 models with voltage ratings from 1.7 to 14. Suitable for dense packaging on printed circuit boards—up to 10 units to the inch—IC compatible. With built-in series resistor. Polarity identified. Low power consumption.

Dialight, the company with the widest choice in switches, LEDs, indicator lights and readouts, looks for needs . . . your needs . . . and then they develop solutions for your every application. No other company offers you one-stop shopping in all these product areas. And no other company has more experience in the visual display field. Dialight helps you do more with these products than any other company in the business, because we are specialists that have done more with them. Talk to the specialists at Dialight first. You won't have to talk to anyone else.

DIALIGHT

Dialight, A North American Philips Company
203 Harrison Place, Brooklyn, N. Y. 11237
(212) 497-7600

See Dialight.

are to within 1.0% for the 5-v output, and 0.1% for the 15-v supplies. Single-unit price for the converter is $149. Delivery is from stock to two weeks.

Data Translation Inc., 109 Concord St., Framingham, Mass. 01701 [389]

'Universal' power supply delivers 20 watts

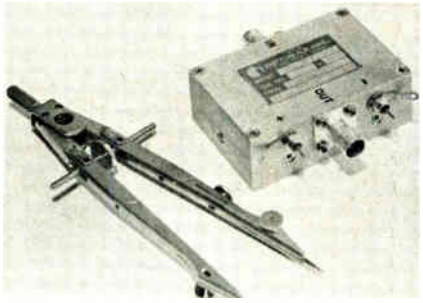
Operating from any dc voltage source in the range of 10 to 32 v, the CellMate model 100 dc-to-dc converter is a triple-output supply with a power rating of 20 w. One of its outputs is at a fixed +5 v dc. The other two are of opposing polarities, and each is independently adjustable over the range from 0 to 15 v.

The unit thus provides most of the commonly required supply voltage combinations in use today. The converter measures 4.5 by 4.0 by 1.625 inches, and weighs 15 ounces. Price is $149 for small quantities; delivery time is 60 days.

CellMate Div., Seven Sciences Inc., 1405 Civic Center Drive, Santa Clara, Calif. 95050 [387]

Amplifier spans 0.5 to 60 MHz

Featuring a gain of 10.7 dB, a frequency range of 0.5 to 60 megahertz, and a maximum noise figure of 7.0 dB, the ADR-4001 rf amplifier is intended for such applications as high-frequency communications systems, over-the-horizon radar systems, and other ground-based and airborne military applications. The



3-inch by 2-inch by 1.02-inch module requires a maximum of 180 milliamperes at 20 v dc for its primary power, and can put out +28 dBm (at the 1-dB compression point). The amplifier comes with a choice of BNC or SMA connectors. Small-quantity delivery time is 30 to 45 days.

Optimax Inc., subsidiary of Alpha Industries Inc., P.O. Box 105, Colmar, Pa. 18915 [390]

12-bit a-d converter has 2.5-μs conversion time

Claimed to be the fastest 12-bit analog-to-digital converter on the market, the Teledyne Philbrick model 4133 has a maximum conversion time of 2.5 microseconds. Intended for use in high-speed data-acquisition systems, pulse-analysis, and fast Fourier transform applications, the converter has a temperature-drift specification of no more than 10 ppm/°C. This is said to ensure linear operation over its operating temperature range of 0° to 70°C. Packaged in a low-profile (0.375-inch) case, the model 4133 sells for $585 in unit quantities, and is available from stock.

Teledyne Philbrick, Allied Drive at Route 128, Dedham, Mass. 02026 [388]

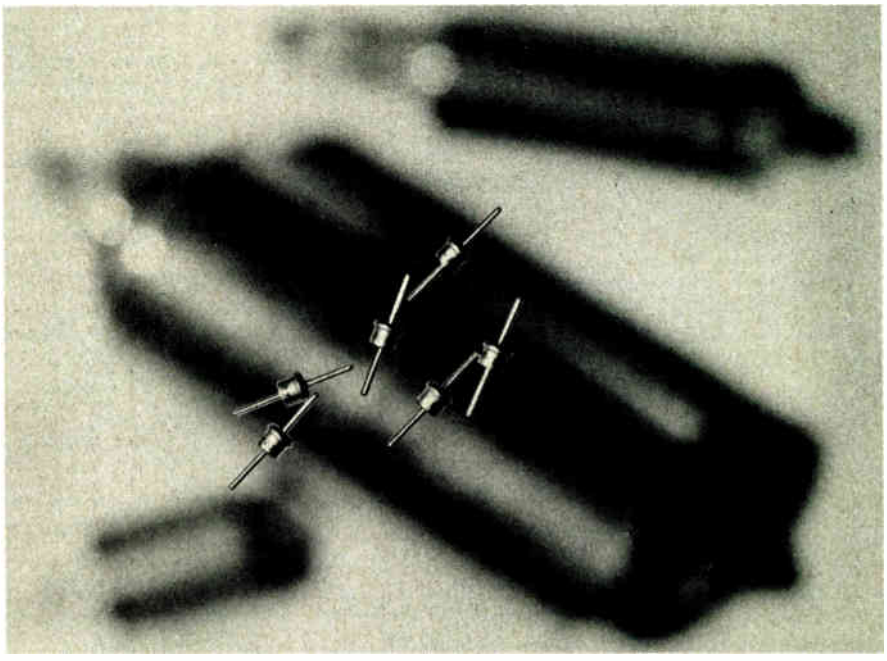
Centralab perspectives

FOR USERS OF ELECTRONIC COMPONENTS

CENTRALAB
Electronics Division
GLOBE-UNION INC.
5757 NORTH GREEN BAY AVENUE
MILWAUKEE, WISCONSIN 53201

When Circuit designs shrink, EMI/RFI problems look bigger

USCC/Centralab's monolithic ceramic filters have evolved in phase with solid state technology and use of ever higher frequencies.



Above is USCC's smallest filter product — the 9900 series feed-thru pictured over larger more costly conventional types.

MSI and LSI technology have been shrinking the world of electronic instrumentation, test equipment, systems and computers — enabling (and dictating) the use of higher, faster frequencies/speeds. With active circuit elements in increasingly intimate relationship, electromagnetic and electric fields are straying into unwanted places; sharp filtering has to be an important design consideration.

U.S. Capacitor Corporation, the worlds leading innovator of monolithic ceramic capacitors and filters, has tracked circuit speed developments with one set of filter parameters in mind: improved attenuation at increasingly higher frequencies, in state of the art sizes and at *affordable prices*. Ceramic Filter evolution has been accelerated at USCC/Centralab. We've made it happen by basic research in dielectric materials and production-engineering of new manufacturing techniques.

Today's products of this evolution are CERAMOLITHIC® subminiature EMI/RFI filters like our 3112 — widely used in portable communications and in microwave applications. Or our 9900 series feed-thru's giving better than 70 db at 10GHz in only a .110" x .156" diameter case size — for use in medical electronics and CATV.

Where does filter evolution lead tomorrow? In these pages, in the next couple of months, USCC is going to introduce a whole new concept in ceramic filters — with reliability and pricing in mind.

Meanwhile, our new 1974 filter catalog may be useful. Write for one or call Don Thommen direct, (213) 843-4222 to discuss your filter applications.

At USCC Centralab, the filter evolution is tracking your design requirements; EMI/RFI problems just won't look very big.

USCC **USCC/Centralab**
Electronics Division • Globe-Union, Inc.
2151 North Lincoln Street • Burbank, California 91504
(213) 843-4222 • TWX: 910-498-2222

Circle 148 on reader service card

Packaging & production

Laser boosts IC accuracy

Interferometer provides 10-microinch resolution in 4-by-4-inch photomask

A pattern generator for integrated circuits, developed by Gyrex Corp., uses a laser interferometer for positioning of the stage and aperture to give a resolution of 10 microinches in 4-by-4 inch photomasks at a speed of 1 in. per second. The model 8000 uses an equal-length interferometer to control the X-Y stage so that it is not subject to error induced by changes in barometric pressure. The aperture can produce rectangles from 0.001 inch to 1.25 inches (0.0001 to 0.125 inch at the image plane) at any programmed angle between 0° and 360° in 0.1° increments. It can also produce circular pads, company logos and special shapes by the use of one of 25 optional reticles. The aperture is chrome-on-glass, eliminating the problems of dust adhesion found in most knife-edge apertures.

The system consists of two assemblies, the optical section and the electronics cabinet. The optical assembly is a light-tight enclosure that can operate in a normally lighted room. The optical unit is a single casting, totally enclosing critical parts of the assembly. This unit, which is mounted on a 26-by-26-by-6-inch granite block, is maintained at a positive air pressure to exclude dust. The mask stage can handle masks from 2-by-2 in. to 4-by-5 in. with 4-by-4 in. travel. The aperture is a variable slit assembly, and the light source is a xenon pulsed flash lamp with regulated, adjustable power supply. The lamp can operate at up to 100 flashes per second. The optical system is capable of resolving 650 line pairs per millimeter.

The electronics cabinet contains the control and drive circuitry, including a Cincinnati Milacron minicomputer with 16,384 words of memory, a cathode-ray-tube display, keyboard, IBM-format magentic tape and high-speed paper tape, plus controllers for the motor drives and Gyrex input/output controllers. It measures 72 inches high by 23 by 30 in.

A major feature of the system, says marketing manager Michael C. Ditmore, is its software. The software gives the system the flexibility to operate, not only with the Gyresym language, but also with software designed for David W. Mann, Electro Mask, and Gerber pattern generators. The operator develops the program through the integral keyboard and display, which also is used for diagnostics. X-Y interchange, mirroring, scaling, offsetting, etc., are also possible in software. During operation, all functions of the machine can be displayed on the cathode-ray-tube screen. Plotting data is entered from either magnetic or paper tape.

Stage resolution is ±10 microinches with a minimum programmable step of the same size. Positioning inaccuracy does not exceed ±30 microinches, and repeatability is within ±5 microinches over the axis. Maximum speed is 1 inch per second using dc servo control motors. The minimum optical sizing assembly step is 50 microinches at the image plane in both axes. Slit repeatability is within ±10 microinches.

The Gyrex 8000 is priced at $130,000 with deliveries currently

scheduled to commence in March.
Gyrex Corp., 400 East Gutierrez St., Santa Barbara, Calif. 93101 [391]

Bare-board tester is self-programing

A high-speed tester for bare, unstuffed circuit boards programs itself when a known good board is put into its test fixture. After programing, the system can check new boards at a test rate of 100,000 nodes per second. Claimed to be able to interface with any printer and any test fixture, the tester can be built to handle up to 65,000 nodes. Built entirely with C-MOS, except for its LED displays, the system draws a minimum of power from its rechargeable batteries. The price of the system is $6,000 plus $5 per node; tester capacity is sold in 64-node increments. The price includes interfacing to the printer and test fixture with a 10-year warranty.
Algorithm Technology Inc., P. O. Box 1910, Prescott, Ariz. 86301 [393]

Matched coaxial contacts made for circular connectors

A line of matched-impedance coaxial contacts makes coaxial-cable interconnections possible in all miniature circular connectors qualified to MIL-C-26500. They have a nominal impedance of 50 ohms and a standard insulation resistance of 1,000 megohms. The #12 size contacts, designated Amphenol Multi-Coax, can be used with RG-174, -178, -188, and -316/U cables and can operate through 4 GHz with a

Our byte-size brain food for 'little' thinkers:

TRW/Cinch microminiature Dura-Con* connectors

No matter how large your byte, you still have to think "little" to reduce space and weight. That's why TRW/Cinch microminiature Dura-Con connectors offer so much food for thought.

The trim microminiature rectangular series of Dura-Con connectors is available in 9, 15, 21, 37, and 51 positions. Or consider the possibilities in stacking .075" thick Dura-Con strips. Only 33 grams of strips with .050" centers supplies 247 contact positions in a single square inch. Both types are available from TRW/Cinch distributors.

Besides high contact density, the unique Dura-Con design provides highly reliable connections. Each pin contact, formed from precision miniature spring cable of gold-plated 24 gauge copper alloy, provides seven points of peripheral contact with the mating socket wall. Thus continuous mating is assured, no matter what radial forces are applied, from dry circuit to 3 amps.

Also available are TRW/Cinch Dura-Con connectors with #30 AWG contacts on .025" centers in custom configurations. That's up to 1521 contacts in a square inch for those who think much about "little."

For additional information, dial toll-free (800) 645-9201 for the name of your nearest TRW/Cinch sales office. Or write for technical bulletin CD-205 to TRW/Cinch Connectors, an Electronic Components Division of TRW Inc., 1501 Morse Avenue, Elk Grove Village, Illinois 60007; phone (312) 439-8800.

*Trade Name TRW Inc. CC-7502

TRW CINCH CONNECTORS

Circle 151 on reader service card

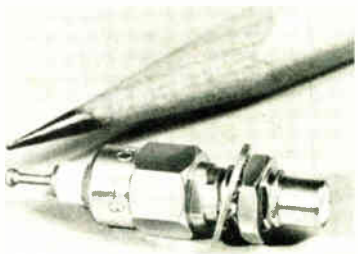
New products

VSWR of less than 1.40 for a mated pair. The contacts can be attached to cables with standard crimping tools, and the completed assemblies have the same insertion and withdrawal features as standard power contacts.

Amphenol RF Division, Bunker Ramo Corp., 33 East Franklin St., Danbury, Conn. 06810 [394]

Rf connector includes built-in low-pass filter

Designed specifically for applications in which spurious radiation must be minimized, the latest Conhex rf connectors are available with built-in low-pass filters. Representative of the new units is the #60-043-2039, a screw or jack receptacle for bulkhead mounting. It has a minimum attenuation of 45 decibels from 0.2 to 2.0 gigahertz. Other mating engagements or attenuation characteristics are also available.

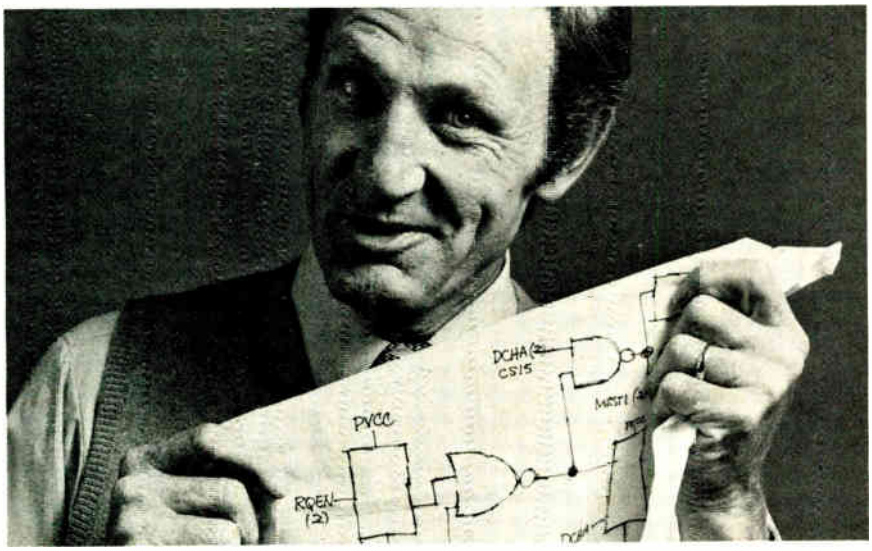


Sealectro Corp., Rf Components Division, 225 Hoyt St., Mamaroneck, N. Y. 10543 [396]

DIPs accept hybrid circuits, have standard row spacings

A line of ceramic dual in-line packages with row spacings of 0.3, 0.4, and 0.6 inch can house thick-film or thin-film substrates or a number of monolithic chips. They consist of large-cavity multilayer ceramic bodies with externally brazed-on leads. Delivery of 14, 16, 18, 22, and 24-lead configurations is immediate, and for several of them there's a

Calma presents Norman's latest napkin masterpiece.

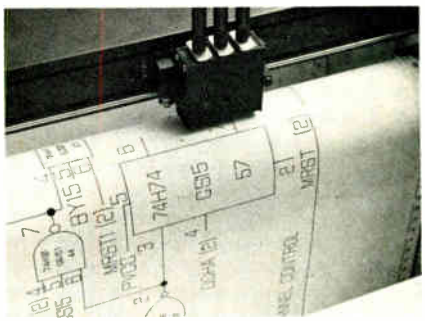


A report on circuit art production. Norman is a conceptual genius. A little sloppy perhaps, but a genius nonetheless. His greatest idea was conceived halfway through an anchovie and pepperoni pizza at Bruno's last Wednesday. After lunch, a young lady earning $8400 per year turned Norman's napkin into flawless circuit art in just 54 minutes. She did it on a Calma interactive graphics system. She did it one hundred times faster than a speeding draftsman, about twice as fast as she could on any other system. The Calma system checked her accuracy, drew all the lines and symbols automatically, relieved her of the drudge work.

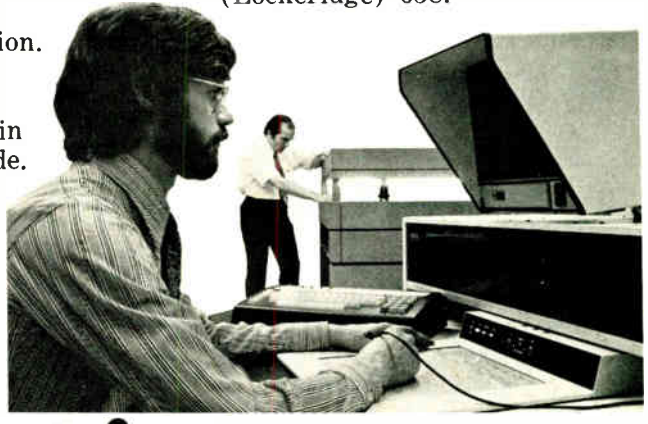
Changes made lightning fast. While eating pretzels two days later, Norman had a brainstorm. A way to get even hotter performance out of the same circuit concept. Presto. In microseconds, the original design was retrieved from storage and displayed on the CRT at Norman's own interactive work station. In about three minutes Norman himself modified the original. Electronically. Just that fast the company benefited from his fertile mind with a totally new and competitive circuit. Incidentally, up to six work stations can be included in one system with no degradation of performance.

The fast generation. Where Calma really makes tracks is the transition from art to production. Each Calma system drives up to three high speed plotters in the background mode. All operate at full rated speeds, never interfering with design or drafting at the system's six work stations. The secret of Calma's non-stop productivity is that no function ever interferes with another.

Reliable sophistication! For all its sophistication a Calma system is incredibly reliable. More than 100 have been installed and almost all were up and operating the day they were delivered. Learn how this powerful computer-based graphics system can speed your circuits from conception to production. For literature or to arrange a demonstration, phone or write Calma Company,

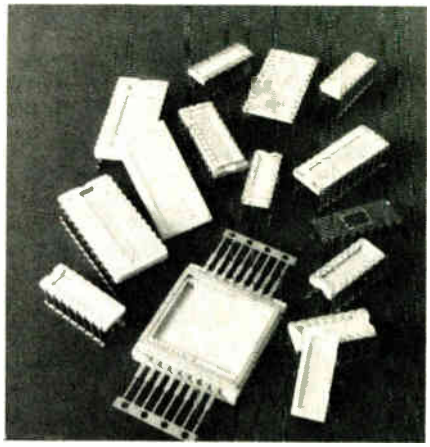


Corporate Marketing Headquarters, 1930 Isaac Newton Square East, Reston, Virginia 20090. Phone (703) 471-1450. European Marketing Headquarters, P.O. Box 6, Marlborough, Wiltshire, SN8 4EW, England. Phone 067286 (Lockeridge) 658.



Calma Interactive Graphics Systems.

New products

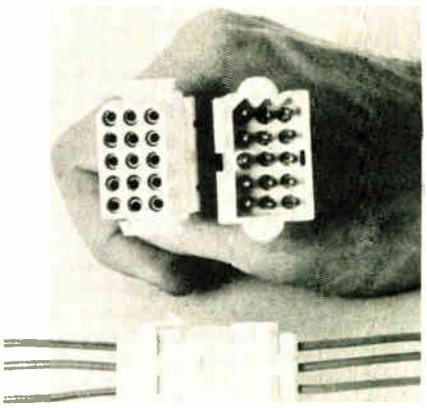


choice of cavity size. Applications are expected to include resistor networks, solid-state relays, voltage regulators, a-d and d-a converters, and op amps. For uses requiring hermetic sealing, each package can be supplied with metal rings as an option. Delivery of the packages is from stock.

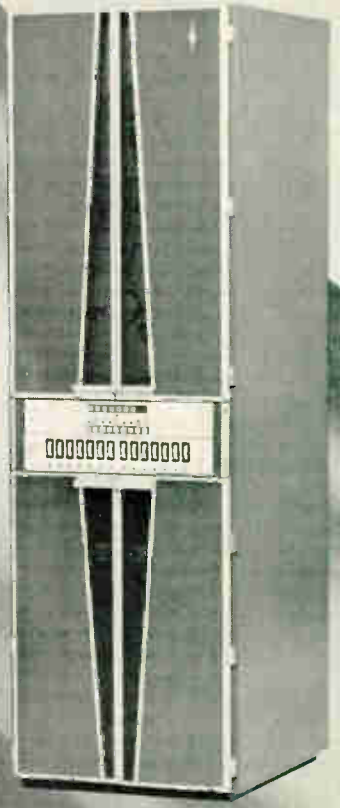
MetCeram, Huntington Industrial Park, Providence, R. I. 02907 [395]

Low-cost plug and receptacle can have up to 15 contacts

Manufactured with 1-, 3-, 9-, 12-, and 15-contact layouts, the Econ-A-Mate plug and receptacle connector costs little enough for use in home-appliance, vending-machine, automotive, and other price-sensitive applications. For example, the 15-contact plug with locking slots and its matching 15-contact receptacle



One for All and Four for One



Because magnetic tape recording needs differ, Bell & Howell has four precision laboratory-grade instruments to handle data acquisition and reduction requirements. • From the laboratory to remote locations, from airborne applications to submarine data collection, these Bell & Howell recorders meet the most stringent environmental and military standards. • Bell & Howell's M-14 Series meets Navy standards for use in ELINT (electromagnetic intelligence) activities. Compact, lightweight and reliable, these 14 or 28 track recorders are at home in the instrumentation laboratory or in nuclear submarines. • The CPR-4010, a 14-channel recorder/reproducer, has many of its big brothers' features. Expandable to 28 tracks, it is completely self-contained, portable and is one of the most cost-effective tape recorders available. • For performance and dependability, few recorders match the VR-3700B. Its performance specifications and characteristics are unmatched by any competing recorder. It can also record up to 80 million BPS over 28 tracks. • STARR, the State-of-the-Art Recorder/Reproducer, was designed to handle virtually every difficult data reduction task. Wide dynamic range, data integrity, spectral purity and ease of operation are major design considerations of STARR. • These, like all Bell & Howell recorders, are backed by nearly 30 years in the design and development of quality instrumentation. • For more information on how we can help you handle your recording requirements, contact William Zondler at (213) 796-9381 or circle the information retrieval number. • We have four good solutions to your magnetic tape recording problems.

CEC/INSTRUMENTS DIVISION

360 Sierra Madre Villa, Pasadena, California 91109

BELL & HOWELL

M-14 and STARR are trademarks of Bell & Howell Company

Circle 155 on reader service card

New products

at 6.2 cents in quantities of 5,000. The Underwriters-Laboratories-approved connectors use flame-retardant polypropylene as a dielectric material; competitive units, the company claims, use nylon, which absorbs moisture and tends to crack and warp when it drys. The Econ-A-Mate employs 0.093-inch-diameter crimp-removable contacts, furnished in chain form for automatic or seminautomatic assembly. Various versions of the connector can handle from 7.5 to 12 amperes per contact at 250 volts.

Malco, a Microdot Co., 5150 W. Roosevelt Rd., Chicago, Ill. 60650 [399]

Molded nylon cover insulates TO-3 devices

A molded nylon cover for devices packaged in TO-3 cans is offered in black and white versions. It is intended to prevent accidental shocks from exposed TO-3 cans. A 0.047-inch test-probe hole in the center allows electrical measurements to be made without removing the cover. Price of the 8903N covers, in quantities of 1,000, is 12 cents each. Delivery is from stock.

Thermalloy Inc., P. O. Box 34829, Dallas, Texas 75234 [397]

Wafer prober has microprocessor control

A three-product family of wafer-probing systems is noteworthy for its use of both a 16-bit microprocessor for control-logic functions and a laser sensing and alignment system. Designated the "Autoprobe" series, the new systems have an indexing speed of 5 inches per second, a resolution of 0.4 micrometer, and repeatibility of ±0.0001 inch. Because a microprocessor is used, all of the system's control logic fits on just two printed-circuit boards.

Computervision Corp., Cobilt Division, 1135 East Arques Ave., Sunnyvale, Calif. 94086 [398]

Right Choice

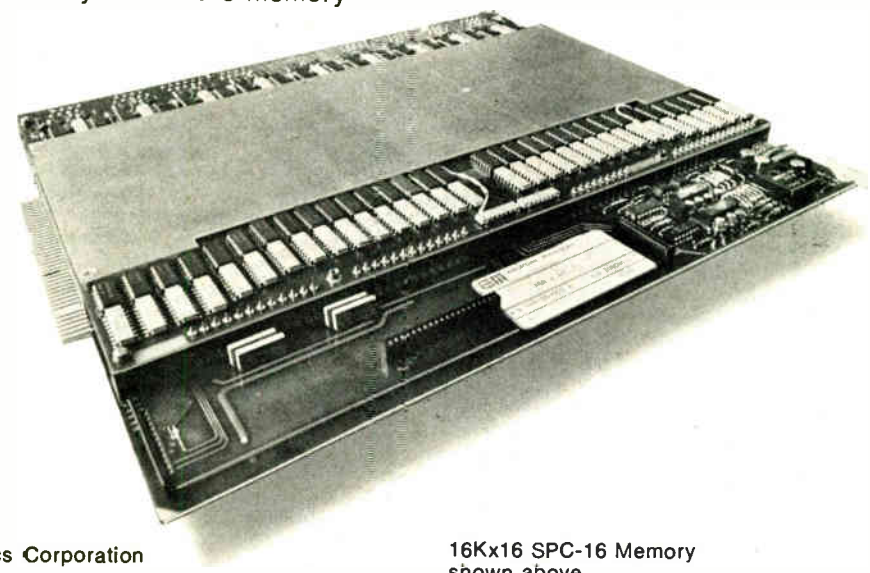
for GAI SPC-16 or Interdata 7/16 & 7/32 memory

When you want to buy a minicomputer, you go to a minicomputer company. That makes sense. When you want to buy memory, go to the memory company. That saves dollars.

Naturally, if you're designing a minicomputer-based system, nothing is more important than choosing the right minicomputer. If you choose the Interdata 7/16 or 7/32, or the GAI SPC-16, chances are you've made the right choice. They're versatile, dependable minis that you can bank on.

But the next most important thing is the memory for your mini. You can buy it from the minicomputer company and spend a lot of money. Or you can buy it from the memory company and save a lot of money. The choice is yours.

This message has been brought to you by EMM. *The memory company.*



16Kx16 SPC-16 Memory shown above

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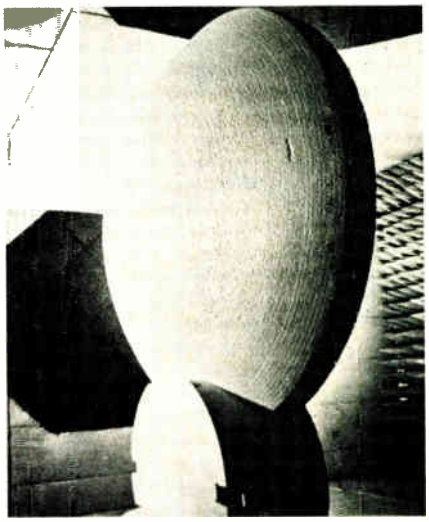
REPRESENTATIVES: Gentry Associates; Orlando (305) 894-4401, Huntsville (205) 534-9771, Burlington, N.C. (919) 227-3639. In Canada: Megatronix, Ltd.; Toronto (416) 742-8015, Montreal (514) 488-0404, Ottawa (613) 729-4004, Burnaby (604) 526-3312.

New products/materials

Polystyrene-based foams Eccofoam PS-A and Eccofoam PS are intended for the fabrication of light-



weight microwave lenses. With densities of about 3 pounds per cubic foot and dielectric constants in the range of 1 to 2, Eccofoam PS is available in sheets costing from $35 to $99, while Eccofoam PS-A comes in 17-inch cubes that sell for $600 each.

Emerson & Cuming Inc., Canton, Mass. 02021 [476]

Copper brazing pastes Cu-Braze (for brazing in a reducing atmosphere) and Cu-Vac (for vacuum brazing) are suitable for large-volume brazing applications where low cost is important. Consisting of powdered copper and a neutral binder, which keeps the mixture in a stable paste form, Cu-Braze and Cu-Vac are custom formulated to fit specific customer requirements.

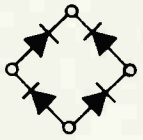
Fusion Inc., Willoughby, Ohio [477]

Rodent damage caused by squirrels and other animals that run along telephone, power, and CATV cables can be avoided by the application of a ribbon of Trak Tac squirrel repellent. This chemical, which is claimed to be non-toxic and odorless, is supposed to be noxious to rodents, and therefore to deter them from climbing on cables and strands to which it has been applied.

Communications Technology Corp., 2237 Colby Ave., Los Angeles, Calif. 90064 [478]

EBR

EPOXY BRIDGE RECTIFIERS



New Epoxy BRIDGE Rectifiers 15 Amp and 30 Amp.

VL series has 15A (I_O)
and 100A, ½ cycle surge (I_{FSM}) at 80°C (T_C)
VK series has 30A (I_O)
and 300A, ½ cycle surge (I_{FSM})at 80°C (T_C)

Both series feature controlled avalanche types with 250V, 450V, 650V and 850V min. avalanche voltages (V_{BR}) with 200V, 400V, 600V and 800V (V_{RRM}).

Non-controlled avalanche types have 50V, 100V, 200V, 400V, 600V, 800V and 1kV (V_{RRM}).

The same small size epoxy package is used for both series and is available in two configurations: standard .25" (6,35mm) spade terminals bent 90° to mounting plane or parallel to mounting plane.

The package features a bonded metal-to-ceramic substrate with the ceramic providing circuit-to-case electrical isolation. The exposed copper mounting pad results in an extremely low thermal resistance from junction-to-heat sink.

Economical pricing and small size make these bridges ideal for many industrial and commercial applications.

Typical low pricing:
VL048 (15A, 50V) **$1.69** ea., 1000 qnty.
VK048 (30A, 50V) **$1.94** ea., 1000 qnty.

Design us in . . . we'll stay there

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VARO SEMICONDUCTOR, INC.

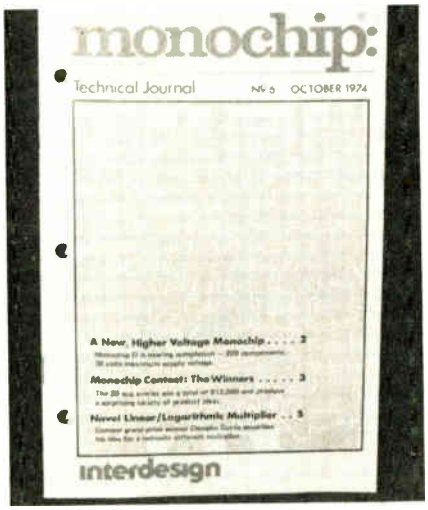
P.O. BOX 676, 1000 N. SHILOH, GARLAND, TEX. 75040 (214) 272-4551 TWX 910-860-5178

For immediate delivery contact your nearest distributor:

ALLIED ELECTRONICS, Chicago, Ill. 312/697-8200; Ft. Worth, Tex. 817/336-5401; Garden Grove, Cal. 714/894-7581. **THE ALTAIR CO.,** Houston, Tex. 713/462-3029; Richardson, Tex. 214/231-5166. **BELL INDUSTRIES,** Sunnyvale, Cal. 408/734-8570; Skokie, Ill. 312/965-7500; Bellevue, Wash. 206/747-1515. **CRAMER ELECTRONICS,** Nationwide, Newton, Mass. 617/969-7700; **MILGRAY ELECTRONICS,** Freeport, N. Y. 516/546-6000; Hyattsville, Md. 301/864-1111; Cherry Hill, N. J. 609/424-1300; Cleveland, Ohio 216/881-8800; Orlando, Fla. 305/647-5747. **WESTATES ELECTRONICS,** Chatsworth, Calif. 213/341-4411.

In Canada:
ELECTRO SONIC, Toronto, Ont. 416/924-9301. **R.A.E. ELECTRONICS,** Vancouver, B. C. 604/687-2621.

New literature



Analog multiplier. The latest issue (No. 6) of Interdesign's "Monochip Technical Journal" features a detailed description of a novel analog multiplier. The journal is available without charge from Interdesign Inc., 1255 Reamwood Ave., Sunnyvale, Calif. 94086. Circle 421 on reader service card.

Resistor networks. A six-page guide to custom thin-film resistor networks is offered by Analog Devices Inc., P. O. Box 280, Norwood, Mass.

02062. The bulletin includes a circuit-evaluation and design checklist and discusses applications of thin-film networks. [422]

Industrial switches. The latest Rundel-IDEC catalog is a 36-page booklet that describes the company's line of push-button operators, pilot lights, illuminated push buttons, selector switches, maintained-contact operators, and special devices. The

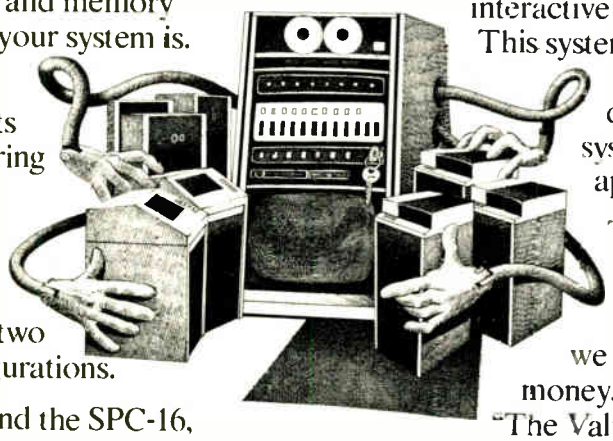
IF WE CAN'T MAKE YOUR MINICOMPUTER SYSTEM DO MORE WORK FOR LESS MONEY, NOBODY CAN.

When we introduced the SPC-16, we promised it would be the world's most powerful, versatile, cost-effective family of minicomputers.

It was. It still is.

The SPC-16 isn't the lowest priced hardware you can buy. But it will give you the lowest cost solution.

Through advanced systems architecture, simplified interfacing and a powerful instruction repertoire, the SPC-16 allows you to minimize programming, interfacing and memory costs no matter what size your system is.



Six mighty minis.

The SPC-16 family consists of six minicomputers offering a choice of three memory cycle times (800ns, 960ns and 1440ns), memory expansion to 128K using efficient 16K boards, and two different packaging configurations.

If you build a system around the SPC-16, it will do more work for less money than any other system you could build.

And that translates into more profits.

We know it for a fact. In the past few years, we helped a lot of OEMs get the edge on their competition by designing our product into their products. We helped a lot of end users solve a lot of tough, tight-budget applications. And, we produced some cost-effective systems of our own.

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catalog can be obtained from Rundel-IDEC, 950 Charter St., Redwood City, Calif. 94063 [423]

Wash-away spacers. Applications of the company's line of Diss-o-pad wash-away spacers are outlined in a packaging guide published by Bivar Inc., 1617 E. Edinger Ave., Santa Ana, Calif. 92705. The spacers are mainly intended for use in the manufacture of printed-circuit boards, where they are washed away by warm water after the soldering operation. [424]

Optical components. The company's line of opto-electronic components, including various emitters, detectors, and isolators, is described in a catalog available from ASEA-HAFO AB, Fack, S-162 10 Vällingby, Sweden. [425]

Sample-and-hold module. A data sheet gives details on a new sample-and-hold module produced by Analogic. Included are applications data and a block diagram of the module. The data sheet for the model MP240 is available from Analogic, Audubon Rd., Wakefield, Mass. 01880 [426]

Microwave sources. "Equal-Step Miniature Synthesizer Signal Sources" is the title of a bulletin describing two lines of signal sources that cover the range from 0.5 to 18 GHz. One series is tuned remotely, the other is adjusted mechanically and is recommended for applications where frequencies are seldom changed. The bulletin is offered by Communication Techniques Inc., 1279 Route 46, Parsippany, N. J. 07054 [427]

Logic controllers. Allen-Bradley's Cardlok series of solid-state logic controllers is explained in the company's bulletin No. 1720. The eight-page brochure describes the operation of the more than 80 different cards in the series and tells how they make the system compatible with most existing industrial installations. Allen-Bradley, 1201 S. Second St., Milwaukee, Wis. 53204 [428]

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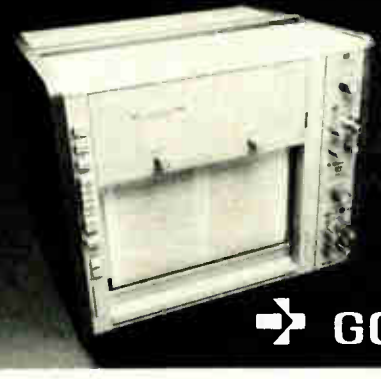

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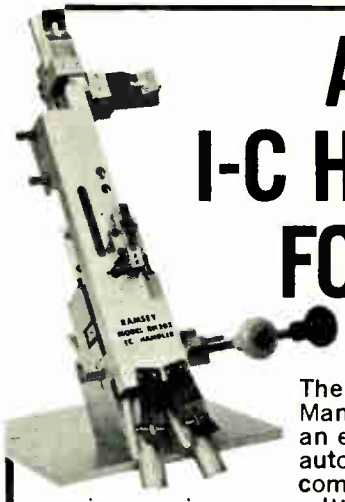

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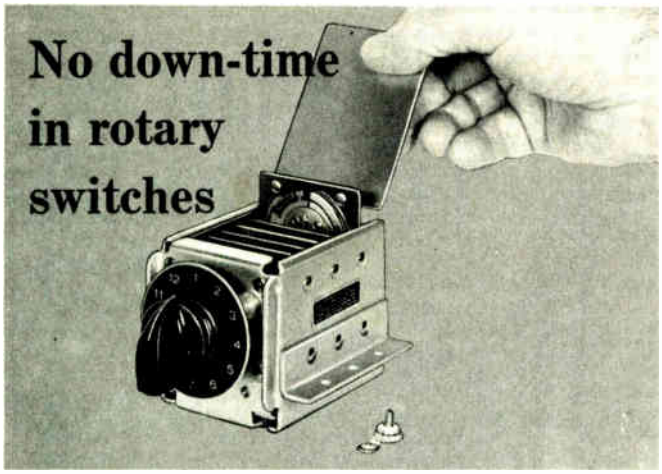

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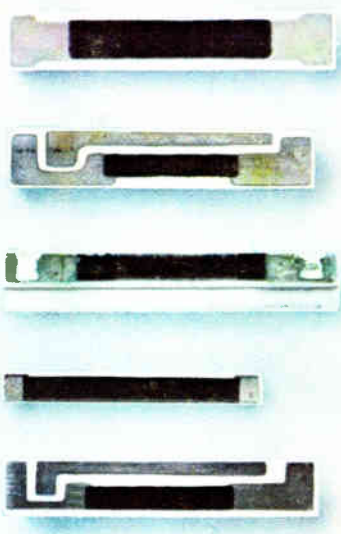

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